No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
1	物化	Sundström, Maria; Bogdanska, Jasna; Pham, Hung V; Athanasios, Vlastaras; Nobel, Stefan; McAlees, Alan; Eriksson, Johan; DePierre, Joseph W; Bergman, Åke	Radiosynthesis of perfluorooctanesulfonate (P	2012	Chemosphere. 2012 May;87(8):865-71. doi: 10.1016/j.chemosphere.2012.01.027. Epub 2012 Feb 14.	Here, we describe for the first time the synthesis of [(35)S] PFOS and [(35)S] PFBS with sulfur-35 enriched sulfur dioxide as the radiolabelled reagent, resulting in 2.5 and 2.3 mCi of product, respectively. Basic information concerning the physicochemical properties of perfluorooctanesulfonate (PFOS), perfluorobutanesulfonate (PFBS) and perfluorooctanoic acid (PFOA) are still limited. Hence, we utilized these radiolabelled perfluoroalkanesulfonates (PFSAs), as well as carbon-14 labelled perfluorooctanoic acid ([(14)C] PFOA) to determine some basic characteristics of physiological and experimental significance. The solubility of PFOS in buffered aqueous solutions at pH 7.4 was found to be severely reduced in the presence of potassium and sodium ions, which, however, did not reduce the solubility of PFOA or PFBS. PFOS was found to adhere to a small extent to polypropylene and polystyrene, whereas no such adhesion of PFOA or PFBS was detected. The extents of adhesion of PFOS and PFOA to glass were found to be 20% and 10%, respectively. For the first time, the partition coefficients for PFOS, PFBS and PFOA between n-octanol and water were determined experimentally, to be -0.7, -0.3, and 1.4, respectively, reflecting the difference in the amphiphilic natures of these molecules.	1			1		1		1														D	-	イオン強度を考えれば溶解度はすぐに議論できるはずなのに，一切そうしたことに触れられていない．	
2	物化	Rayne, S.; Forest, K.	Theoretical studies on the pKa values of perflu	2010	J Mol Struct Theochem. 949: 60-69. doi: 10.1016/j.theochem.2010.03.003	Computational studies were conducted using the major levels of semiempirical, ab initio, density functional theory (DFT), and the CBS-Q//B3 method and various solvation models on a homologous series of straight chain perfluoroalkyl carboxylic acids (PFCAs) ranging in chain length from C-1(trifluoroacetic acid) to C-9(n-perfluorodecanoic acid) as well as the monomethyl branched C-7(n-perfluorooctanoic acid; n-PFOA) isomers. Regardless of perfluoroalkyl chain length and theoretical method employed, application of a computational thermodynamic cycle indicated no significant change in the estimated aqueous monomeric pK(a) values between C-1 and C-9, all having a relatively constant pK(a) of about 0 that is in agreement with earlier predictions and recent experimental evidence. Perfluoroalkyl chain helicity does not appear to result in increased monomeric PFCA pK(a) values at chain lengths greater than 5 Increasing chain length does not substantially influence the structural or electronic character of the carboxylic acid head group. A MMFF94 conformational search yielded 2915 separate low- through high-energy conformers of n-PFOA. Ranking of these structures gave the 94 lowest MMFF94 energy conformations that were subjected to DFT investigations. Application of a thermodynamic cycle approach, coupled with aqueous and gas phase DFT calculations on the molecular and anionic forms for each of the conformers, gave conformationallyaveraged pK(a), values for n-PFOA equal to the global minimum helical conformer pK(a). The conformational populations under study occupy similar to 1 of the global n-PFOA conformational space, indicating no higher energy/low acidity conformations remain unexamined that could influence the predicted composite aqueous monomeric pK(a) of zero for this compound.		1					1														D	-	貴重な計算結果ではあるが，やる前から結果はわかりきっている．	
3	物化	Campbell, Tammy Y; Vecitis, Chad D; Mader, Brian T; Hoffmann, Michael R	Perfluorinated surfactant chain-length effects	2009	J Phys Chem A. 2009 Sep 10;113(36):9834-42. doi: 10.1021/jp903003w.	The sonochemical degradation kinetics of the aqueous perfluorochemicals (PFCs) perfluorobutanoate (PFBA), perfluorobutanesulfonate (PFBS), perfluorohexanoate (PFHA), and perfluorohexanesulfonate (PFHS) have been investigated. Surface tension measurements were used to evaluate chain-length effects on equilibrium air-water interface partitioning. The PFC air-water interface partitioning coefficients, KeqPF, and maximum surface concentrations, Gamma(max)PF, were determined from the surface pressure equation of state for PFBA, PFBS, PFHA, and PFHS. Relative KeqPF values were dependent upon chain length KeqPFHS approximately equal to 2.1KeqPFHA approximately equal to 3.9KeqPFBS approximately equal to 5.0KeqPFBA, whereas relative GammamaxPF values had minimal chain length dependence Gamma(max)PFHS approximately equal to Gamma(max)PFHA approximately equal to Gamma(max)PFBS approximately equal to 2.2Gamma(max)PFBA. The rates of sonolytic degradation were determined over a range of frequencies from 202 to 1060 kHz at dilute (<1 microM) initial PFC concentrations and are compared to previously reported results for their C8 analogs: perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA). Under all conditions, the time-dependent PFC sonolytic degradation was observed to follow pseudo-first-order kinetics, i.e., below kinetic saturation, suggesting bubble-water interface populations were significantly below the adsorption maximum. The PFHX (where X = A or S) sonolysis rate constant was observed to peak at an ultrasonic frequency of 358 kHz, similar to that for PFOX. In contrast, the PFBX degradation rate constants had anapparent maximum at 610 kHz. Degradation rates observed for PFHX are similar to previously determined PFOX rates, kapp,358PFOX approximately equal to kapp,358PFHX. PFOX is sonolytically pyrolyzed at the transiently cavitating bubble-water interface, suggesting that rates should be proportional to equilibrium interfacial partitioning. However, relative equilibrium air-water interfacial partitioning predicts that KeqPFOX 5KeqPFHX. This suggests that at dilute PFC concentrations, adsorption to the bubble-water interface is ultrasonically enhanced due to high-velocity radial bubble oscillations. PFC sonochemical kinetics are slower for PFBS and further diminished for PFBA as compared to longer analogs, suggesting that PFBX surface films are of lower stability due to their greater water solubility.	1	1		1					1												B	-	超音波による化学的な劣化を界面科学と組み合わせて議論している．	
4	物化	Wang, Z., MacLeod, M., Cousins, I. T., Scheringer, M. & Hungerbühler, K.	Using COSMOtherm to predict physicochemica	2011	Environmental Chemistry., 8(4), 389-398. doi:10.1071/EN10143	Recently, there has been concern about the presence of poly- and perfluorinated alkyl substances (PFASs) in the environment, biota and humans. However, lack of physicochemical data has limited the application of environmental fate models to understand the environmental distribution and ultimate fate of PFASs. We employ the COSMOtherm model to estimate physicochemical properties for 130 individual PFASs, namely perfluoroalkyl acids (including branched isomers for C(4)-C(8) perfluorocarboxylic acids), their precursors and some important intermediates. The estimated physicochemical properties are interpreted using structure-property relationships and rationalised with insight into molecular interactions. Within a homologous series of linear PFASs with the same functional group, both air-water and octanol-water partition coefficient increase with increasing perfluorinated chain length, likely due to increasing molecular volume. For PFASs with the same perfluorinated chain length but different functional groups, the ability of the functional group to form hydrogen bonds strongly influences the chemicals' partitioning behaviour. The partitioning behaviour of all theoretically possible branched isomers can vary considerably; however, the predominant isopropyl and monomethyl branched isomers in technical mixtures have similar properties as their linear counterparts (differences below 0.5 log units). Our property estimates provide a basis for further environmental modelling, but with some caveats and limitations.									1	1			1								1	A	-	COSMOtherm modelという分子起動計算の手法で，物理化学的特性（蒸気圧、水溶性など）の推定値を求める手法を提案している．	
5	物化	Kaiser M.A., Larsen B.S., Kao C.-P.C., and Buck R.C.	Vapor Pressures of Perfluorooctanoic, -nonanc	2005	Journal of Chemical & Engineering Data 2005, 50(6), 1841-1843. doi: 10.1021/je050070r	A dynamic method was used to determine the vapor pressures of perfluorooctanoic, -nonanoic, -decanoic, -undecanoic, and -dodecanoic acids. Measurements were made over the temperature range from (59.25 to 190.80) ° C for perfluorooctanoic acid, from (99.63 to 203.12) ° C for perfluorononanoic acid, from (129.56 to 218.88) ° C for perfluorodecanoic acid, from (112.04 to 237.65) ° C for perfluoroundecanoic acid, and from (127.58 to 247.36) ° C for perfluorododecanoic acid. Pressures ranged from (0.128 to 96.50) kPa for perfluorooctanoic acid, from (1.12 to 99.97) kPa for perfluorononanoic acid, from (3.129 to 99. 97) kPa for perfluorodecanoic acid, from (0.616 to 99.97) kPa for perfluoroundecanoic acid, and from (0.856 to 99.96) kPa for perfluorododecanoic acid. A sealed vial experiment demonstrated that perfluorooctanoic acid sublimes at room temperature.									1												B	-	蒸気圧のデータ集	
6	物化	Kaiser MA, Larsen BS, Kao CPC, et al.	Vapor pressures of perfluoro-octanoic, -nonan	2005	J Chem Eng Data 50(6):1841-1843. doi:10.1021/je050070r	A dynamic method was used to determine the vapor pressures of perfluorooctanoic, -nonanoic, -decanoic, -undecanoic, and -dodecanoic acids. Measurements were made over the temperature range from (59.25 to 190.80) ° C for perfluorooctanoic acid, from (99.63 to 203.12) ° C for perfluorononanoic acid, from (129.56 to 218.88) ° C for perfluorodecanoic acid, from (112.04 to 237.65) ° C for perfluoroundecanoic acid, and from (127.58 to 247.36) ° C for perfluorododecanoic acid. Pressures ranged from (0.128 to 96.50) kPa for perfluorooctanoic acid, from (1.12 to 99.97) kPa for perfluorononanoic acid, from (3.129 to 99. 97) kPa for perfluorodecanoic acid, from (0.616 to 99.97) kPa for perfluoroundecanoic acid, and from (0.856 to 99.96) kPa for perfluorododecanoic acid. A sealed vial experiment demonstrated that perfluorooctanoic acid sublimes at room temperature.				1									1				No. 5と重複		B	-	蒸気圧のデータ集	
7	物化	Bhhatarai, Barun; Gramatica, Paola	Prediction of aqueous solubility, vapor pressur	2011	Environ Sci Technol. 2011 Oct 1;45(19):8120-8. doi: 10.1021/es101181g. Epub 2010 Oct 19.	The majority of perfluorinated chemicals (PFCs) are of increasing risk to biota and environment due to their physicochemical stability, wide transport in the environment and difficulty in biodegradation. It is necessary to identify and prioritize these harmful PFCs and to characterize their physicochemical properties that govern the solubility, distribution and fate of these chemicals in an aquatic ecosystem. Therefore, available experimental data (10-35 compounds) of three important properties: aqueous solubility (AqS), vapor pressure (VP) and critical micelle concentration (CMC) on per- and polyfluorinated compounds were collected for quantitative structure-property relationship (QSPR) modeling. Simple and robust models based on theoretical molecular descriptors were developed and externally validated for predictivity. Model predictions on selected PFCs were compared with available experimental data and other published in silico predictions. The structural applicability domains (AD) of the models were verified on a bigger data set of 221 compounds. The predicted properties of the chemicals that are within the AD, are reliable, and they help to reduce the wide data gap that exists. Moreover, the predictions of AqS, VP, and CMC of most common PFCs were evaluated to understand the aquatic partitioning and to derive a relation with the available experimental data of bioconcentration factor (BCF).				1									1						B	-	収集した物性値をもとに外挿的に他の物性値を予測したもの．	
8	物化	Krusic PJ, Marchione AA, Roe DC.	Gas-phase NMR studies of the thermolysis of p	2005	J Fluor Chem 126:1510-1516. doi: 10.1016/j.jfluchem.2005.08.016	The thermolysis of perfluorooctanoic acid (CF3(CF2)6COOH) has been studied kinetically by high-temperature gas-phase NMR in both sodium borosilicate glass and quartz ampoules. In both cases, 1-H-perfluoroheptane is the major product, but the decomposition is considerably slower in quartz. The decomposition in borosilicate ampoules at 307 ° C is greatly accelerated by the presence of crushed borosilicate glass and the reaction appears to be completely heterogeneous. Perfluoro-1-heptene is produced as a minor product and time-of-flight secondary ion mass spectrometry (ToF-SIMS) examination of the inner surface of the borosilicate glass ampoule after reaction reveals the presence of NaF. The thermolysis in quartz ampoules was studied by ex situ heating in the temperature range 355–385 ° C and produced moderate amounts of perfluoro-1-heptene and SiF4 in addition to 1-H-perfluoroheptane. Thermolysis in the presence of added crushed quartz accelerates the decomposition, as does increasing the concentration of perfluorooctanoic acid or carrying out the thermolysis in the presence of water. The thermolysis of perfluorooctanoic acid thus proceeds at widely different rates depending on concentration and on the physical and chemical environment. By contrast, the pyrolysis of ammonium perfluorooctanoate is more facile by orders of magnitude and proceeds by first-order kinetics at essentially the same rates in both quartz and borosilicate ampoules with an estimated half-life of 2 s at 307 ° C.													1						A	-	気相での高熱分解過程をNMRで定量的に追跡したもの．分解反応プロセスも解明されている．	
9	物化	Kwan WC.	Physical property determination of perfluorinat	2001	A thesis submitted in conformity with the requirements for the degree of Masters of Science in Environmental Chemistry, Graduate Department of Chemistry, University of Toronto. https://tspace.library.utoronto.ca/bitstream/1807/16278/1/MQ62941.pdf. March 8, 2019.	Fluorinated surfactants, perfluorocarboxylic acids in particular, have become increasingly popular in numerous industrial and domestic applications although little is known about their environmental fate. The purpose of the study was to measure the physical properties (vapour pressure, vp, and Henry's Law constant, KH) of the protonated form of perfluorocarboxylic acids. In order to supplement the determination of these physical properties, a series of simple and novel methods for the separation and detection of perfluorocarboxylates and perfluoroalkyl sulfonates by ion chromatogaphy (IC) were developed. Mixtures of perfluorocarboxylates ranging in chain length from perfluoropropionate to perfluorodecanoate, as well as perfluorohexyl sulfonate and perfluorooctyl sulfonate were separated using either an isocratic anion exchange separation method or a gradient reverse phase method. It was found that separation and method application (anion exchange vs. reverse phase) was dependent on the length of the perfluoro portion of these compounds. Anion exchange separation was appropriate for shorter chain compounds while reverse phase was better for longer chained perfluoro compounds. Once developed, the KH was determined using an acidified water method while vp was determined using the boiling point method. Results from the physical property determination experiments show the unique attributes of the carbon--fluorine bond, and the perfluoro chain. Vapour pressure results showed little deviation with increasing perfluoro chain length while Henry's Law constant results showed an inflection in the volatility of perfluorocarboxylic acids, with a maximum value at perfluoropentanoic acid.													1						D	-	学位論文で，扱いにくい．	
10	物化	Savu PM.	Fluorinated higher carboxylic acids	1994	In: Kirk-Othmer encyclopedia of chemical technology. John Wiley & Sons, Inc., 1-7. http://mrw.interscience.wiley.com/emrw/9780471238966/kirk/article/fluosavu.a01/current/pdf. April 01, 2008.	Perfluorinated carboxylic acids are corrosive liquids or solids. The acids are completely ionized in water. The acids are of commercial significance because of their unusual acid strength, chemical stability, high surface activity, and salt solubility characteristics. The higher members of the series have the property of decreasing the surface tension of aqueous solutions well below the point possible with any type of hydrocarbon surfactant. There are five methods for the preparation of long-chain perfluorinated carboxylic acids and derivatives: electrochemical fluorination, direct fluorination, telomerization of tetrafluoroethylene, oligomerization of hexafluoropropylene oxide, and photooxidation of tetrafluoroethylene and hexafluoropropylene. In general, the reactions of the perfluoroacids are similar to those of the hydrocarbon acids, although in some cases the electronegativity of the perfluoroalkyl groups make formation of certain derivatives easier or harder. A general summary of formation and properties of the derivatives of perfluorinated acids is discussed. Data on the fluorinated dicarboxylic acids and their derivatives are also summarized.													1						B	-	PFAS固有の物性の理解に努めようとしているのはわかるが，データの俯瞰に終わっている．	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
11	物化	Savu P.	Fluorine-containing polymers, perfluoroalkanes	1994	In: Kirk-Othmer encyclopedia of chemical technology. John Wiley & Sons, Inc., 1-7. http://mrw.interscience.wiley.com/emrw/9780471238966/kirk/article/perfsavu.a01.current/pdf. April 01, 2008.	Perfluoroalkanesulfonic acids and their derivatives are of commercial significance because of their unusual acid strength, chemical stability, and the surface activity of the higher members of the series (eight carbons and larger). The best method of preparation is via the perfluorinated sulfonyl fluorides derived from electrochemical fluorination, although other methods including direct fluorination with fluorine gas are known. The first member of the series, trifluoromethanesulfonic acid, is one of the strongest acids known. Alkyl esters of trifluoromethanesulfonic acid are among the best leaving groups known and are commonly used in that capacity in displacement reactions. Lithium trifluoromethanesulfonate solutions are very conductive and can find application as electrolytes in primary lithium batteries and as antistats for films. Derivatives of the longer-chain perfluoroalkanesulfonic acids have a number of unique surface-active properties and have formed a basis for a number of commercial products. The longer-chain acids and their salts, particularly C8F17SO3H and higher, are surface-active agents in aqueous media. They reduce the surface tension of water to levels not possible with hydrocarbon surfactants. Preparation of difunctional perfluoroalkanesulfonates and their derivatives is discussed, including fluorosulfonylacetyl fluoride. Fluorosulfonyldifluoracetyl fluoride is an important industrial intermediate used in the production of Du Pont's Nafion ion-exchange membranes and in many other applications.														1						B	-	上記と同一内容	
12	分析	Bangma, Jacqueline T; Reiner, Jessica; Fry, Rebecca C; Manuck, Tracy; McCord, James; Strynar, Mark J	Identification of an Analytical Method Interfere	2021	Environ Sci Technol Lett. 2021 Nov 19;8(12):1085-1090. doi: 10.1021/acs.estlett.1c00901.	The investigation of per- and polyfluorinated alkyl substances (PFAS) in environmental and biological samples relies on both high- and low-resolution mass spectrometry (MS) techniques. While high-resolution MS (HRMS) can be used for identification and quantification of novel compounds, low-resolution MS is the more commonly used and affordable approach for studies examining previously identified PFAS. Of note, perfluorobutanoic acid (PFBA) is one of the smaller PFAS observed in biological and environmental samples and has only one major MS/MS transition, preventing the use of qualitative transitions for verification. Recently, our laboratories undertook a targeted investigation of PFAS in the human placenta from high-risk pregnancies utilizing low-resolution, targeted MS/MS. Examination of placental samples revealed a widespread (n = 93/122 (76%)) chemical interferent in the quantitative ion channel for PFBA (213 → 169). PFBA concentrations were influenced by up to ~3 ng/g. Therefore, additional chromatographic and HRMS/MS instrumentation was utilized to investigate the suspect peak and putatively assign the identity of the interfering compound as the saturated oxo-fatty acid (SOFA) 3-oxo-dodecanoic acid.	1					1													B	-	PFBA分析の問題点について指摘	
13	分析	Kato, Kayoko; Calafat, Antonia M; Needham, Larry L	Polyfluoroalkyl chemicals in house dust	2009	Environ Res. 2009 Jul;109(5):518-23. doi: 10.1016/j.envres.2009.01.005. Epub 2009 Mar 3.	We developed a high throughput analytical method using on-line solid phase extraction coupled with isotope dilution high-performance liquid chromatography-tandem mass spectrometry (on-line SPE-HPLC-MS/MS) to simultaneously determine the concentrations of 17 polyfluoroalkyl chemicals (PFCs) in house dust. The sample preparation includes dispersion of the dust samples in 0.1 M formic acid:MeOH (1:1), followed by agitation and filtration, addition of the isotope-labeled internal standard solution to the filtrate, and analysis by on-line SPE-HPLC-MS/MS. The limits of quantitation were <4.0 ng/g. The method accuracies ranged between 73.2% and 100.2% for the different analytes at two spike levels. We confirmed the validity of the method by analyzing 39 household dust samples collected in 2004. Of the 17 PFCs measured, 6 of them--perfluorobutane sulfonate (PFBuS), N-ethyl-perfluorooctane sulfonamide, 2-(N-ethyl-perfluorooctane sulfonamido) acetic acid (Et-PFOSA-AcOH), 2-(N-methyl-perfluorooctane sulfonamido) ethanol (Me-PFOSA-EtOH), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS)--had detection frequencies >70%. We detected PFOS, PFBuS, and PFHxS at the highest median concentration, followed by Et-PFOSA-AcOH and Me-PFOSA-EtOH.		1					1	1		1					1				B	-	17PFAS	
14	分析	Strynar, Mark; Dagnino, Sonia; McMahen, Rebecca; Liang, Shuang; Lindstrom, Andrew; Andersen, Erik; McMillan, Larry; Thurman, Michael; Ferrer, Imma; Ball, Carol	Identification of Novel Perfluoroalkyl Ether Car	2015	Environ Sci Technol. 2015 Oct 6;49(19):11622-30. doi: 10.1021/acs.est.5b01215. Epub 2015 Sep 22.	Recent scientific scrutiny and concerns over exposure, toxicity, and risk have led to international regulatory efforts resulting in the reduction or elimination of certain perfluorinated compounds from various products and waste streams. Some manufacturers have started producing shorter chain per- and polyfluorinated compounds to try to reduce the potential for bioaccumulation in humans and wildlife. Some of these new compounds contain central ether oxygens or other minor modifications of traditional perfluorinated structures. At present, there has been very limited information published on these "replacement chemistries" in the peer-reviewed literature. In this study we used a time-of-flight mass spectrometry detector (LC-ESI-TOFMS) to identify fluorinated compounds in natural waters collected from locations with historical perfluorinated compound contamination. Our workflow for discovery of chemicals included sequential sampling of surface water for identification of potential sources, nontargeted TOFMS analysis, molecular feature extraction (MFE) of samples, and evaluation of features unique to the sample with source inputs. Specifically, compounds were tentatively identified by (1) accurate mass determination of parent and/or related adducts and fragments from in-source collision-induced dissociation (CID), (2) in-depth evaluation of in-source adducts formed during analysis, and (3) confirmation with authentic standards when available. We observed groups of compounds in homologous series that differed by multiples of CF2 (m/z 49.9968) or CF2O (m/z 65.9917). Compounds in each series were chromatographically separatedand had comparable fragments and adducts produced during analysis. We detected 12 novel perfluoroalkyl ether carboxylic and sulfonic acids in surface water in North Carolina, USA using this approach. A key piece of evidence was the discovery of accurate mass in-source n-mer formation (H(+) and Na(+)) differing by m/z 21.9819, corresponding to the mass difference between the protonated and sodiated dimers.					1			1			1									B	-		
15	分析	Kuklenyik, Zsuzsanna; Reich, John Adam; Tully, Jason S; Needham, Larry L; Calafat, Antonia M	Automated solid-phase extraction and measur	2004	Environ Sci Technol. 2004 Jul 1;38(13):3698-704. doi: 10.1021/es040332u.	Organic fluorochemicals are used in multiple commercial applications including surfactants, lubricants, paints, polishes, food packaging, and fire-retarding foams. Recent scientific findings suggest that several perfluorochemicals (PFCs), a group of organic fluorochemicals, are ubiquitous contaminants in humans and animals world wide. Furthermore, concern has increased about the toxicity of these compounds. Therefore, monitoring human exposure to PFCs is important. We have developed a high-throughput method for measuring trace levels of 13 PFCs (2 perfluorosulfonates, 8 perfluorocarboxylates, and 3 perfluorosulfonamides) in serum and milk using an automated solid-phase extraction (SPE) cleanup followed by high-performance liquid chromatography-tandem mass spectrometry. The method is sensitive, with limits of detection between 0.1 and 1 ng in 1 mL of serum or milk, is not labor intensive, involves minimal manual sample preparation, and uses a commercially available automated SPE system. Our method is suitable for large epidemiologic studies to assess exposure to PFCs. We measured the serum levels of these 13 PFCs in 20 adults nonoccupationally exposed to these compounds. Nine of the PFCs were detected in at least 75% of the subjects. Perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHxS), 2-(N-methylperfluorooctane-sulfonamido)acetate (Me-PFOSA-AcOH), perfluorooctanoate (PFOA), and perfluorononanoate (PFNA) were found in all of the samples. The concentration order and measured levels of PFOS, PFOA, Me-PFOSA-AcOH, and PFHxS compared well with human serum levels previouslyreported. Although no human data are available for the perfluorocarboxylates (except PFOA), the high frequency of detection of PFNA and other carboxylates in our study suggests that human exposure to long-alkyl-chain perfluorocarboxylates may be widespread. We also found PFOS in the serum and milk of rats administered PFOS by gavage, but not in the milk of rats not dosed with PFOS. Furthermore, we did not detect most PFCs in two human milk samples. These findings suggest that PFCs may not be as prevalent in human milk as they are in serum. Additional studies are needed to determine whether environmental exposure to PFCs can result in PFCs partitioning into milk. Large epidemiological studies to determine the levels of PFCs among the U.S. general population are warranted.					1				1						1					B	-	血清・ミルク中のPFASの分析法、オンライン濃縮＋LC-MS/MS	
16	分析	Nickerson, Anastasia; Maizel, Andrew C; Kulkarni, Poonam R; Adamson, David T; Kornuc, John J; Higgins, Christopher P	Enhanced Extraction of AFFF-Associated PFAS	2020	Environ Sci Technol. 2020 Apr 21;54(8):4952-4962. doi: 10.1021/acs.est.0c00792. Epub 2020 Apr 3.	Poly- and perfluoroalkyl substances (PFASs) derived from aqueous film-forming foam (AFFF) are increasingly recognized as groundwater contaminants, though the composition and distribution of AFFF-derived PFASs associated with soils and subsurface sediments remain largely unknown. This is particularly true for zwitterionic and cationic PFASs, which may be incompletely extracted from subsurface solids by analytical methods developed for anionic PFASs. Therefore, a method involving sequential basic and acidic methanol extractions was developed and evaluated for recovery of anionic, cationic, and zwitterionic PFASs from field-collected, AFFF-impacted soils. The method was validated by spike-recovery experiments with equilibrated soil-water-AFFF and analytical standards. To determine the relative importance of PFASs lacking commercially available analytical standards, their concentrations were estimated by a novel semiquantitation approach. Total PFAS concentrations determined by semiquantitation were compared with concentrations determined by the total oxidizable precursor assay. Finally, the described method was applied to two soil cores from former fire-training areas in which cations and zwitterions were found to contribute up to 97% of the total PFAS mass. This result demonstrates the need for extraction and analysis methods, such as the ones presented here, that are capable of quantifying cationic and zwitterionic PFASs in AFFF-impacted source zone soils.					1				1											B	-	アニオン、カチオン、両正イオンのPFASの測定法	
17	分析	Schultz, Melissa M; Barofsky, Douglas F; Field, Jennifer A	Quantitative determination of fluorinated alkyl	2006	Environ Sci Technol. 2006 Jan 1;40(1):289-95. doi: 10.1021/es051381p.	A quantitative method was developed for the determination of fluorinated alkyl substances in municipal wastewater influents and effluents. The method consisted of centrifugation followed by large-volume injection (500 microL) of the supernatant onto a liquid chromatograph with a reverse-phase column and detection by electrospray ionization and tandem mass spectrometry. The fluorinated analytes studied include perfluoroalkyl sulfonates, fluorotelomer sulfonates, perfluorocarboxylates, and select fluorinated alkyl sulfonamides. Recoveries of the fluorinated analytes from wastewater treatment plant (WWTP) raw influents and final effluent were in the ranges of 82-100% and 86-100%, respectively. The lower limit of quantitation was 0.5 ng/L depending on the analyte. The method was applied to flow-proportional composites of raw influent and final effluent collected over a 24 h period from 10 WWTPs nationwide. Fluorinated alkyl substances were observed in wastewater at all treatment plants, and each plant exhibited unique distributions of fluorinated alkyl substances despite similarities in treatment processes. In 9 out of the 10 plants sampled, at least one class of fluorinated alkyl substances exhibited increased concentrations in the effluent as compared to the influent concentrations. In some instances, decreases in certain fluorinated analyte concentrations were observed and attributed to sorption to sludge.					1				1						1					B	-	排水中のPFASの測定法	
18	分析	Perez, Francisca; Llorca, Marta; Farré, Marinella; Barceló, Damià	Automated analysis of perfluorinated compoun	2012	Anal Bioanal Chem. 2012 Mar;402(7):2369-78. doi: 10.1007/s00216-011-5660-5. Epub 2012 Jan 7.	Perfluorinated compounds (PFCs) are ubiquitous contaminants of humans and animals worldwide. PFCs are bioaccumulated because of their affinity for proteins. It has been shown they could have a variety of toxicological effects and cause damage to human health, emphasizing the need for sensitive and robust analytical methods to assess their bioaccumulation in humans. In this paper we report the development and validation of an analytical method for analysis of PFCs in the non-invasive human matrices hair and urine. The method is based on rapid and simple sample pre-treatment followed by online turbulent flow liquid chromatography and tandem mass spectrometry (TFC-LC-MS-MS) for analysis of 21 PFCs. The method was validated for both matrices. Percentage recovery was between 60 and 105 for most compounds in both matrices. Limits of quantification ranged from 0.1 to 9 ng mL(-1) in urine and from 0.04 to 13.4 in hair. The good performance of the method was proved by investigating the presence of selected PFCs in 24 hair and 30 urine samples from different donors living in Barcelona (NE Spain). The results were indicative of bioaccumulation of these compounds in both types of sample. PFOS and PFOA were most frequently detected in hair and PFBA in urine.					1				1											B	-	髪や尿中のPFASの測定法	
19	分析	Tröger, Rikard; Klöckner, Philipp; Ahrens, Lutz; Wiberg, Karin	Micropollutants in drinking water from source t	2018	Sci Total Environ. 2018 Jun 15;627:1404-1432. doi: 10.1016/j.scitote	A multi-residue screening method for simultaneous measurement of a wide range of micropollutants in drinking water (DW) resources was developed. The method was applied in a field study in central Sweden on water from source to tap, including samples of surface water (upstream and downstream of a wastewater treatment plant, WWTP), intake water before and after a DW treatment plant (DWTP, pilot and full-scale), treated DW leaving the plant and tap water at end users. Low detection limits (low ng L(-1) levels) were achieved by using large sample volumes (5 L) combined with ultra performance liquid chromatography high resolution mass spectrometry (UPLC-HRMS). In total, 134 different micropollutants were analyzed, including pesticides, pharmaceuticals and personal care products (PPCPs), drug-related compounds, food additives, and perfluoroalkyl substances (PFASs). Of these 134 micropollutants, 41 were detected in at least one sample, with individual concentrations ranging from sub ng L(-1) levels to ~80 ng L(-1). Two solid phase extraction (SPE) cartridges (Oasis HLB and Bond-Elut ENV) were shown to be complementary in the field study, with three compounds detected exclusively using HLB. The total concentration in treated drinking water (56-57 ng L(-1)) was at a similar level as upstream from the WWTP (79-90 ng L(-1)). The composition of micropollutants changed along the water path, to a higher fraction of food additives and PFASs. Median treatment efficiency in the full-scale DWTP was close to 0%, but with high variability for individual compounds. In contrast, median treatment efficiency in the pilot-scaleDWTP was ~90% when using nanofiltration followed by a freshly installed granulated active carbon (GAC) filter.					1				1											B	-	HRMS、スクリーニング法、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
20	分析	Hopkins, Z. R.; Sun, M.;ei; Dewitt, J. C.; Knappe, D. R. U.	Recently detected drinking water contaminant	2018	J Am Water Works Assoc., 110(7), 13-28. doi: 10.1002/awwa.1073	For several decades, a common processing aid in the production of fluoropolymers was the ammonium salt of perfluorooctanoic acid (PFOA). Because PFOA is persistent, bioaccumulative, and toxic, its production and use are being phased out in the United States. In 2009, the US Environmental Protection Agency stipulated conditions for the manufacture and commercial use of GenX, a PFOA replacement. While GenX is produced for commercial purposes, the acid form of GenX is also generated as a byproduct during the production of fluoromonomers. The discovery of high concentrations of GenX and related perfluoroalkyl ether acids (PFEAs) in the Cape Fear River and in finished drinking water of more than 200000 North Carolina residents required quick action by researchers, regulators, public health officials, commercial laboratories, drinking water providers, and consulting engineers. Information about sources and toxicity of GenX as well as an analytical method for the detection of GenX and eight related PFEAs is presented. GenX/PFEA occurrence in water and GenX/PFEA removal by different drinking water treatment processes are also discussed.					1							1											B	-	水道関係の総説、PFAS	
21	分析	Jurado-Sánchez, B.; Ballesteros, E.; Gallego, M.	Analytical method for biomonitoring of perfluor	2014	Talanta. 2014 Oct;128:141-6. doi: 10.1016/j.talanta.2014.04.071. Epub 2014 May 8.	Perfluoroalkyl acids are an important class of synthetic compounds widely used in commercial and residential settings, which may have potential adverse health effects. The objective of this study was to monitor 6 perfluorocarboxylic acids and perfluorooctane sulphonate in human urine to obtain a way to asses exposure. The target analytes were extracted from urine by using a semi automated solid-phase extraction module and derivatised with isobutyl chloroformate by catalysis with 0.03 N,N-dicyclohexylcarbodiimide in pyridine. Determination and quantisation were achieved by gas chromatography with a mass spectrometer detector operating in the selected-ion monitoring mode. The developed approach is fast and provided low limits of detection (0.2-1.0 ng L(-1)) with good precision (relative standard deviation lower than 7.5%, within-day and between day). Recoveries from urine samples, which were spiked with the studied compounds at levels of 10 and 50 ng L(-1) ranged from 0.93 to 96%. Perfluorohexanoic (≤ 70 ng L(-1)) and perfluoroheptanoic acids (<2 ng L(-1)) were found in the urine samples from exposed researchers taken after handling these compounds. From the calculation of the excretion kinetics it was found that the dosage absorbed was eliminated within 15 h after exposure.			1													1					B	-	尿中のPFASの分析方法	
22	分析	Gao, Ke; Gao, Yan; Li, Yili; Fu, Jianjie; Zhang, Aiqian	A rapid and fully automatic method for the acc	2016	J Chromatogr A. 2016 Nov 4;1471:1-10. doi: 10.1016/j.chroma.2016.09.050. Epub 2016 Sep 23.	A rapid and fully automatic method for determining 21 per- and polyfluoroalkyl substances (with carbon chains ranging from C4 to C18, including 13 PFCAs, 5 PFSAs, 2 Cl-PFESAs, and PFOSA) in human serum samples was developed. The HPLC parameters, Turboflow column, mobile phase, sample injection volume, loading flow rate, and sample cleanup and elution time were optimized. 25 μL serum sample was directly injected into the developed on-line Turboflow SPE HPLC-MS/MS system for analysis after dilution. Matrix effects were corrected due to the matrix removal efficiency of the Turboflow column and sufficient types of internal isotope standards that were used. The established method showed a good linearity (r(2)>0.99), rapid processing time (20min per sample), satisfactory recoveries (matrix spiked recoveries range from 84.6% to 114%) and precision (intra-day and inter-day RSDs ranged from 1.5% to 9.2% and from 1.1% to 7.0%, respectively). The limits of detection (LODs) of the 21 analyzed PFASs were between 0.008 and 0.19ngmL(-1). The LODs of short- and long-chain PFASs, such as PFBA, PFPeA, PFHxDA, and PFODA, were 0.008, 0.022, 0.15 and 0.19ngmL(-1), respectively; the spiked recoveries of these PFASs were 101, 105, 87.1, and 85.8%, respectively. Both the LODs and recoveries were better than previous studies. Further, serum PFASs concentrations detected by the presented on-line SPE method were consistent with the traditional off-line SPE method (r: 0.98-0.99), which verified the accuracy and applicability of the present method. The method shows good practical prospects in the analysis of trace per- and polyfluoroalkyl substances in humanserum.	1															1					B	-	オンライン濃縮分析法、血清中、PFAS	
23	分析	Kato, Kayoko; Kalathil, Akil A; Patel, Ayesha M; Ye, Xiaoyun; Calafat, Antonia M	Per- and polyfluoroalkyl substances and fluorin	2018	Chemosphere. 2018 Oct;209:338-345. doi: 10.1016/j.chemosphere.2018.06.085. Epub 2018 Jun 14.	Per- and polyfluoroalkyl substances (PFAS), man-made chemicals with variable length carbon chains containing the perfluoroalkyl moiety (C(n)F(2n+1)-), are used in many commercial applications. Since 1999-2000, several long-chain PFAS, including perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), have been detected at trace levels in the blood of most participants of the National Health and Nutrition Examination Survey (NHANES)-representative samples of the U.S. general population-while short-chain PFAS have not. Lower detection frequencies and concentration ranges may reflect lower exposure to short-chain PFAS than to PFOS or PFOA or that, in humans, short-chain PFAS efficiently eliminate in urine. We developed on-line solid phase extraction-HPLC-isotope dilution-MS/MS methods for the quantification in 50 μL of urine or serum of 15 C(3)-C(11) PFAS (C(3) only in urine), and three fluorinated alternatives used as PFOA or PFOS replacements: GenX (ammonium salt of 2,3,3,3,-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoate, also known as HFPO-DA), ADONA (ammonium salt of 4,8-dioxa-3H-perfluorononanoate), and 9Cl-PF3ONS (9-chlorohexadecafluoro-3-oxanonane-1-sulfonate), main component of F53-B. Limit of detection for all analytes was 0.1 ng/mL. To validate the method, we analyzed 50 commercial urine/serum paired samples collected in 2016 from U.S. volunteers with no known exposure to the chemicals. In serum, detection frequency and concentration patterns agreed well with those from NHANES. By contrast, except for perfluorobutanoate, we did not detect long-chain or short-chain PFASin urine. Also, we did not detect fluorinated alternatives in either urine or serum. Together, these results suggest limited exposure to both short-chain PFAS and select fluorinated alternatives in this convenience population.	1	1	1	1											1					B	-	分析方法、尿、血清、PFAS	
24	分析	Vestergren, Robin; Ullah, Shahid; Cousins, Ian T; Berger, Urs	A matrix effect-free method for reliable quantifi	2012	J Chromatogr A. 2012 May 11;1237:64-71. doi: 10.1016/j.chroma.2012.03.023. Epub 2012 Mar 14.	In recent exposure modeling studies diet has been identified as the dominant pathway of human exposure to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). However, the paucity of highly sensitive and accurate analytical data to support these studies means that their conclusions are open to question. Here a novel matrix effect-free method is described for ultra-trace analysis of perfluoroalkyl carboxylic acids and perfluoroalkane sulfonic acids in dietary samples of varied composition. The method employs ion pair extraction of the analytes into methyl tert-butyl ether and subsequent solid phase extraction clean-up on Florisil and graphitized carbon. The target compounds are separated and detected using ultra performance liquid chromatography coupled to tandem mass spectrometry. Special care was taken to avoid procedural blank contamination and potential contamination sources were elucidated. The performance of the method was validated for five different food test matrices including a duplicate diet sample. Method detection limits in the low to sub pgg(-1) range were obtained for all target analytes, which is 5-100 times more sensitive than previously reported for duplicate diet samples. Total method recoveries were consistently between 50 and 80% for all analytes in all tested food matrices and effects of co-extracted matrix constituents on ionization of the target compounds were found to be negligible. The precision of the method (defined as percentage relative standard deviation) at concentrations close to the respective method limits of quantification was <15% for all analytes. Accurate quantification at ultra-tracelevels was demonstrated by laboratory control spike experiments. For the first time the presence of long-chain PFCAs in duplicate diet samples is reported. The method presented here can thus support an improved assessment of human exposure from dietary intake for a range of PFCA and PFSA homologues. Re-analysis of duplicate diet samples, which had been analyzed earlier using another analytical methodology, indicated that dietary intake of PFOA and PFOS may previously have been overestimated.				1											1					B	-		
25	ばく露	Heo, Jin-Ju; Lee, Ji-Woo; Kim, Seung-Kyu; Oh, Jeong-Eun	Foodstuff analyses show that seafood and wat	2014	J Hazard Mater. 2014 Aug 30;279:402-9. doi: 10.1016/j.jhazmat.2014.07.004. Epub 2014 Jul 14.	We measured concentrations of PFAAs in 397 foods, of 66 types, in Korea, and determined the daily human dietary PFAAs intake and the contribution of each foodstuff to that intake. The PFAAs concentration in the 66 different food types ranged from below the detection limit to 48.3ng/g. Perfluorooctane sulfonate (PFOS) and long-chain perfluorocarboxylic acids (PFCAs) were the dominant PFAAs in fish, shellfish, and processed foods, while perfluorooctanoic acid (PFOA) and short-chain PFCAs dominated dairy foodstuffs and beverages. The Korean adult dietary intake ranges, estimated for a range of scenarios, were 0.60-3.03 and 0.17-1.68ngkg(-1)bwd(-1) for PFOS and PFOA, respectively, which were lower than the total daily intake limits suggested by European Food Safety Authority (PFOS: 150ngkg(-1)bwd(-1); PFOA: 1500ngkg(-1)bwd(-1)). The major contributors to PFAAs dietary exposure varied with subject age and PFAAs. For example, fish was a major contributor of PFOS but dairy foods were major contributors of PFOA. However, tap water was a major contributor to PFOA intake when it was the main source of drinking water (rather than bottled water).	1					1	1												B	-	韓国、397食品、人の食事からの摂取	
26	ばく露	Kim, Seung-Kyu; Kannan, Kurunthachalam	Perfluorinated acids in air, rain, snow, surface	2007	Environ Sci Technol. 2007 Dec 15;41(24):8328-34. doi: 10.1021/es072107t.	Concentrations of perfluorinated acids (PFAs) were measured in various environmental matrices (air, rain, snow, surface runoff water, and lake water) in an urban area, to enable identification of sources and pathways of PFAs to urban water bodies. Total PFA concentrations ranged from 8.28 to 16.0 pg/ m3 (mean 11.3) in bulk air (sum of vapor and particulate phases), 0.91 to 13.2 ng/L (6.19) in rainwater, 0.91 to 23.9 ng/L (7.98) in snow, 1.11-81.8 ng/L (15.1 ng/L) in surface runoff water (SRW), and 9.49 to 35.9 ng/L (21.8) in lake water. Perfluorooctanoic acid (PFOA) was the predominant compound, accounting for > 35% of the total PFA concentrations, in all environmental matrices analyzed. Concentrations and relative compositions of PFAs in SRW were similar to those found for urban lakes. SRW contributes to contamination by PFOA in urban lakes. The measured concentration ratios of FTOH to PFOA in air were 1-2 orders of magnitude lower than the ratios calculated based on an assumption of exclusive atmospheric oxidation of FTOHs. Nevertheless, the mass balance analysis suggested the presence of an unknown input pathway that could contribute to a significant amount of total PFOA loadings to the lake. Flux estimates of PFOA at the air-water interface in the urban lake suggest net volatilization from water.	1					1				1					1					B	-	水系の水源や経路の特定、種々の環境試料中のPFAS	
27	ばく露	Kotthoff, Matthias; Müller, Josef; Jürling, Heinrich; Schlummer, Martin; Fiedler, Dominik	Perfluoroalkyl and polyfluoroalkyl substances i	2015	Environ Sci Pollut Res Int. 2015 Oct;22(19):14546-59. doi: 10.1007/s11356-015-4202-7. Epub 2015 Feb 19.	Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are used in a wide range of products of all day life. Due to their toxicological potential, an emerging focus is directed towards their exposure to humans. This study investigated the PFAS load of consumer products in a broad perspective. Perfluoroalkyl sulfonic acids (C4, C6-C8, C10-PFSA), carboxylic acids (C4-C14-PFCA) and fluorotelomer alcohols (4:2, 6:2; 8:2 and 10:2 FTOH) were analysed in 115 random samples of consumer products including textiles (outdoor materials), carpets, cleaning and impregnating agents, leather samples, baking and sandwich papers, paper baking forms and ski waxes. PFCA and PFSA were analysed by HPLC-MS/MS, whereas FTOH were detected by GC/CI-MS. Consumer products such as cleaning agents or some baking and sandwich papers show low or negligible PFSA and PFCA contents. On the other hand, high PFAS levels were identified in ski waxes (up to about 2000 μg/kg PFOA), leather samples (up to about 200 μg/kg PFBA and 120 μg/kg PFBS), outdoor textiles (up to 19 μg/m(2) PFOA) and some other baking papers (up to 15 μg/m(2) PFOA). Moreover, some test samples like carpet and leather samples and outdoor materials exceeded the EU regulatory threshold value for PFOS (1 μg/m(2)). A diverse mixture of PFASs can be found in consumer products for all fields of daily use in varying concentrations. This study proves the importance of screening and monitoring of consumer products for PFAS loads and the necessity for an action to regulate the use of PFASs, especially PFOA, in consumer products.	1					1									1	1				B	-	消費者製品からのPFASの負荷	
28	ばく露	Liu, Xiaoyu; Guo, Zhishi; Krebs, Kenneth A; Pope, Robert H; Roache, Nancy F	Concentrations and trends of perfluorinated ch	2014	Chemosphere. 2014 Mar;98:51-7. doi: 10.1016/j.chemosphere.2013.10.001. Epub 2013 Nov 19.	Certain perfluorinated chemicals (PFCs) in consumer products used indoors are potential indoor PFCs sources and have been associated with developmental toxicity and other adverse health effects in laboratory animals (Lao et al., 2007). The concentrations of selected PFCs including perfluorooctanoic acid (PFOA) and other perfluorocarboxylic acids (PFCAs), in 35 selected consumer products that are commonly used in indoors were measured from the year of 2007 through 2011. The products collected included carpet, commercial carpet-care liquids, household carpet/fabric-care liquids, treated apparel, treated home textiles, treated non-woven medical garments, floor waxes, food-contact paper, membranes for apparel, and thread-sealant tapes. They were purchased from retail outlets in the United States between March 2007 and September 2011. The perfluorocarboxylic acid (PFCA) contents in the products have shown an overall downward trend. However, PFOA (C8) could still be detected in many products that we analyzed. Reductions of PFCAs were shown in both short-chain PFCAs (sum of C4 to C7) and long-chain PFCAs (sum of C8 to C12) over the study period. There were no significant changes observed between short-chain PFCAs and long-chain PFCAs. Fourteen products were analyzed to determine the amounts of perfluoroalkyl sulfonates (PFASs) they contained. These limited data show the pronounced increase of perfluoro-butane sulfonate (PFBS), an alternative to perfluorooctanoic sulfonate (PFOS), in the samples. A longer and wider range of study will be required to confirm this observed trend.	1					1		1		1					1					B	-	室内の35消費者製品中のPFAS	
29	ばく露	Lorenzo, M.; Farré, M.; Blasco, C.; Onghena, M.; Picó, Y.; Barceló, D.	Perfluoroalkyl substances in Breast milk, infant	2016	Environ Nanotechnol Monit Manag 6: 108-115. doi: 10.1016/j.enmm.2016.09.001.	Environmental and human exposures to perfluoroalkyl substances (PFASs) are of emerging concern since they are persistent and bioaccumulative. The present study reports PFASs levels in human milk, infant formulas and baby food (dry cereals and pots) from the Valencian Community (Spain) in order to evaluate the infant exposure to these substances through the diet. The results show that perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA) were in all the samples of the four selected matrices (except PFOA in one sample of dry cereal baby food). Perfluoroheptanoic acid (PFHpA) and perfluorodecanoic acid (PFDA) were also detected in 0.7 of the breast milk samples. In infant formulas, PFDA and perfluorooctanesulfonate (PFOS) were detected in 0.75 and 69%, respectively. In dry cereals baby food, PFBA was in 1 of the samples while PFOA and PFOS in 92%. In baby food pots, PFDA was also detected in 0.83 of the samples. Estimated daily intakes (EDIs) of PFOA (maximum 32.2 ng kg − 1 day − 1) and PFOS (9.0 ng kg − 1 day − 1) are lower than tolerable daily intakes (TDIs) established for PFOA (1500 ng kg − 1 day − 1) and PFOS (150 ng kg − 1 day − 1).	1					1														B	-	スペイン、母乳、乳児用粉ミルク、乳児食中のPFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
30	ばく露	Post, Gloria B; Louis, Judith B; Lippincott, R Lee; Procopio, Nicholas A	Occurrence of perfluorinated compounds in raw	2013	Environ Sci Technol. 2013;47(23):13266-75. doi: 10.1021/es402884x. Epub 2013 Nov 19.	Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were previously detected (≥ 4 ng/L) in 65% and 30%, respectively, of 23 New Jersey (NJ) public drinking water systems (PWS) sampled in 2006. We now report on a 2009 study of the occurrence of PFOA, PFOS, and eight other perfluorinated compounds (PFCs) in raw water samples from 30 intakes (18 groundwater and 12 surface water) from 29 additional NJ PWS. Between 1 and 8 PFCs were detected (≥ 5 ng/L) in 21 (70%) of 30 PWS samples at total PFC concentrations of 5-174 ng/L. Although PFOA was the most commonly detected PFC (57% of samples) and was found at the highest maximum concentration (100 ng/L), some of the higher levels of other PFCs were at sites with little or no PFOA. Perfluorononanoic acid was detected more frequently (30%) and at higher concentrations (up to 96 ng/L) than in raw or finished drinking water elsewhere, and it was found at several sites as the sole or predominant PFC, a pattern not reported in other drinking water studies. PFOS, perfluoropentanoic acid, and perfluorohexanoic acid were each detected in more than 20% of samples, while perfluoroheptanoic acid, perfluorobutane sulfonic acid, and perfluorohexane sulfonic acid were detected less frequently. Perfluorobutanoic acid was found only once (6 ng/L), and perfluorodecanoic acid was not detected. Total PFCs were highest in two reservoirs near an airfield; these were also the only sites with total perfluorosulfonic acids higher than total perfluorocarboxylic acids (PFCAs). PFC levels in raw and finished water from the same source were similar at those sites where both were tested. Fivewells of two additional NJ PWS known to be contaminated with PFOA were also each sampled 4-9 times in 2010-13 for nine of the same PFCs. Total PFCs (almost completely PFCAs) at one of these PWS located near an industrial source of PFCs were higher than in any other PWS tested (up to 330 ng/L). These results show that multiple PFCs are commonly found in raw water from NJ PWS. Future work is needed to develop approaches for assessing the potential human health risks of exposure to mixtures of PFCs found in drinking water and other environmental media.	1					1		1		1	1	1				1					B	-	29水道システムの30浄水場原水、PFAS	
31	ばく露	Prevedouros, Konstantinos; Cousins, Ian T; Buck, Robert C; Korzeniowski, Stephen H	Sources, fate and transport of perfluorocarboxy	2006	Environ Sci Technol. 2006 Jan 1;40(1):32-44. doi: 10.1021/es0512475.	This review describes the sources, fate, and transport of perfluorocarboxylates (PFCAs) in the environment, with a specific focus on perfluorooctanoate (PFO). The global historical industry-wide emissions of total PFCAs from direct (manufacture, use, consumer products) and indirect (PFCA impurities and/or precursors) sources were estimated to be 3200-7300 tonnes. It was estimated that the majority (approximately 80%) of PFCAs have been released to the environment from fluoropolymer manufacture and use. Although indirect sources were estimated to be much less importantthan direct sources, there were larger uncertainties associated with the calculations for indirect sources. The physical-chemical properties of PFO (negligible vapor pressure, high solubility in water, and moderate sorption to solids) suggested that PFO would accumulate in surface waters. Estimated mass inventories of PFO in various environmental compartments confirmed that surface waters, especially oceans, contain the majority of PFO. The only environmental sinks for PFO were identified to be sediment burial and transport to the deep oceans, implying a long environmental residence time. Transport pathways for PFCAs in the environment were reviewed, and it was concluded that, in addition to atmospheric transport/degradation of precursors, atmospheric and ocean water transport of the PFCAs themselves could significantly contribute to their long-range transport. It was estimated that 2-12 tonnes/ year of PFO are transported to the Artic by oceanic transport, which is greater than the amount estimated to result from atmospheric transport/degradation of precursors.	1					1				1						1		1			B	-	総説、環境中のPFASの輸送	
32	ばく露	Stahl, Leanne L; Snyder, Blaine D; Olsen, Anthony R; Kincaid, Thomas M; Wathen, John B; McCarty, Harry B	Perfluorinated compounds in fish from U.S. urb	2014	Sci Total Environ. 2014 Nov 15;499:185-95. doi: 10.1016/j.scitotenv.2014.07.126. Epub 2014 Sep 2.	Perfluorinated compounds (PFCs) have recently received scientific and regulatory attention due to their broad environmental distribution, persistence, bioaccumulative potential, and toxicity. Studies suggest that fish consumption may be a source of human exposure to perfluorooctane sulfonate (PFOS) or long-chain perfluorocarboxylic acids. Most PFC fish tissue literature focuses on marine fish and waters outside of the United States (U.S.). To broaden assessments in U.S. fish, a characterization of PFCs in freshwater fish was initiated on a national scale using an unequal probability design during the U.S. Environmental Protection Agency's (EPA's) 2008-2009 National Rivers and Streams Assessment (NRSA) and the Great Lakes Human Health Fish Tissue Study component of the 2010 EPA National Coastal Condition Assessment (NCCA/GL). Fish were collected from randomly selected locations--164 urban river sites and 157 nearshore Great Lake sites. The probability design allowed extrapolation to the sampled population of 17,059 km in urban rivers and a nearshore area of 11,091 km(2) in the Great Lakes. Fillets were analyzed for 13 PFCs using high-performance liquid chromatography tandem mass spectrometry. Results showed that PFOS dominated in frequency of occurrence, followed by three other longer-chain PFCs (perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanoic acid). Maximum PFOS concentrations were 127 and 80 ng/g in urban river samples and Great Lakes samples, respectively. The range of NRSA PFOS detections was similar to literature accounts from targeted riverine fish sampling. NCCA/GL PFOS levelswere lower than those reported by other Great Lakes researchers, but generally higher than values in targeted inland lake studies. The probability design allowed development of cumulative distribution functions (CDFs) to quantify PFOS concentrations versus the sampled population, and the application of fish consumption advisory guidance to the CDFs resulted in an estimation of the proportion of urban rivers and the Great Lakes that exceed human health protection thresholds.	1					1	1			1											B	-		
33	ばく露	Sun, M.; Arevalo, E.; Strynar, M.; Lindstrom, A.; Richardson, M.; Kearns, B.; Pickett, A.; Smith, C.; Knappe, D. R. U.	Legacy and emerging perfluoroalkyl substances	2016	Environ Sci Technol Lett 3: 415-419. doi: 10.1021/acs.estlett.6b00398.	Long-chain per- and polyfluoroalkyl substances (PFASs) are being replaced by short-chain PFASs and fluorinated alternatives. For ten legacy PFASs and seven recently discovered perfluoroalkyl ether carboxylic acids (PFECAs), we report -1 their occurrence in the Cape Fear River (CFR) watershed, -2 their fate in water treatment processes, and -3 their adsorbability on powdered activated carbon (PAC). In the headwater region of the CFR basin, PFECAs were not detected in raw water of a drinking water treatment plant (DWTP), but concentrations of legacy PFASs were high. The U.S. Environmental Protection Agency's lifetime health advisory level (70 ng/L) for perfluorooctanesulfonic acid and perfluorooctanoic acid (PFOA) was exceeded on 57 of 127 sampling days. In raw water of a DWTP downstream of a PFAS manufacturer, the mean concentration of perfluoro-2-propoxypropanoic acid (PFPrOPrA), a replacement for PFOA, was 631 ng/L (n = 37). Six other PFECAs were detected, with three exhibiting chromatographic peak areas up to 15 times that of PFPrOPrA. At this DWTP, PFECA removal by coagulation, ozonation, biofiltration, and disinfection was negligible. The adsorbability of PFASs on PAC increased with increasing chain length. Replacing one CF2 group with an ether oxygen decreased the affinity of PFASs for PAC, while replacing additional CF2groups did not lead to further affinity changes.	1					1		1				1								B	-	水源での存在、浄水プロセスでの挙動、PACでの吸着性能	
34	ばく露	Wang, Zhanyun; Cousins, Ian T; Scheringer, Martin; Buck, Robert C; Hungerbühler, Konrad	Global emission inventories for C4-C14 perfluo	2014	Environ Int. 2014 Sep;70:62-75. doi: 10.1016/j.envint.2014.04.013. Epub 2014 Jun 2.	We quantify global emissions of C4-C14 perfluoroalkyl carboxylic acid (PFCA) homologues during the life-cycle of products based on perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctane sulfonyl fluoride (POSF), and fluorotelomer compounds. We estimate emissions of 2610-21400 tonnes of C4-C14 PFCAs in the period from 1951 to 2015, and project 20-6420 tonnes to be emitted from 2016 to 2030. The global annual emissions steadily increased in the period 1951-2002, followed by a decrease and then another increase in the period 2002-2012. Releases from fluoropolymer production contributed most to historical PFCA emissions (e.g. 55-83% in 1951-2002). Since 2002, there has been a geographical shift of industrial sources (particularly fluoropolymer production sites) from North America, Europe and Japan to emerging Asian economies, especially China. Sources differ between PFCA homologues, sometimes considerably, and the relative contributions of each source change over time. For example, whereas 98-100% of historical (1951-2002) PFOA emissions are attributed to direct releases during the life-cycle of products containing PFOA as ingredients or impurities, a much higher historical contribution from PFCA precursor degradation is estimated for some other homologues (e.g. 9-78% for PFDA). We address the uncertainties of the PFCA emissions by defining a lower and a higher emission scenario, which differ by approximately a factor of eight.	1					1										1				B	-	PFAS、排出インベントリー	
35	ばく露	Anderson, R Hunter; Long, G Cornell; Porter, Ronald C; Anderson, Janet K	Occurrence of select perfluoroalkyl substances	2016	Chemosphere. 2016 May;150:678-685. doi: 10.1016/j.chemosphere.2016.01.014. Epub 2016 Jan 16.	The use of aqueous film-forming foam (AFFF) to extinguish hydrocarbon-based fires is recognized as a significant source of environmental poly- and perfluoroalkyl substances (PFASs). Although the occurrence of select PFASs in soil and groundwater at former fire-training areas (FTAs) at military installations operable since 1970 has been consistently confirmed, studies reporting the occurrence of PFASs at other AFFF-impacted sites (e.g. emergency response locations, AFFF lagoons, hangar-related AFFF storage tanks and pipelines, and fire station testing and maintenance areas) are largely missing from the literature. Further, studies have mostly focused on a single site (i.e., FTAs at military installations) and, thus, lack a comparison of sites with diverse AFFF release history. Therefore, the purpose of this investigation was to evaluate select PFAS occurrence at non-FTA sites on active U.S. Air Force installations with historic AFFF use of varying magnitude. Concentrations of fifteen perfluoroalkyl acids (PFAAs) and perfluorooctane sulfonamide (PFOSA), an important PFOS precursor, were measured from several hundred samples among multiple media (i.e., surface soil, subsurface soil, sediment, surface water, and groundwater) collected from forty AFFF-impacted sites across ten installations between March and September 2014, representing one of the most comprehensive datasets on environmental PFAS occurrence to date. Differences in detection frequencies and observed concentrations due to AFFF release volume are presented along with rigorous data analyses that quantitatively demonstrate phase-dependent(i.e., solid-phase vs aqueous-phase) differences in the chemical signature as a function of carbon chain-length and in situ PFOS (and to a slightly lesser extent PFHxS) formation, presumably due to precursor biotransformation.		1	1			1	1	1				1						B	-		
36	ばく露	Baduel, Christine; Paxman, Christopher J; Mueller, Jochen F	Perfluoroalkyl substances in a firefighting train	2015	J Hazard Mater. 2015 Oct 15;296:46-53. doi: 10.1016/j.jhazmat.2015.03.007. Epub 2015 Mar 21.	The present study investigates the occurrence and fate of 15 perfluoroalkyl substances (PFASs) and one fluorotelomer sulfonate from a firefighting training ground (FTG) that was contaminated by intensive use of aqueous film forming foams (AFFF). The contamination levels and their spatial and vertical distribution are assessed in the structure. At the surface of the pad, perfluorooctane sulphonate (PFOS) is the dominant PFASs measured, with concentration varying from 10 to 200 μg g(-1). PFASs were also detected in a concrete core at up to 12 cm depth, suggesting the vertical movement and higher transport potential of shorter chain compounds. The estimated mass load of linear PFOS in this specific pad was >300 g with a total of 1.7 kg for the sum of all PFASs analyzed. The kinetics of desorption of PFOS, PFOA and 6:2FTS from the concrete into an overlaying static water volume has been measured under field conditions at two constant temperatures. Fitting the desorption data and estimated rainfall/runoff to a kinetic model suggests that this and similar firefighting training pads will likely remain a source of PFASs for many decades (t0.5=25 years for PFOS).		1				1						1						B	-	消防訓練場でのPFAS存在の実態	
37	ばく露	Bräunig, Jennifer; Baduel, Christine; Heffernan, Amy; Rotander, Anna; Donaldson, Eric; Mueller, Jochen F	Fate and redistribution of perfluoroalkyl acids t	2017	Sci Total Environ. 2017 Oct 15;596-597:360-368. doi: 10.1016/j.scitotenv.2017.04.095. Epub 2017 Apr 22.	Leaching of perfluoroalkyl acids (PFAAs) from a local point source, a fire-fighting training area, has led to extensive contamination of a groundwater aquifer which has spread underneath part of a nearby town, Oakey, situated in the State of Queensland, Australia. Groundwater is extracted by residents from privately owned wells for daily activities such as watering livestock and garden beds. The concentration of 10 PFAAs in environmental and biological samples (water, soil, grass, chicken egg yolk, serum of horses, cattle and sheep), as well as human serum was investigated to determine the extent of contamination in the town and discuss fate and redistribution of PFAAs. Perfluorooctane sulfonate (PFOS) was the dominant PFAA in all matrices investigated, followed by perfluorohexane sulfonate (PFHxS). PFOS concentrations measured in water ranged between <0.17-14 μg/L, concentrations of PFHxS measured between <0.07-6 μg/L. PFAAs were detected in backyards (soil, grass), livestock and chicken egg yolk. Significant differences (p<0.01) in PFOS and PFHxS concentrations in two groups of cattle were found, one held within the contamination plume, the other in the vicinity but outside of the contamination plume. In human serum PFOS concentrations ranged from 38 to 381 μg/L, while PFHxS ranged from 39 to 214 μg/L. Highest PFOS concentrations measured in human serum were >30-fold higher compared to the general Australian population. Through use of contaminated groundwater secondary sources of PFAA contamination are created on private property, leading to further redistribution of contamination and creation of additional humanexposure pathways.		1				1												B	-	環境・生物試料、人血漿中のPFAS	
38	ばく露	Chen, Wen-Ling; Bai, Fang-Yu; Chang, Ying-Chia; Chen, Pau-Chung; Chen, Chia-Yang	Concentrations of perfluoroalkyl substances in	2018	J Food Drug Anal. 2018 Jul;26(3):994-1004. doi: 10.1016/j.jfda.2017.12.011. Epub 2018 Jan 17.	This study quantified five perfluorocarboxylic acids (PFCAs) and two perfluorosulfonic acids in cereals, meats, seafood, eggs, pork liver, and milk in Taiwan using ultra-performance liquid chromatography-tandem mass spectrometry and evaluated the dietary exposure of the general population and pregnant women using per capita consumption and a questionnaire, respectively. Perfluorooctanoic acid (PFOA) and PFCAs of 10-12 carbons were found in almost all of the samples in considerable concentrations in rice and pork liver, reaching as high as 283 ng/g (PFOA in pork liver); the levels are two to three orders of magnitude higher than previous reports. Perfluorooctane sulfonate (PFOS), the most frequently mentioned perfluoroalkyl substance, was rarely detected in many food items (detection frequencies <20% in rice, flour, pork, chicken, salmon, squid, eggs, and milk) at <0.4 ng/g, except for beef, pork liver and some seafood (detection frequencies: 100%, GMs: 0.05-3.52 ng/g). Compared to populations in Western countries, people in Taiwan are exposed to much more perfluorohexanoic acid, PFOA, perfluorodecanoic acid, and perfluoroundecanoic acid (11.2, 85.1, 44.2, and 4.45 ng/kg b.w./day, respectively), mainly due to the higher contaminations in food. The exposure of 8.0 μg PFOA/person/day in the 95 percentile of pregnant women was due to their frequent consumption of pork liver.		1				1										1		B	-	台湾、食品中のPFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
39	ばく露	Goodrow, Sandra M; Ruppel, Bruce; Lippincott, Robert L; Post, Gloria B; Procopio, Nicholas A	Investigation of levels of perfluoroalkyl substar	2020	Sci Total Environ. 2020 Aug 10;729:138839. doi: 10.1016/j.scitotenv.2020.138839. Epub 2020 Apr 28.	Per- and polyfluoroalkyl substances (PFAS) are persistent, bioaccumulative, and toxic substances found in New Jersey (NJ) due to historic and current industrial activities and the use of aqueous film forming foams. This research documents PFAS occurrence in surface water, sediments, and fish tissue at 11 targeted waterbodies in NJ suspected to be impacted by PFAS. Thirteen PFAS compounds were quantified from each media. The profile of detected PFAS differed among media from the same site, with shorter chain PFAS tending to predominate in surface water while longer chain PFAS predominated in fish and sediments. All water samples contained detectable levels of at least four perfluoroalkyl substances. PFOA, PFHpA and PFPeA were detected at every site. Σ PFAS concentrations in water samples ranged from 22.9 to 279.5 ng/L. At least one, and up to eight, PFAS were detected in sediment samples at 10 sites, while there were no detections of PFAS in sediments at the reference site. Σ PFAS concentrations in sediment samples ranged from below detection to 30.9 ng/g. At least one fish of each species at every site had detectable levels of PFAS compounds. Σ PFAS concentrations in fish were highest at sites downstream from a military facility, and lowest at the reference site. PFOS, PFDA, PFUnA and PFDoA were the predominant PFAS detected in fish tissue. PFOS was generally found in fish tissue at higher concentrations than other PFAS, with higher PFOS concentrations found in the tissue of yellow perch, American eel, pumpkinseed, and largemouth bass collected at sites with higher detections of PFOS in surface waters. PFOS levels in nearly all fishspecies were, on average, high enough to trigger fish consumption advisories. Additional studies are needed to further evaluate the sources and occurrence of PFAS in NJ and to better understand their movement through the environment and potential risks.		1				1														B	-	米国、11水源、表流水・底泥・魚の組織中のPFAS	
40	ばく露	Houtz, Erika F; Higgins, Christopher P; Field, Jennifer A; Sedlak, David L	Persistence of perfluoroalkyl acid precursors in	2013	Environ Sci Technol. 2013 Aug 6;47(15):8187-95. doi: 10.1021/es4018877. Epub 2013 Jul 25.	Several classes of polyfluorinated chemicals that are potential precursors to the perfluorinated carboxylates and sulfonates are present in aqueous film-forming foams (AFFF). To assess the persistence of these AFFF-derived precursors, groundwater, soil, and aquifer solids were obtained in 2011 from an unlined firefighter training area at a U.S. Air Force Base where AFFF was regularly used between 1970 and 1990. To measure the total concentration of perfluorinated carboxylate and sulfonate precursors in archived AFFF formulations and AFFF-impacted environmental samples, a previously developed assay that uses hydroxyl radical to oxidize precursors to perfluorinated carboxylates was adapted for these media. This assay was employed along with direct measurement of 22 precursors found in AFFF and a suite of other poly- and perfluoroalkyl substances (PFASs). On a molar basis, precursors accounted for 41-100% of the total concentration of PFASs in archived AFFF formulations. In the training area, precursors measured by the oxidation assay accounted for an average of 23% and 28% of total PFASs (i.e., precursors and perfluorinated carboxylates and sulfonates) in groundwater and solids samples, respectively. One precursor in AFFF, perfluorohexane sulfonamide amine, was observed on several highly contaminated soil and aquifer solids samples, but no other precursors present in AFFF formulations were detected in any samples at this field site. Suspected intermediate transformation products of precursors in AFFF that were directly measured accounted for approximately half of the total precursor concentration insamples from the training site. The fraction of PFASs consisting of perfluorinated carboxylates and sulfonates was greater in groundwater and solid samples than in any archived AFFF formulations, suggesting that much of the mass of precursors released at the site was converted to perfluorinated carboxylates and sulfonates. The precursors that have persisted at this site may generate significant amounts of additional perfluorinated carboxylates and sulfonates upon remediation of contaminated groundwater or aquifer solids.		1				1				1										B	-	米国、空軍消火訓練地域、地下水、土壌、帯水層土壌のPFAS	
41	ばく露	Karásková, Pavlína; Venier, Marta; Melymuk, Lisa; Bečanová, Jitka; Vojta, Šimon; Prokeš, Roman; Diamond, Miriam L; Klánová, Jana	Perfluorinated alkyl substances (PFASs) in hou	2016	Environ Int. 2016 Sep;94:315-324. doi: 10.1016/j.envint.2016.05.031. Epub 2016 Jun 10.	Concentrations of 20 perfluorinated alkyl substances (PFASs) were measured in dust samples from 41 homes in Canada, the Czech Republic, and United States in the spring-summer of 2013. The most frequently detected compounds were perfluorohexanoic acid (PFHxA) and perfluorooctane sulfonate (PFOS). PFOS and perfluorooctanoic acid (PFOA) had the highest concentrations of PFASs in all countries. PFOS median concentrations for the three countries were between 9.1 and 14.1ng/g, and PFOA medians ranged between 8.2 and 9.3ng/g. In general, concentrations in North America were higher than in the Czech Republic, which is consistent with usage patterns. No differences were found for perfluorooctane sulfonamides/sulfonamidoethanols (FOSA/Es) levels due to the low number of detections. Homologue profiles suggest that the shift from longer to shorter chain PFASs is more advanced in North America than in Europe. Significant relationships were found among individual homologues and between PFAS concentrations in dust and type of floor, number of people living in the house, and building age.		1				1			1	1				1					B	-	カナダ、チェコ、米国、ダスト中のPFAS	
42	ばく露	Knobeloch, Lynda; Imm, Pamela; Anderson, Henry	Perfluoroalkyl chemicals in vacuum cleaner du	2012	Chemosphere. 2012 Aug;88(7):779-83. doi: 10.1016/j.chemosphere.2012.03.082. Epub 2012 Apr 27.	Perfluoroalkyl chemicals (PFCs) have been used as surfactants and stain repellants in a variety of consumer products for more than 50years and there is growing concern regarding their persistence and toxicity. Human exposure to these chemicals is essentially universal in North America and researchers have linked them to a variety of health problems ranging from higher rates of cancer, to developmental and reproductive problems, and higher cholesterol levels. Major exposure pathways are food and water ingestion, dust ingestion via hand to mouth transfer. In an effort to assess residential exposure, the Wisconsin Department of Health Services tested vacuum cleaner contents from thirty-nine homes for 16 perfluoroalkyl chemicals. PFOS, PFOA, PFHxS, PFHpA and PFNA were found in all of the vacuum dust samples and dust from eight homes contained all 16 PFCs included in our analysis. The most commonly detected compounds were perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHxS) and perfluorooctanoic acid (PFOA) which together made up 70% of the total PFC residues in dust from these homes. Summed PFC concentrations in these dust samples ranged from 70 to 2513ng/g (median 280ng/g). Our investigation suggests that these chemicals may be ubiquitous contaminants in US homes.		1				1			1	1									B	-	ダスト中のPFAS	
43	ばく露	Moreta, Cristina; Tena, María Teresa	Determination of perfluorinated alkyl acids in c	2014	J Chromatogr A. 2014 Aug 15;1355:211-8. doi: 10.1016/j.chroma.2014.06.018. Epub 2014 Jun 17.	An analytical method is proposed to determine ten perfluorinated alkyl acids (PFAAs) [nine perfluorocarboxylic acids (PFCAs) and perfluorooctane sulfonate (PFOS)] in corn, popcorn and microwave popcorn packaging by focused ultrasound solid-liquid extraction (FUSLE) and ultra high performance liquid chromatography (UHPLC) coupled to quadrupole-time of flight mass spectrometry (QTOF-MS/MS). Selected PFAAs were extracted efficiently in only one 10-s cycle by FUSLE, a simple, safe and inexpensive technique. The developed method was validated for microwave popcorn bags matrix as well as corn and popcorn matrices in terms of linearity, matrix effect error, detection and quantification limits, repeatability and recovery values. The method showed good accuracy with recovery values around 100% except for the lowest chain length PFAAs, satisfactory reproducibility with RSDs under 16%, and sensitivity with limits of detection in the order of hundreds picograms per gram of sample (between 0.2 and 0.7ng/g). This method was also applied to the analysis of six microwave popcorn bags and the popcorn inside before and after cooking. PFCAs contents between 3.50ng/g and 750ng/g were found in bags, being PFHxA (perfluorohexanoic acid) the most abundant of them. However, no PFAAs were detected either corn or popcorn, therefore no migration was assumed.		1				1													B	-	コーン、ポップコーン、袋中のPFAS	
44	ばく露	Pérez, Francisca; Llorca, Marta; Köck-Schulmeyer, Marianne; Škrbić, Biljana; Oliveira, Luis Silva; da Boit Martinello, Kátia; Al-Dhabi, Naif A; Antić, Igor; Farré, Marinella; Barceló, Damià	Assessment of perfluoroalkyl substances in foo	2014	Environ Res. 2014 Nov;135:181-9. doi: 10.1016/j.envres.2014.08.004. Epub 2014 Oct 1.	This study assessed the levels of 21 perfluoroalkyl substances (PFASs) in 283 food items (38 from Brazil, 35 from Saudi Arabia, 174 from Spain and 36 from Serbia) among the most widely consumed foodstuffs in these geographical areas. These countries were chosen as representatives of the diet in South America, Western Asia, Mediterranean countries and South-Eastern Europe. The analysis of foodstuffs was carried out by turbulent flow chromatography (TFC) combined with liquid chromatography with triple quadrupole mass spectrometry (LC-QqQ-MS) using electrospray ionization (ESI) in negative mode. The analytical method was validated for the analysis of different foodstuff classes (cereals, fish, fruit, milk, ready-to-eat foods, oil and meat). The analytical parameters of the method fulfill the requirements specified in the Commission Recommendation 2010/161/EU. Recovery rates were in the range between 70% and 120%. For all the selected matrices, the method limits of detection (MLOD) and the method limits of quantification (MLOQ) were in the range of 5 to 650 pg/g and 17 to 2000 pg/g, respectively. In general trends, the concentrations of PFASs were in the pg/g or pg/mL levels. The more frequently detected compounds were perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorobutanoic acid (PFBA). The prevalence of the eight-carbon chain compounds in biota indicates the high stability and bioaccumulation potential of these compounds. But, at the same time, the high frequency of the shorter chain compounds is also an indication of the use of replacement compounds in the new fluorinated materials. When comparingthe compounds profile and their relative abundances in the samples from diverse origin, differences were identified. However, in absolute amounts of total PFASs no large differences were found between the studied countries. Fish and seafood were identified as the major PFASs contributors to the diet in all the countries. The total sum of PFASs in fresh fish and seafood was in the range from the MLOQ to 28ng/g ww. According to the FAO-WHO diets composition, the daily intake (DI) of PFASs was calculated for various age and gender groups in the different diets. The total PFASs food intake was estimated to be between 2300 and 3800 ng /person per day for the different diets. Finally, the risk intake (RI) was calculated for selected relevant compounds. The results have indicated that by far in no case the tolerable daily intake (TDI) (150, 1500, 50,000, 1,000,000, 150, 1500 ng/kg body weight, for perfluorohexanesulfonate (PFHxS), fluorotelomer alcohol (FTOH), perfluorobutanesulfonic acid (PFBS), perfluorobutanoic acid (PFBA), PFOS and PFOA, respectively) was exceeded.	1	1		1		1												B	-	食品中のPFAS	
45	ばく露	Shao, Mihua; Ding, Guanghui; Zhang, Jing; Wei, Lie; Xue, Huanhuan; Zhang, Nannan; Li, Yang; Chen, Guanqun; Sun, Yeqing	Occurrence and distribution of perfluoroalkyl s	2016	Environ Pollut. 2016 Sep;216:675-681. doi: 10.1016/j.envpol.2016.06.031. Epub 2016 Jun 23.	Perfluoroalkyl substances (PFASs) have been recognized as emerging environmental pollutants. However, there is limited information on the contamination level and spatial distribution of PFASs in the Shuangtaizi Estuary, where the Shuangtaizi Hekou Nature Reserve is located. In the present study, the contamination level and spatial distribution of PFASs in surface water (approximately 0.5 m below the surface) and bottom water (about 0.5 m above the bottom) of the Shuangtaizi Estuary were investigated. The data indicated that the Shuangtaizi Estuary was commonly contaminated by PFASs. The total concentration of PFASs in surface and bottom water of the Shuangtaizi Estuary ranged from 66.2 to 185 ng L(-1) and from 44.8 to 209 ng L(-1), respectively. The predominant PFASs were perfluorobutanoic acid (PFBA), perfluoropentanoic acid, perfluorooctanoic acid, perfluorohexanoic acid and perfluorobutane sulfonate (PFBS). In general, PFAS concentrations in surface water samples were lower than those in bottom water samples. The spatial distribution of PFASs in the Shuangtaizi Estuary was mainly affected by particular landform, tide and residual currents in Liaodong Bay. The total mass flux of 15 PFASs from the Shuangtaizi River to Liaodong Bay was estimated to be 352 kg year(-1), which was lower than the total flux from the Daling River and the Daliao River. As short-chain PFASs, such as PFBS and PFBA, have been the prevalent compounds in some places and are continuously produced and used, long-term monitoring and effective pollution controls are suggested.	1	1		1		1			1									B	-	中国、河川河口、表層水、下部水のPFAS	
46	ばく露	Strynar, Mark J; Lindstrom, Andrew B	Perfluorinated compounds in house dust from	2008	Environ Sci Technol. 2008 May 15;42(10):3751-6. doi: 10.1021/es7032058.	The perfluoroalkyl acids (PFAAs), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), have come under increasing scrutiny due to their persistence, global distribution, and toxicity. Given that their human exposure routes remain poorly characterized, the potential role of house dust needs to be more completely evaluated. In this study, new methods for the analysis of 10 PFAAs and three fluorinated telomer alcohols (FTOHs) were developed for dust samples collected from homes (n = 102) and day care centers (n = 10) in Ohio and North Carolina in 2000-2001. FTOHs were measured by GC/ MS and PFAAs were analyzed by LC-MS/MS. PFOS and PFOA were the most prominent compounds detected, occurring in over 95% of the samples at median concentrations of 201 and 142 ng/g of dust, respectively. Maximal concentrations of PFOS were 12 100 ng/g (95th percentile, 2240 ng/g), PFOA 1960 ng/g (95th percentile, 1200 ng/g), and perfluorohexanesulfonate (PFHS) 35 700 ng/g (95th percentile, 2300 ng/g). The 8:2 FTOH, which is volatile and can degrade to PFOA, had a maximum concentration of 1660 ng/g dust (95th percentile, 669 ng/g). These results indicate that perfluorinated compounds are present in house dust at levels that may represent an important pathway for human exposure.		1				1			1					1				B	-	ダスト中のPFAS	
47	ばく露	Wang, Xiaoping; Halsall, Crispin; Codling, Garry; Xie, Zhiyong; Xu, Baiqing; Zhao, Zhen; Xue, Yonggang; Ebinghaus, Ralf; Jones, Kevin C	Accumulation of perfluoroalkyl compounds in t	2014	Environ Sci Technol. 2014;48(1):173-81. doi: 10.1021/es4044775. Epub 2013 Dec 16.	The use of snow and ice cores as recorders of environmental contamination is particularly relevant for per- and polyfluoroalky substances (PFASs) given their production history, differing source regions and varied mechanisms driving their global distribution. In a unique study perfluoroalkyl acids (PFAAs) were analyzed in dated snow-cores obtained from high mountain glaciers on the Tibetan Plateau (TP). One snow core was obtained from the Mt Muztagata glacier (accumulation period of 1980-1999), located in western Tibet and a second core from Mt. Zuoqiupo (accumulation period: 1996-2007) located in southeastern Tibet, with fresh surface snow collected near Lake Namco in 2010 (southern Tibet). The higher concentrations of ΣPFAAs were observed in the older Mt Muztagata core and dominated by perfluorooctanesulfonic acid (PFOS) (61.4-346 pg/L) and perfluorooctanoic acid (PFOA) (40.8-243 pg/L), whereas in the Mt Zuoqiupu core the concentrations were lower (e.g., PFOA: 37.8-183 pg/L) with PFOS below detection limits. These differences in PFAA concentrations and composition profile likely reflect the upwind sources affecting the respective sites (e.g., European/central Asian sources for Mt Muztagata and India sources for Mt Zuoqiupu). Perfluorobutanoic acid (PFBA) dominated the recent surface snowpack of Lake Namco which is mainly associated with India sources where the shorter chain volatile PFASs precursors predominate. The use of snow cores in different parts of Tibet provides useful recorders to examine the influence of different PFASs source regions and reflect changing PFAS production/use in the NorthernHemisphere.		1				1												B	-	高山、アイスコア、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
48	ばく露	EFSA	Perfluoroalkylated substances in food: Occurre	2012	EFSA Journal 2012;10(6):2743, 55 pp. doi: 10.2903/j.efsa.2012.2743	Perfluoroalkylated substances (PFASs) are highly fluorinated aliphatic compounds with high thermal and chemical stability, as well as high surface activity. PFASs are used in a range of industrial and chemical applications e.g. textiles, paper, packaging materials, paint and varnish, and fire-extinguishing liquids. Several PFASs are recognised as environmentally persistent organic pollutants and are associated with adverse health effects. Diet is considered the main source of exposure to PFASs. In 2008, the EFSA Scientific Panel on Contaminants in the Food Chain (CONTAM Panel) performed a risk assessment for perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) concluding that it is unlikely that adverse effects of PFOS or PFOA are occurring in the general population. The CONTAM Panel acknowledged the limitation of available data and recommended further monitoring of PFAS in food. The present report summarises occurrence data for PFASs collected in 13 European countries during the period 2006 to 2012. A total of 54,195 analytical results covering a list of 27 substances were included in the assessment. The overall proportion of quantified results was very low. Across food groups, PFASs were found more frequently in fish and other seafood and in meat and meat products (liver in particular). For PFOS, the dietary exposure estimates in the adult population was < 3.5 % of the TDI for average consumers and < 6.7 % of the TDI in high consumers. For the same consumer groups, exposure to PFOA represented < 0.3 % and < 0.5 % of the TDI, respectively. Exposure in toddlers was two to three times higher compared to adults. For the other PFASs evaluated, daily dietary exposure was estimated to be in the low ng/kg b.w. range. The current review confirmed that dietary exposure to PFOS and PFOA is highly unlikely to exceed health-based guidance values.				1				1											評価書に該当		A	-	食事中のPFAS、EFSAのデータ178番と同じ	
49	ばく露	Houtz, Erika F; Sutton, Rebecca; Park, June-Soo; Sedlak, Margaret	Poly- and perfluoroalkyl substances in wastew	2016	Water Res. 2016 May 15;95:142-9. doi: 10.1016/j.watres.2016.02.055. Epub 2016 Mar 10.	In late 2014, wastewater effluent samples were collected from eight treatment plants that discharge to San Francisco (SF) Bay in order to assess poly- and perfluoroalkyl substances (PFASs) currently released from municipal and industrial sources. In addition to direct measurement of twenty specific PFAS analytes, the total concentration of perfluoroalkyl acid (PFAA) precursors was also indirectly measured by adapting a previously developed oxidation assay. Effluent from six municipal treatment plants contained similar amounts of total PFASs, with highest median concentrations of PFHxA (24 ng/L), followed by PFOA (23 ng/L), PFBA (19 ng/L), and PFOS (15 ng/L). Compared to SF Bay municipal wastewater samples collected in 2009, the short chain perfluorinated carboxylates PFBA and PFHxA rose significantly in concentration. Effluent samples from two treatment plants contained much higher levels of PFASs: over two samplings, wastewater from one municipal plant contained an average of 420 ng/L PFOS and wastewater from an airport industrial treatment plant contained 560 ng/L PFOS, 390 ng/L 6:2 FtS, 570 ng/L PFPeA, and 500 ng/L PFHxA. The elevated levels observed in effluent samples from these two plants are likely related to aqueous film forming foam (AFFF) sources impacting their influent; PFASs attributable to both current use and discontinued AFFF formulations were observed. Indirectly measured PFAA precursor compounds accounted for 33%-63% of the total molar concentration of PFASs across all effluent samples and the PFAA precursors indicated by the oxidation assay were predominately short-chained. PFAS levels inSF Bay effluent samples reflect the manufacturing shifts towards shorter chained PFASs while also demonstrating significant impacts from localized usage of AFFF.				1				1			1					1					B	-	米国、排水処理場、PFAS	
50	ばく露	Hu, Xindi C; Andrews, David Q; Lindstrom, Andrew B; Bruton, Thomas A; Schaider, Laurel A; Grandjean, Philippe; Lohmann, Rainer; Carignan, Courtney C; Blum, Arlene; Balan, Simona A; Higgins, Christopher P; Sunderland, Elsie M	Detection of Poly- and Perfluoroalkyl Substanc	2016	Environ Sci Technol Lett. 2016 Oct 11;3(10):344-350. doi: 10.1021/acs.estlett.6b00260. Epub 2016 Aug 9.	Drinking water contamination with poly- and perfluoroalkyl substances (PFASs) poses risks to the developmental, immune, metabolic, and endocrine health of consumers. We present a spatial analysis of 2013-2015 national drinking water PFAS concentrations from the U.S. Environmental Protection Agency's (US EPA) third Unregulated Contaminant Monitoring Rule (UCMR3) program. The number of industrial sites that manufacture or use these compounds, the number of military fire training areas, and the number of wastewater treatment plants are all significant predictors of PFAS detection frequencies and concentrations in public water supplies. Among samples with detectable PFAS levels, each additional military site within a watershed's eight-digit hydrologic unit is associated with a 20% increase in PFHxS, a 10% increase in both PFHpA and PFOA, and a 35% increase in PFOS. The number of civilian airports with personnel trained in the use of aqueous film-forming foams is significantly associated with the detection of PFASs above the minimal reporting level. We find drinking water supplies for 6 million U.S. residents exceed US EPA's lifetime health advisory (70 ng/L) for PFOS and PFOA. Lower analytical reporting limits and additional sampling of smaller utilities serving <10000 individuals and private wells would greatly assist in further identifying PFAS contamination sources.				1				1				1	1						B	-	米国、UCMR3データ、飲料水、PFAS、工業地域、軍消防訓練場、排水処理施設に関連したところ	
51	ばく露	Nakayama, Shoji; Strynar, Mark J; Helfant, Laurence; Egeghy, Peter; Ye, Xibiao; Lindstrom, Andrew B	Perfluorinated compounds in the Cape Fear Dr	2007	Environ Sci Technol. 2007 Aug 1;41(15):5271-6. doi: 10.1021/es070792y.	Concern over perfluorinated organic compounds (PFCs), e.g., perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), is due to a number of recent studies which show that the PFCs are persistent, bioaccumulative, and toxic in animals. Despite sustained interest in this topic, little information is available concerning the environmental distributions of the compounds. In this study, a new method was developed for the analysis of 10 target PFCs and its performance was examined in a systematic evaluation of surface water in the Cape Fear River Basin in North Carolina. One hundred samples from 80 different locations were collected during the spring of 2006. Detectable levels of the target PFCs were found in all samples, and were comparable to values reported previously, with maximum PFOS at 132 ng/L, PFOA at 287 ng/L, perfluorononanoic acid (C9) at 194 ng/L, and perfluoroheptanoic acid (C7) at 329 ng/L. In general, the lowest concentrations of the PFCs were found in the smallest tributaries while the highest levels were found in middle reaches of the Drainage Basin. Variability of PFC concentrations suggests a series of source inputs throughout the Basin. Seventeen sample sites (22%) had PFOS concentrations greater than 43 ng/L, a conservative safe water concentration estimated to be protective of avian life. In addition, a total of 26 sites (32%) had PFOA concentrations above 40 ng/L.				1				1		1						1			B	-	米国、表流水、PFAS	
52	ばく露	Nakayama, Shoji F; Strynar, Mark J; Reiner, Jessica L; Delinsky, Amy D; Lindstrom, Andrew B	Determination of perfluorinated compounds in	2010	Environ Sci Technol. 2010 Jun 1;44(11):4103-9. doi: 10.1021/es100382z.	Despite ongoing efforts to develop robust analytical methods for the determination of perfluorinated compounds (PFCs) such as perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) in surface water, comparatively little has been published on method performance, and the environmental distribution of these materials remains poorly described worldwide. In this study, an existing method was improved and applied in a large-scale evaluation of the Upper Mississippi River Basin, one of the largest watersheds in the world. Samples were collected in 2008 in an effort that involved multiple sample sites and collection teams, long-range transport, and storage of up to 4 weeks before analysis. Ninety-four percent of the resulting 177 samples had quantifiable PFC concentrations, with 80% of the individual target compounds below 10 ng/L. The most abundant PFCs were perfluorobutanoic acid (C4; 77% above the limit of quantitation, LOQ), perfluorooctanoic acid (C8; 73%), perfluorooctanesulfonate (PFOS; 71%), perfluorohexanoic acid (C6; 70%), and perfluoroheptanoic acid (C7; 69%), with the remaining target compounds occurring above the LOQ in less than 50% of the samples. The highest concentrations recorded include C4 at 458 ng/L, PFOS at 245 ng/L, and C8 at 125 ng/L, suggesting various point source inputs within the Basin.				1				1											B	-	ミシシッピ川流域、PFAS	
53	ばく露	Schaider, Laurel A; Balan, Simona A; Blum, Arlene; Andrews, David Q; Strynar, Mark J; Dickinson, Margaret E; Lunderberg, David M; Lang, Johnsie R; Peaslee, Graham F	Fluorinated Compounds in U.S. Fast Food Pac	2017	Environ Sci Technol Lett. 2017;4(3):105-111. doi: 10.1021/acs.estlett.6b00435.	Per- and polyfluoroalkyl substances (PFASs) are highly persistent synthetic chemicals, some of which have been associated with cancer, developmental toxicity, immunotoxicity, and other health effects. PFASs in grease-resistant food packaging can leach into food and increase dietary exposure. We collected ~400 samples of food contact papers, paperboard containers, and beverage containers from fast food restaurants throughout the United States and measured total fluorine using particle-induced γ-ray emission (PIGE) spectroscopy. PIGE can rapidly and inexpensively measure total fluorine in solid-phase samples. We found that 46% of food contact papers and 20% of paperboard samples contained detectable fluorine (>16 nmol/cm2). Liquid chromatography/high-resolution mass spectrometry analysis of a subset of 20 samples found perfluorocarboxylates, perfluorosulfonates, and other known PFASs and/or unidentified polyfluorinated compounds (based on nontargeted analysis). The total peak area for PFASs was higher in 70% of samples (10 of 14) with a total fluorine level of >200 nmol/cm2 compared to six samples with a total fluorine level of <16 nmol/cm2. Samples with high total fluorine levels but low levels of measured PFASs may contain volatile PFASs, PFAS polymers, newer replacement PFASs, or other fluorinated compounds. The prevalence of fluorinated chemicals in fast food packaging demonstrates their potentially significant contribution to dietary PFAS exposure and environmental contamination during production and disposal.				1				1				1	1						B	-	米国、食品容器中のPFAS	
54	ばく露	Zhang, Xianming; Lohmann, Rainer; Dassuncao, Clifton; Hu, Xindi C; Weber, Andrea K; Vecitis, Chad D; Sunderland, Elsie M	Source attribution of poly- and perfluoroalkyl s	2016	Environ Sci Technol Lett. 2016 Sep 13;3(9):316-321. doi: 10.1021/acs.estlett.6b00255. Epub 2016 Aug 4.	Exposure to poly and perfluoroalkyl substances (PFASs) has been associated with adverse health effects in humans and wildlife. Understanding pollution sources is essential for environmental regulation but source attribution for PFASs has been confounded by limited information on industrial releases and rapid changes in chemical production. Here we use principal component analysis (PCA), hierarchical clustering, and geospatial analysis to understand source contributions to 14 PFASs measured across 37 sites in the Northeastern United States in 2014. PFASs are significantly elevated in urban areas compared to rural sites except for perfluorobutane sulfonate (PFBS), N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA), perfluoroundecanate (PFUnDA) and perfluorododecanate (PFDoDA). The highest PFAS concentrations across sites were for perfluorooctanate (PFOA, 56 ng L(-1)) and perfluorohexane sulfonate (PFOS, 43 ng L(-1)) and PFOS levels are lower than earlier measurements of U.S. surface waters. PCA and cluster analysis indicates three main statistical groupings of PFASs. Geospatial analysis of watersheds reveals the first component/cluster originates from a mixture of contemporary point sources such as airports and textile mills. Atmospheric sources from the waste sector are consistent with the second component, and the metal smelting industry plausibly explains the third component. We find this source-attribution technique is effective for better understanding PFAS sources in urban areas.				1				1	1			1							B	-	汚染源解析、PFAS	
55	ばく露	Zhao, Zhen; Xie, Zhiyong; Möller, Axel; Sturm, Renate; Tang, Jianhui; Zhang, Gan; Ebinghaus, Ralf	Distribution and long-range transport of polyfl	2012	Environ Pollut. 2012 Nov;170:71-7. doi: 10.1016/j.envpol.2012.06.004. Epub 2012 Jul 5.	The global distribution and long-range transport of polyfluoroalkyl substances (PFASs) were investigated using seawater samples collected from the Greenland Sea, East Atlantic Ocean and the Southern Ocean in 2009-2010. Elevated levels of ΣPFASs were detected in the North Atlantic Ocean with the concentrations ranging from 130 to 650 pg/L. In the Greenland Sea, the ΣPFASs concentrations ranged from 45 to 280 pg/L, and five most frequently detected compounds were perfluorooctanoic acid (PFOA), perfluorohexanesulfonate (PFHxS), perfluorohexanoic acid (PFHxA), perfluorooctane sulfonate (PFOS) and perfluorobutane sulfonate (PFBS). PFOA (15 pg/L) and PFOS (25-45 pg/L) were occasionally found in the Southern Ocean. In the Atlantic Ocean, the ΣPFASs concentration decreased from 2007 to 2010. The elevated PFOA level that resulted from melting snow and ice in Greenland Sea implies that the Arctic may have been driven by climate change and turned to be a source of PFASs for the marine ecosystem.			1	1				1		1	1							B	-	グリーンランド、東大西洋、南極海の海水中のPFAS	
56	ばく露	Galloway, Jason E; Moreno, Anjelica V P; Lindstrom, Andrew B; Strynar, Mark J; Newton, Seth; May, Andrew A; Weavers, Linda K	Evidence of Air Dispersion: HFPO-DA and PFO	2020	Environ Sci Technol. 2020 Jun 16;54(12):7175-7184. doi: 10.1021/acs.est.9b07384. Epub 2020 May 27.	Perfluorooctanoic acid (PFOA) was used as a fluoropolymer manufacturing aid at a fluoropolymer production facility in Parkersburg, WV from 1951 to 2013. The manufacturer introduced a replacement surfactant hexafluoropropylene oxide dimer acid (HFPO-DA) that has been in use at this site since 2013. Historical releases of PFOA and related epidemiological work in this area has been primarily focused on communities downstream. To provide an update on the ongoing impacts from this plant, 94 surface water samples and 13 soil samples were collected mainly upstream and downwind of this facility. PFOA was detected in every surface water sample with concentrations exceeding 1000 ng/L at 13 sample sites within an 8 km radius of the plant. HFPO-DA was also found to be widespread with the highest levels (>100 ng/L) found in surface water up to 6.4 km north of the plant. One sample site, 28 km north of the plant, had PFOA at 143 ng/L and HFPO-DA at 42 ng/L. Sites adjacent to landfills containing fluorochemical waste had PFOA concentrations ranging up to >1000 ng/L. These data indicate that downwind atmospheric transport of both compounds has occurred and that the boundaries of the impact zone have yet to be fully delineated.				1				1	1										B	-	フッ素ポリマー工場の影響評価、周辺の表流水、土壌中のPFAS	
57	ばく露	Gebbink, Wouter A; van Asseldonk, Laura; van Leeuwen, Stefan P J	Presence of Emerging Per- and Polyfluoroalkyl	2017	Environ Sci Technol. 2017 Oct 3;51(19):11057-11065. doi: 10.1021/acs.est.7b02488. Epub 2017 Sep 15.	The present study investigated the presence of legacy and emerging per- and polyfluoroalkyl substances (PFASs) in river water collected in 2016 up- and downstream from a fluorochemical production plant, as well as in river water from control sites, in The Netherlands. Additionally, drinking water samples were collected from municipalities in the vicinity from the production plant, as well as in other regions in The Netherlands. The PFOA replacement chemical GenX was detected at all downstream river sampling sites with the highest concentration (812 ng/L) at the first sampling location downstream from the production plant, which was 13 times higher than concentrations of sum perfluoroalkylcarboxylic acids and perfluoroalkanesulfonates (ΣPFCA+ΣPFSA). Using high resolution mass spectrometry, 11 polyfluoroalkyl acids belonging to the C(2n)H(2n)F(2n)O(2), C(2n)H(2n+2)F(2n)SO(4) or C(2n+1)H(2n)F(2n+4)SO(4) homologue series were detected, but only in downstream water samples. These emerging PFASs followed a similar distribution as GenX among the downstream sampling sites, suggesting the production plant as the source. Polyfluoroalkyl sulfonates (C(2n)H(2)F(4n)SO(3)) were detected in all collected river water samples, and therefore appear to be ubiquitous contaminants in Dutch rivers. GenX was also detected in drinking water collected from 3 out of 4 municipalities in the vicinity of the production plant, with highest concentration at 11 ng/L. Drinking water containing the highest level of GenX also contained two C(2n)H(2n)F(2n)O(2) homologues.				1				1	1										B	-	フッ素化学工場の上下流の河川、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
58	ばく露	Heydebreck, Franziska; Tang, Jianhui; Xie, Zhiyong; Ebinghaus, Ralf	Alternative and Legacy Perfluoroalkyl Substanc	2015	Environ Sci Technol. 2015 Jul 21;49(14):8386-95. doi: 10.1021/acs.est.5b01648. Epub 2015 Jul 7.	The production and use of long-chain perfluoroalkyl substances (PFASs) must comply with national and international regulations. Driven by increasingly stringent regulations, their production has been outsourced to less regulated countries in Asia. In addition, the fluoropolymer industry started to use fluorinated alternatives, such as 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid (HFPO-DA). Between August 2013 and September 2014, we investigated the occurrence and distribution of HFPO-DA and legacy PFASs in surface waters of the following river/estuary systems: the Elbe and Rhine Rivers in Germany, the Rhine-Meuse delta in The Netherlands, and the Xiaoqing River in China. Distinct differences were revealed among the study areas; notably, the Chinese samples were highly polluted by an industrial point source discharging mainly perfluorooctanoic acid (PFOA). This particular point source resulted in concentrations more than 6000 times higher than an industrial point source observed in the Scheur River, where HFPO-DA was the dominant compound with a concentration of 73.1 ng/L. Moreover, HFPO-DA was detected in all samples along the coastline of the North Sea, indicating that the compound may be transported from the Rhine-Meuse delta into the German Bight via the water current. To the best of our knowledge, the fluorinated alternative, HFPO-DA, was detected for the first time in surface waters of Germany and China.					1				1												B	-	表流水、伝統的なPFASとHFPO-DA	
59	ばく露	Joerss, H.; Xie, Z.; Wagner, C. C.; von Appen, W. J.; Sunderland, E. M.; Ebinghaus, R.	Transport of Legacy Perfluoroalkyl Substances	2020	Environ Sci Technol. 2020 Aug 18;54(16):9958-9967. doi: 10.1021/acs.est.0c00228. Epub 2020 Jul 29.	The spatial distribution of 29 per- and polyfluoroalkyl substances (PFASs) in seawater was investigated along a sampling transect from Europe to the Arctic and two transects within Fram Strait, located between Greenland and Svalbard, in the summer of 2018 Hexafluoropropylene oxide-dimer acid (HFPO-DA), a replacement compound for perfluorooctanoic acid (PFOA), was detected in Arctic seawater for the first time. This provides evidence for its long-range transport to remote areas. The total PFAS concentration was significantly enriched in the cold, low-salinity surface water exiting the Arctic compared to warmer, higher-salinity water from the North Atlantic entering the Arctic (260 ± 20 pg/L versus 190 ± 10 pg/L). The higher ratio of perfluoroheptanoic acid (PFHpA) to perfluorononanoic acid (PFNA) in outflowing water from the Arctic suggests a higher contribution of atmospheric sources compared to ocean circulation. An east-west cross section of the Fram Strait, which included seven depth profiles, revealed higher PFAS concentrations in the surface water layer than in intermediate waters and a negligible intrusion into deep waters (>1000 m). Mass transport estimates indicated a net inflow of PFASs with ≥8 perfluorinated carbons via the boundary currents and a net outflow of shorter-chain homologues. We hypothesize that this reflects higher contributionsfrom atmospheric sources to the Arctic outflow and a higher retention of the long-chain compounds in melting snow and ice.				1		1				1											B	-	海水、29PFAS	
60	ばく露	Pan, Yitao; Zhang, Hongxia; Cui, Qianqian; Sheng, Nan; Yeung, Leo W Y; Sun, Yan; Guo, Yong; Dai, Jiayin	Worldwide Distribution of Novel Perfluoroether	2018	Environ Sci Technol. 2018 Jul 17;52(14):7621-7629. doi: 10.1021/acs.est.8b00829. Epub 2018 May 11.	Driven by increasingly stringent restrictions on long-chain per- and polyfluoroalkyl substances (PFASs), novel fluorinated compounds have emerged on the market. Here we report on the occurrences of several perfluoroalkyl ether carboxylic and sulfonic acids (PFECAs and PFESAs), including hexafluoropropylene oxide dimer and trimer acids (HFPO-DA and HFPO-TA), ammonium 4,8-dioxa-3 H-perfluorononanoate (ADONA), chlorinated polyfluorinated ether sulfonic acid (6:2 Cl-PFESA), and its hydrogen-substituted analogue (6:2 H-PFESA) in surface waters from China (n = 106), the United States (n = 12), the United Kingdom (n = 6), Sweden (n = 10), Germany (n = 14), The Netherlands (n = 6), and Korea (n = 6). Results showed that HFPO-DA, HFPO-TA, and 6:2 Cl-PFESA (median = 0.95, 0.21, and 0.31 ng/L, respectively) were frequently detected in all countries, indicating ubiquitous dispersal and distribution in global surface waters. The presence of 6:2 H-PFESA was widely detected in China (detection rate > 95%) but not in any other country. Only trace levels of ADONA (0.013-1.5 ng/L) were detected in the Rhine River flowing through Germany. The estimated total riverine mass discharges of HFPO-DA, HFPO-TA, and ∑PFESAs reached 2.6, 6.0, and 4.3 ton/year in five of the major river systems in China. Our results indicated that novel PFECAs and PFESAs might become global contaminants, and future investigations are warranted.					1				1				1							B	-	世界各国の表流水、PFAS	
61	ばく露	Pétré, Marie-Amélie; Genereux, David P; Koropeckyj-Cox, Lydia; Knappe, Detlef R U; Dubosco, Sandrine; Gilmore, Troy E; Hopkins, Zachary R	Per- and Polyfluoroalkyl Substance (PFAS) Tra	2021	Environ Sci Technol. 2021 May 4;55(9):5848-5856. doi: 10.1021/acs.est.0c07978. Epub 2021 Apr 2.	We quantified per- and polyfluoroalkyl substance (PFAS) transport from groundwater to five tributaries of the Cape Fear River near a PFAS manufacturing facility in North Carolina (USA). Hydrologic and PFAS data were coupled to quantify PFAS fluxes from groundwater to the tributaries. Up to 29 PFAS were analyzed, including perfluoroalkyl acids and recently identified fluoroethers. Total quantified PFAS (Σ PFAS) in groundwater was 20-4773 ng/L (mean = 1863 ng/L); the range for stream water was 426-3617 ng/L (mean = 1717 ng/L). Eight PFAS constituted 98% of Σ PFAS; perfluoro-2-(perfluoromethoxy)propanoic acid (PMPA) and hexafluoropropylene oxide dimer acid (GenX) accounted for 61%. For PFAS discharge from groundwater to one tributary, values estimated from stream water measurements (18 ± 4 kg/yr) were similar to those from groundwater measurements in streambeds (22-25 ± 5 kg/yr). At baseflow, 32 ± 7 kg/yr of PFAS discharged from groundwater to the five tributaries, eventually reaching the Cape Fear River. Given the PFAS emission timeline at the site, groundwater data suggest the abundant fluoroethers moved through the subsurface to streams in ≪50 yr. Discharge of contaminated groundwater may lead to long-term contamination of surface water and impacts on downstream drinking water supplies. This work addresses a gap in the PFAS literature: quantifying PFAS mass transfer between groundwater and surface water using field data.					1				1											B	-	地下水から河川への輸送、PFAS	
62	ばく露	Song, Xiaowei; Vestergren, Robin; Shi, Yali; Huang, Jun; Cai, Yaqi	Emissions, Transport, and Fate of Emerging Pe	2018	Environ Sci Technol. 2018 Sep 4;52(17):9694-9703. doi: 10.1021/acs.est.7b06657. Epub 2018 Aug 17.	Fluoropolymer manufacturing is a major historical source of perfluorooctanoic acid (PFOA) on a global scale, but little is known about the emissions, transport, and fate of emerging per- and polyfluoroalkyl substances (PFASs). Here, we performed a comprehensive spatial trend and interyear comparison of surface water and sediment samples from the Xiaoqing River, which receives water discharge from one of the major fluoropolymer manufacturing facilities in China. A suspect screening identified 42 chemical formulas, including the tetramer acid of hexafluoropropylene oxide (HFPO-TeA) and numerous tentatively detected isomers of C9-C14 per- or polyfluoroalkyl ether carboxylic acids (PFECAs). As revealed by the spatial trends and peak area-based sediment-water distribution coefficients, emerging PFASs with 3-9 perfluorinated carbons were transported unimpededly with the bulk water flow having no measurable degradation. Emerging PFASs with >9 perfluorinated carbons displayed more rapidly decreasing spatial trends than shorter-chain homologues in surface water due to increasing sedimentation rates. The presence of HFPO oligomers, monoether PFECAs, monohydrogen-substituted perfluoroalkyl carboxylic acids (PFCAs) and monochlorine-substituted PFCAs could partly be explained by the active use of polymerization aids or the impurities therein. However, further research is encouraged to better characterize the emissions of low-molecular-weight PFASs from fluoropolymers throughout their life-cycle.					1				1											B	-	河川、表流水・底泥、PFAS	
63	ばく露	D'eon, Jessica C; Crozier, Patrick W; Furdui, Vasile I; Reiner, Eric J; Libelo, E Laurence; Mabury, Scott A	Perfluorinated phosphonic acids in Canadian s	2009	Environ Toxicol Chem. 2009 Oct;28(10):2101-7. doi: 10.1897/09-048.1.	The environmental prevalence of a new class of perfluorinated acids, the perfluorinated phosphonic acids (PFPAs), was determined in Canadian surface waters and wastewater treatment plant (WWTP) effluent. For quality control and comparison, the C8- to C11-perfluorinated carboxylic acids and perfluorooctane sulfonic acid were included in the analysis. Water samples were extracted using weak anion-exchange solid-phase extraction cartridges. Perfluorinated phosphonic acids were observed in 80% of surface water samples and in six of the seven WWTP effluent samples. The C8-PFPA was observed at concentrations ranging from 88 +/- 33 to 3400 +/- 900 pg/L in surface waters and from 760 +/- 270 to 2500 +/- 320 pg/L in WWTP effluent. To our knowledge, this is the first observation of PFPAs in the environment. Given their structural similarities with perfluorinated carboxylic and sulfonic acids, PFPAs are expected to be persistent. The observation of PFPAs in the majority of samples analyzed here suggests they are prevalent environmental contaminants and should be considered in future environmental monitoring campaigns to better understand the total burden of fluorinated materials in the environment.					1				1											B	-	カナダ、表流水と排水処理施設、PFAS	
64	ばく露	De Silva, Amila O; Spencer, Christine; Scott, Brian F; Backus, Sean; Muir, Derek C G	Detection of a cyclic perfluorinated acid, perflu	2011	Environ Sci Technol. 2011 Oct 1;45(19):8060-6. doi: 10.1021/es200135c. Epub 2011 Apr 29.	Perfluoroethylcyclohexanesulfonate (PFECHS) is a cyclic perfluorinated acid (PFA) mainly used as an erosion inhibitor in aircraft hydraulic fluids. It is expected to be as recalcitrant to environmental degradation as aliphatic PFAs including perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS). For the first time, PFECHS is reported in top predator fish (<MDL to 3.7 ng g(-1) wet weight in whole body homogenate) from the Great Lakes and in surface waters (0.16-5.7 ng L(-1)). PFOS was the major aliphatic PFA in fish from the Great Lakes. Concentrations of most of the PFAs were not statistically different from previously reported 2004 trout data in Lake Ontario. Shorter chain perfluorocarboxylates were prevalent in surface waters of the Great Lakes, dominated by PFOA (0.65-5.5 ng/L). An impurity in the commercial PFECHS formulation, perfluoromethylcyclohexane sulfonate (PFMeCHS), was also detected in the dissolved phase but not above detection limits in fish tissue. Bioaccumulation factors (BAFs) were estimated by taking the ratio of fish to water concentrations. The mean log BAF values corresponded to 2.8 for PFECHS, 2.1 for PFOA, and 4.5 for PFOS. It is not certain whether the fish-water BAF for PFECHS is an overestimate due to the influence of precursor biotransformation. Further studies are recommended to understand the extent of PFECHS contamination.					1				1					1						B	-	魚・表流水中のPFECHS（環状PFAS）	
65	ばく露	Furdui, Vasile I; Stock, Naomi L; Ellis, David A; Butt, Craig M; Whittle, D Michael; Crozier, Patrick W; Reiner, Eric J; Muir, Derek C G; Mabury, Scott A	Spatial distribution of perfluoroalkyl contamina	2007	Environ Sci Technol. 2007 Mar 1;41(5):1554-9. doi: 10.1021/es0620484.	Individual whole body homogenates of 4 year old lake trout (Salvelinus namaycush) samples collected in 2001 from each of the Great Lakes were extracted using a novel fluorophilicity cleanup step and analyzed for perfluoroalkyl compounds (PFCs). Standard addition and internal standardization were used for quantification. Results were reported (+/- SE) for perfluorinated carboxylates (PFCAs), perfluorinated sulfonates (PFSAs), and unsaturated fluorotelomer carboxylates (8:2 and 10:2 FTUCA). The lowest average concentration of sigmaPFC was found in samples from Lake Superior (13+/-1 ng g(-1)), while the highest average concentration was found in samples from Lake Erie (152+/-14 ng g(-1)). Samples from Lake Ontario (60+/-5 ng g(-1)) and Lake Huron (58 +/-10 ng g(-1)) showed similar average sigmaPFC concentrations, although the perfluorinated sulfonate/carboxylate ratios were different. The major perfluoroalkyl contaminant observed was perfluorooctane sulfonate (PFOS) with the highest concentration found in samples from Lake Erie (121+/-14 ng g(-1)), followed by samples from Lake Ontario (46+/-5 ng g(-1)), Lake Huron (39 +/-10 ng g(-1)), Lake Michigan (16+/-3 ng g(-1)), and Lake Superior (5+/-1 ng g(-1)). Perfluorodecane sulfonate (PFDS) was detected in 89% of the samples, with the highest concentration in Lake Erie samples (9.8+/-1.6 ng g(-1)), and lowest concentration in samples from Lake Superior (0.7 +/- 0.1 ng g(-1)). Statistically significant correlations were observed between PFOS and PFDS concentrations, and PFOS concentration and body weight, respectively. The PFCAs were detected in all samples, with the highesttotal average concentration in samples from Lake Erie (19 ng g(-1)), followed by samples from Lake Huron (16 ng g(-1)), Lake Ontario (10 ng g(-1)), Lake Michigan (9 ng g(-1)) and Lake Superior (7 ng g(-1)). The compounds with significant contributions to the sigmaPFCA concentrations were PFOA and C9-C13-PFCAs. The 8:2 FTUCA was detected at concentrations ranging between 0.1 and 0.2 ng g-1, with the highest level in samples showing also elevated concentrations of PFOA (4.4 ng g(-1) for Lake Michigan vs 1.5 ng g(-1) for all other samples). The 10:2 FTUCA was detected only in 9% of all samples (nd, 45 pg g(-1)). For those PFCs where we determined lake water concentrations, the highest log BAFs were calculated for PFOS (4.1), PFDA (3.9), and PFOSA (3.8).					1				1					1	1					B	-	レイクトラウト中のPFAS	
66	ばく露	Holder, Chris; DeLuca, Nicole; Luh, Jeanne; Alexander, Parnian; Minucci, Jeffrey M; Vallero, Daniel A; Thomas, Kent; Cohen Hubal, Elaine A	Systematic Evidence Mapping of Potential Exp	2023	Environ Sci Technol. 2023 Apr 4;57(13):5107-5116. doi: 10.1021/acs.est.2c07185. Epub 2023 Mar 20.	Given that human biomonitoring surveys show per- and polyfluoroalkyl substances (PFAS) to be ubiquitous, humans can be exposed to PFAS through various sources, including drinking water, food, and indoor environmental media. Data on the nature and level of PFAS in residential environments are required to identify important pathways for human exposure. This work investigated important pathways of exposure to PFAS by reviewing, curating, and mapping evidence for the measured occurrence of PFAS in exposure media. Real-world occurrence for 20 PFAS was targeted primarily in media commonly related to human exposure (outdoor and indoor air, indoor dust, drinking water, food, food packaging, articles, and products, and soil). A systematic-mapping process was implemented to conduct title-abstract and full-text screening and to extract PECO-relevant primary data into comprehensive evidence databases. Parameters of interest included the following: sampling dates and locations, numbers of collection sites and participants, detection frequencies, and occurrence statistics. Detailed data were extracted on PFAS occurrence in indoor and environmental media from 229 references and on PFAS occurrence in human matrices where available from those references. Studies of PFAS occurrence became numerous after 2005. Studies were most abundant for PFOA (80% of the references) and PFOS (77%). Many studies analyzed additional PFAS, particularly, PFNA and PFHxS (60% of references each). Food (38%) and drinking water (23%) were the commonly studied media. Most studies found detectable levels of PFAS, and detectable levels were reported in amajority of states in the United States. Half or more of the limited studies for indoor air and products detected PFAS in 50% or more of the collected samples. The resulting databases can inform problem formulation for systematic reviews to address specific PFAS exposure queries and questions, support prioritization of PFAS sampling, and inform PFAS exposure measurement studies. The search strategy should be extended and implemented to support living evidence review in this rapidly advancing area.	1	1	1	1					1										B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
67	ばく露	Lindstrom, Andrew B; Strynar, Mark J; Delinsky, Amy D; Nakayama, Shoji F; McMillan, Larry; Libelo, E Laurence; Neill, Michael; Thomas, Lee	Application of WWTP biosolids and resulting pe	2011	Environ Sci Technol. 2011 Oct 1;45(19):8015-21. doi: 10.1021/es1039425. Epub 2011 Apr 22.	Perfluorinated chemicals (PFCs) such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been produced and used in a wide range of industrial and consumer products for many decades. Their resistance to degradation has led to their widespread distribution in the environment, but little is known about how humans become exposed. Recent studies have demonstrated that the application of PFC contaminated biosolids can have important effects on local environments, ultimately leading to demonstrable human exposures. This manuscript describes a situation in Decatur, Alabama where PFC contaminated biosolids from a local municipal wastewater treatment facility that had received waste from local fluorochemical facilities were used as a soil amendment in local agricultural fields for as many as twelve years. Ten target PFCs were measured in surface and groundwater samples. Results show that surface and well water in the vicinity of these fields had elevated PFC concentrations, with 22% of the samples exceeding the U.S. Environmental Protection Agency's Provisional Health Advisory level for PFOA in drinking water of 400 ng/L. Water/soil concentration ratios as high as 0.34 for perfluorohexanoic acid, 0.17 for perfluoroheptanoic acid, and 0.04 for PFOA verify decreasing mobility from soils with increasing chain length while indicating that relatively high transport from soils to surface and well water is possible.			1						1	1						1					B	-		
68	ばく露	Meyer, Torsten; De Silva, Amila O; Spencer, Christine; Wania, Frank	Fate of perfluorinated carboxylates and sulfona	2011	Environ Sci Technol. 2011 Oct 1;45(19):8113-9. doi: 10.1021/es200106q. Epub 2011 Jun 21.	The transport dynamics of perfluorinated carboxylic acids and sulfonates during snowmelt in the highly urbanized Highland Creek watershed in Toronto, Canada was investigated by analyzing river water, bulk snow, and groundwater, sampled in February and March 2010, by means of liquid chromatography-tandem mass spectrometry. Perfluorohexanoate, perfluorooctanoate, and perfluorooctane sulfonate were dominant in river water, with concentrations of 4.0-14 ng·L(-1), 2.2-7.9 ng·L(-1), and 2.1-6.5 ng·L(-1), respectively. Relatively high levels of perfluorohexanoate may be related to the recent partial replacement in various consumer products of perfluorooctyl substances with shorter-chained perfluorinated compounds (PFCs). Highest PFC concentrations were found within the more urbanized part of the drainage area, suggestive of residential, industrial, and/or traffic-related sources. The riverine flux of PFCs increased during the snowmelt period, but only approximately one-fifth of the increased flux can be attributed to PFCs present in the snowpack, mostly because concentration in snow are generally quite low compared to those in river water. The remainder of the increased flux must be due to the mobilization of PFCs by the high flow conditions prevalent during snowmelt. Run-off behavior was clearly dependent on perfluoroalkyl chain length: Dilution with relatively clean snowmelt water caused a drop in the river water concentrations of short-chain PFCs at high flow during early melting. This prevented an early concentration peak of those water-soluble PFCs within the stream, as could have been expected in response to their earlyrelease from a melting snowpack. Instead, concentrations of particle-associated long-chain PFCs in creek water peaked early in the melt, presumably because high flow mobilized contaminated particles from impervious surfaces in the more urbanized areas of the watershed. The ability to enter the subsurface and deeper groundwater aquifers increased with the PFCs' water solubility, that is, was inversely related to perfluoroalkyl chain length.			1						1												B	-	雪解けによる水源でのPFAS輸送	
69	ばく露	Quiñones, Oscar; Snyder, Shane A	Occurrence of perfluoroalkyl carboxylates and	2009	Environ Sci Technol. 2009 Dec 15;43(24):9089-95. doi: 10.1021/es9024707.	The prevalence and persistence of perfluoroalkyl compounds (PFCs) in environmental and biological systems has been well documented, and a rising number of reports suggest that certain PFCs can result in adverse health effects in mammals. As traditional water sources become increasingly impacted by waste discharge and the demand for planned potable reuse grows, there is recent interest in determining PFC occurrence in drinking water supplies. Here we report monitoring results from drinking water treatment facility samples collected across the United States, and from associated surface, ground, and wastewater sources. Using automated solid phase extraction (SPE) and isotope-dilution liquid chromatography/tandem mass spectrometry (LC/MS-MS), samples were screened for perfluorohexanoic acid (PFHxA), perfluorohexanesulfonate (PFHxS), perfluorooctanoic acid (PFOA), perfluorooctanesulfonate (PFOS), perfluorononanoic acid (PFNA) perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUdA), and perfluorododecanoic acid (PFDoA). Method reporting limits (MRLs) were established at 1.0 ng/L for all monitored PFCs except PFOA, for which the MRL was set at 5.0 ng/L given elevated procedural and instrumental background levels. PFOS was the only investigated PFC detected in minimally impacted surface waters, with individual site averages of 2.0 ng/L and lower. Conversely, wastewater treatment plant (WWTP) effluents and other highly impacted waters had almost 100% detection frequency for all PFCs except PFUdA and PFDoA, which were not detected above MRL in any samples. Of the investigated PFCs, PFOA averaged the highest overallconcentration at any site at 115 ng/L. Substantial impacts from treated wastewater generally caused increased summed PFC concentrations at downstream drinking water facilities, although levels and distribution suggest geographical variability. No discernible differences between influent and effluent PFC levels were observed for drinking water facilities. Removal of PFCs, however, was observed at an indirect potable reuse facility using microfiltration and reverse osmosis for wastewater treatment, in which case all PFC levels in effluents were below the MRL.			1						1		1					1					B	-		
70	ばく露	Schecter, Arnold; Colacino, Justin; Haffner, Darrah; Patel, Keyur; Opel, Matthias; Päpke, Olaf; Birnbaum, Linda	Perfluorinated compounds, polychlorinated biph	2010	Environ Health Perspect. 2010 Jun;118(6):796-802. doi: 10.1289/ehp.0901347. Epub 2010 Feb 10.	OBJECTIVES: The objective of this article is to extend our previous studies of persistent organic pollutant (POP) contamination of U.S. food by measuring perfluorinated compounds (PFCs), organochlorine pesticides, and polychlorinated biphenyls (PCBs) in composite food samples. This study is part of a larger study reported in two articles, the other of which reports levels of polybrominated diphenyl ethers and hexabromocyclododecane brominated flame retardants in these composite foods [Schecter et al. 2010. Polybrominated diphenyl ethers (PBDEs) and hexabromocyclodecane (HBCD) in composite U.S. food samples, Environ Health Perspect 118:357-362]. METHODS: In this study we measured concentrations of 32 organochlorine pesticides, 7 PCBs, and 11 PFCs in composite samples of 31 different types of food (310 individual food samples) purchased from supermarkets in Dallas, Texas (USA), in 2009. Dietary intake of these chemicals was calculated for an average American. RESULTS: Contamination varied greatly among chemical and food types. The highest level of pesticide contamination was from the dichlorodiphenyltrichloroethane (DDT) metabolite p,p -dichlorodiphenyldichloroethylene, which ranged from 0.028 ng/g wet weight (ww) in whole milk yogurt to 2.3 ng/g ww in catfish fillets. We found PCB congeners (28, 52, 101, 118, 138, 153, and 180) primarily in fish, with highest levels in salmon (PCB-153, 1.2 ng/g ww; PCB-138, 0.93 ng/g ww). For PFCs, we detected perfluorooctanoic acid (PFOA) in 17 of 31 samples, ranging from 0.07 ng/g in potatoes to 1.80 ng/g in olive oil. In terms of dietary intake, DDT and DDTmetabolites, endosulfans, aldrin, PCBs, and PFOA were consumed at the highest levels. CONCLUSION: Despite product bans, we found POPs in U.S. food, and mixtures of these chemicals are consumed by the American public at varying levels. This suggests the need to expand testing of food for chemical contaminants.			1						1							1					B	-		
71	ばく露	Simcik, Matt F; Dorweiler, Kelly J	Ratio of perfluorochemical concentrations as a	2005	Environ Sci Technol. 2005 Nov 15;39(22):8678-83. doi: 10.1021/es0511218.	A major question regarding the global distribution of perfluorochemicals (PFCs) is one of transport. It has been suggested that atmospheric transport of volatile precursor compounds to remote areas and subsequent degradation to the nonvolatile PFCs is responsible for contamination of biota. This paper presents surface water PFC concentrations aimed at identifying tracers of atmospheric sources. Concentrations of PFCs including perfluorocarboxylates from C6 to C10 and perfluorooctane sulfonate (PFOS) are presented here from urban surface waters with presumably both atmospheric and nonatmospheric sources of PFCs, remote waters with only atmospheric sources of PFCs, and Lake Michigan. Perfluoroheptanoic acid (PFHpA) and perfluorooctanoic acid (PFOA) were detected in all surface water samples, and PFOS was detected in all but two samples. PFOS concentrations ranged from nondetect to 1.2 ng/L and from 2.4 to 47 ng/L in remote and urban surface waters, respectively. PFOA concentrations ranged from 0.14 to 0.66 ng/L and from 0.45 to 19 ng/L in remote and urban surface waters, respectively. The ratio of PFHpA to PFOA increased with increasing distance from nonatmospheric sources suggesting that it can be used as a tracer of atmospheric deposition of PFCs to surface waters. The ratio ranged from 0.5 to 0.9 in urban areas and from 6 to 16 in remote areas. Applying this tracer to measurements from Lake Michigan indicates that the primary source of PFCs to Lake Michigan is nonatmospheric, most likely inputs from wastewater treatment effluent.			1						1							1					B	-		
72	ばく露	Sinclair, Ewan; Kim, Seung Kyu; Akinleye, Henry B; Kannan, Kurunthachalam	Quantitation of gas-phase perfluoroalkyl surfac	2007	Environ Sci Technol. 2007 Feb 15;41(4):1180-5. doi: 10.1021/es062377w.	Fluoropolymer dispersions are used for coating certain cookware products and food-contact packaging to impart oil and water repellency. Since salts of perfluorooctanoic acid (PFOA) are used as a processing aid in the manufacture of many fluoropolymers, it is necessary to determine if these compounds are still present as residuals after the process used to coat nonstick cookware or packaging, and could be released during typical cooking conditions. In this study, we identified and measured perfluoroalkyl carboxylates (PFCAs), particularly PFOA, and fluorotelomer alcohols (FTOHs; 6:2 FTOH and 8:2 FTOH), released from nonstick cookware into the gas phase under normal cooking temperatures (179 to 233 degrees C surface temperature). PFOA was released into the gas phase at 7-337 ng (11-503 pg/cm2) per pan from four brands of nonstick frying pans. 6:2 FTOH and 8:2 FTOH were found in the gas phase of four brands of frying pans, and the sources of FTOHs released from nonstick cookware are under investigation. We observed a significant decrease in gas-phase PFOA following repeated use of one brand of pan, whereas the other brand did not show a significant reduction in PFOA release following multiple uses. PFOA was found at >5 ng during the fourth use of both brands of pans. FTOHs were not found after the second use of either brand of pans. PFOA was found at 5-34 ng in the vapors produced from a prepacked microwave popcorn bag. PFOA was not found in the vapors produced from plain white corn kernels popped in a polypropylene container. 6:2 FTOH and 8:2 FTOH were measured in the vapors produced from one brand ofprepacked microwave popcorn at 223 + 37 ng and 258 +/- 36 ng per bag, respectively, but not measured at >20 ng (LOQ) in the other two brands. On the packaging surface of one brand of microwave popcorn several PFCAs, including C5-C12, 6:2 FTOH, and 8:2 FTOH, were found at concentrations in the order of 0.5-6.0 ng/cm2. This study suggests that residual PFOA is not completely removed during the fabrication process of the nonstick coating for cookware. They remain as residuals on the surface and may be off-gassed when heated at normal cooking temperatures.			1						1							1	1				B	-		
73	ばく露	Stock, Naomi L; Furdui, Vasile I; Muir, Derek C G; Mabury, Scott A	Perfluoroalkyl contaminants in the Canadian A	2007	Environ Sci Technol. 2007 May 15;41(10):3529-36. doi: 10.1021/es062709x.	Perfluorosulfonates (PFSAs) and perfluorocarboxylates (PFCAs) have been hypothesized to reach remote locations such as the Canadian Arctic either indirectly as volatile precursor chemicals that undergo atmospheric transport and subsequent degradation, or directly via oceanic and atmospheric transport of the PFSAs and PFCAs themselves. Water, sediment, and air samples were collected from three Arctic lakes (Amituk, Char, and Resolute) on Cornwallis Island, Nunavut, Canada. Samples were analyzed for PFSAs and PFCAs, precursor chemicals including the fluorotelomer alcohols (FTOHs) and polyfluorinated sulfonamides (FSAs), and precursor degradation products such as the fluorotelomer unsaturated carboxylates (FTUCAs). PFSAs and PFCAs were detected in water and sediment of all three Arctic lakes (concentrations ranged from nondetect to 69 ng/L and nondetect to 85 ng/g dry weight, respectively). FTOHs and FSAs were observed in air samples (mean concentrations ranged from 2.8 to 29 pg/m3), and confirm that volatile precursors are reaching Arctic latitudes. The observation of degradation products, including FTUCAs observed in sediment and atmospheric particles, and N-ethyl perfluorooctanesulfonamide (NEtFOSA) and perfluorooctanesulfonamide (PFOSA) in air samples, indicate that degradation of the FTOHs and FSAs is occurring in the Arctic environment. PFSAs and PFCAs were also observed on atmospheric particles (mean concentrations ranged from < 0.1 to 5.9 pg/m3). In addition, results of this study also indicate that local perfluoroalkyl contamination of Resolute Lake, which is located downstream of an airport wastewater input, has occurred.			1						1	1											B	-		
74	ばく露	Tittlemier, Sheryl A; Pepper, Karen; Seymour, Carol; Moisey, John; Bronson, Roni; Cao, Xu-Liang; Dabeka, Robert W	Dietary exposure of Canadians to perfluorinated	2007	J Agric Food Chem. 2007 Apr 18;55(8):3203-10. doi: 10.1021/jf0634045. Epub 2007 Mar 24.	Human exposure to perfluorinated compounds is a worldwide phenomenon; however, routes of human exposure to these compounds have not been well-characterized. Fifty-four solid food composite samples collected as part of the Canadian Total Diet Study (TDS) were analyzed for perfluorocarboxylates and perfluorooctanesulfonate (PFOS) using a methanol extraction liquid chromatography tandem mass spectrometry method. Foods analyzed included fish and seafood, meat, poultry, frozen entrées, fast food, and microwave popcorn collected from 1992 to 2004 and prepared as for consumption. Nine composites contained detectable levels of perfluorinated compounds-four meat-containing, three fish and shellfish, one fast food, and one microwave popcorn. PFOS and perfluorooctanoate (PFOA) were detected the most frequently; concentrations ranged from 0.5 to 4.5 ng/g. The average dietary intake of total perfluorocarboxylates and PFOS for Canadians was estimated to be 250 ng/day, using results from the 2004 TDS composites. A comparison with intakes of perfluorocarboxylates and PFOS via other routes (air, water, dust, treated carpeting, and apparel) suggested that diet is an important source of these compounds. There was a substantial margin of exposure between the toxicological points of reference and the magnitude of dietary intake of perfluorinated compounds for Canadians >/= 12 years old.			1						1							1	1				B	-		
75	ばく露	Ye, Xibiao; Strynar, Mark J; Nakayama, Shoji F; Varns, Jerry; Helfant, Larry; Lazorchak, James; Lindstrom, Andrew B	Perfluorinated compounds in whole fish homog	2008	Environ Pollut. 2008 Dec;156(3):1227-32. doi: 10.1016/j.envpol.2008.03.014. Epub 2008 May 2.	A method for the analysis of 10 perfluorinated compounds (PFCs) in whole fish homogenate is presented and applied to 60 fish samples collected from the Ohio, Missouri, and upper Mississippi Rivers in 2005. Method accuracy ranged between 86 and 125% with limits of quantitation between 0.2 and 10 ng/g wet weight. Intra- and inter-batch precision was generally +/-20%. Perfluorooctane sulfonate (PFOS) was the predominant compound identified in these samples, contributing over 80% of total PFC composition in the fish from these rivers, with median PFOS concentrations of 24.4, 31.8, and 53.9 ng/g wet wt in the Missouri, Ohio, and Mississippi Rivers, respectively. Median PFOS levels were significantly (p=0.01) elevated in piscivorous fish (88.0 ng/g) when compared with non-piscivorous fish (15.9 ng/g). The 10 samples with PFOS concentrations above 200 ng/g were broadly scattered across all three rivers, providing evidence of the widespread presence of this compound in these US waterways.			1						1							1					B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
76	ばく露	Young, Wendy M; South, Paul; Begley, Timothy H; Diachenko, Gregory W; Noonan, Gregory O	Determination of perfluorochemicals in cow's r	2012	J Agric Food Chem. 2012 Feb 22;60(7):1652-8. doi: 10.1021/jf204565x. Epub 2012 Feb 8.	This study describes a new method developed for detection of 10 different perfluorochemicals (PFCs) in cow's milk, seven perfluorinated carboxylates and three perfluorinated sulfonate salts. After attempting multiple methods employing both acidic and basic extractions, a basic extraction using 10 mM sodium hydroxide in methanol digestion along with weak anion-exchange solid-phase extraction was employed. Vortex mixing and varying sonication times were compared as part of sample processing. Results show that sonication during sample processing yield decreased recovery of longer chain perfluorinated carboxylates. The final method developed was used to determine the concentration of PFCs in 12 raw and 49 retail milk samples from across the United States. With the exception of a single raw milk sample obtained from a dairy farm that had applied PFC containing biosolids to its fields, there were no milk samples containing PFCs.			1						1												B	-		
77	ばく露	Zheng, Guomao; Boor, Brandon E; Schreder, Erika; Salamova, Amina	Indoor exposure to per- and polyfluoroalkyl sut	2020	Environ Pollut. 2020 Mar;258:113714. doi: 10.1016/j.envpol.2019.113714. Epub 2019 Dec 2.	Per- and polyfluoroalkyl substances (PFAS) are widely used in stain-resistant carpets, rugs, and upholstery, as well as in waxes and cleaners, and are potential contaminants in the childcare environment. However, limited knowledge exists on the occurrence of PFAS in indoor environments, apart from residential homes. Here, we determined the occurrence and distribution of 37 neutral and ionic PFAS, including perfluoroalkyl carboxylates (PFCAs) perfluoroalkyl sulfonates (PFSAs), fluorotelomer alcohols (FTOHs), fluorotelomer sulfonates (FTSs), perfluorooctane sulfonamides and perfluorooctane sulfonamidoethanols (FOSAs/FOSEs), and fluorotelomer acrylates and fluorotelomer methacrylates (FTACs/FTMACs) in the childcare environment and estimated children's exposure through dust ingestion and dermal absorption. We analyzed dust and nap mats, a commonly used item in many childcares, from eight facilities located in the United States. Twenty-eight PFAS were detected in dust with total PFAS concentrations (ΣPFAS) ranging from 8.1 to 3,700 ng/g and were dominated by the two neutral PFAS groups: ΣFTOH (n.d. - 3,100 ng/g) and ΣFOSA/FOSE (n.d. - 380 ng/g). The ionic PFAS were detected at lower concentrations and were dominated by 6:2 FTS and 8:2 FTS (median 12 and 5.8 ng/g, respectively). ΣPFAS concentrations in mats (1.6-600 ng/g) were generally an order of magnitude lower than in dust and were dominated by ΣFOSA/FOSE concentrations (n.d. - 220 ng/g). Daily intake of neutral PFAS in the childcare environment via dust ingestion was estimated at 0.20 ng/kg bw/day and accounted for 75% of the ΣPFAS intake. Thishigher exposure to neutral PFAS is concerning considering that many neutral PFAS are the precursors of toxic ionic PFAS, such as PFOA.			1						1												B	-		
78	ばく露	Ahrens, Lutz; Felizeter, Sebastian; Ebinghaus, Ralf	Spatial distribution of polyfluoroalkyl compoun	2009	Chemosphere. 2009 Jun;76(2):179-84. doi: 10.1016/j.chemosphere.2009.03.052. Epub 2009 Apr 25.	The spatial distribution of polyfluoroalkyl compounds (PFCs) and their composition profile was investigated in 48 water samples collected from the German Bight. All samples were prepared by solid-phase extraction with Strata XAW cartridges and analysed using high performance liquid chromatography/negative electrospray ionisation-tandem mass spectrometry (HPLC/(-)ESI-MS/MS). Concentrations of various PFCs, including perfluorinated sulfonates (PFSAs), perfluorinated carboxylic acids (PFCAs), unsaturated fluorotelomercarboxylic acids, perfluoralkyl sulfonamide and sulfonamidoethanol, were quantified. The Sigma PFC concentration ranges from 9.36 ng L(-1) to 31.2 ng L(-1), while perfluorobutane sulfonate (PFBS, 3.38-17.7 ng L(-1)) and perfluorooctanoic acid (PFOA, 2.67-7.83 ng L(-1)) dominated. The rivers Elbe, Weser and Ems had a high influence on the distribution of most PFCs in the German Bight, with maximum PFC concentrations found in their estuaries, and concentrations decreasing with increasing distance from the coast. Conversely, PFBS had its maximum concentration not in the estuaries but in the western German Bight, which suggest an additional source, where PFBS was transported into the German Bight with the westerly current.				1					1	1											B	-		
79	ばく露	Ahrens, Lutz; Felizeter, Sebastian; Sturm, Renate; Xie, Zhiyong; Ebinghaus, Ralf	Polyfluorinated compounds in waste water tre	2009	Mar Pollut Bull. 2009 Sep;58(9):1326-33. doi: 10.1016/j.marpolbul.2009.04.028. Epub 2009 Jun 6.	Polyfluorinated compounds (PFCs) were investigated in waste water treatment plant (WWTP) effluents and surface waters of the River Elbe from samples collected in 2007. Concentrations of various PFCs, including C(4)-C(8) perfluorinated sulfonates (PFSAs), C(6) and C(8) perfluorinated sulfinates, 6:2 fluorotelomer sulfonate, C(5)-C(13) perfluorinated carboxylic acids (PFCAs), C(4) and C(8) perfluoroalkyl sulfonamides and 6:2, 8:2 and 10:2 unsaturated fluorotelomercarboxylic acids were quantified. Sum PFC concentrations of the river water ranged from 7.6 to 26.4ngL(-1), whereas sum PFC concentrations of WWTP effluents were approximately 5-10 times higher (30.5-266.3ngL(-1)), indicating that WWTPs are potential sources of PFCs in the marine environment. PFC patterns of different WWTP effluents varied depending on the origin of the waste water, whereas the profile of PFC composition in the river water was relatively constant. In both kinds of water samples, perfluorooctanoic acid (PFOA) was the major PFC, whereas perfluorobutane sulfonate (PFBS) was the predominant PFSA.				1					1	1											B	-		
80	ばく露	Ahrens, Lutz; Xie, Zhiyong; Ebinghaus, Ralf	Distribution of perfluoroalkyl compounds in sea	2010	Chemosphere. 2010 Feb;78(8):1011-6. doi: 10.1016/j.chemosphere.2009.11.038. Epub 2009 Dec 16.	The global distribution of perfluoroalkyl compounds (PFCs) were investigated in surface water samples collected onboard the Polarstern in Northern Europe, Atlantic and Southern Ocean (52 degrees N-69 degrees S) in 2008. The water samples were solid-phase extracted with Oasis WAX cartridges and analysed using the high-performance liquid chromatography interfaced to tandem mass spectrometry. Concentrations of various PFCs, including C(4), C(6), C(8) perfluoroalkyl sulfonates (PFSAs), perfluorooctane sulfinate (PFOSi), C(5)-C(12) perfluoroalkyl carboxylic acids (PFCA) and perfluorooctane sulfonamide (FOSA) were quantified. Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were the predominant compounds with a maximum concentration of 232 and 223pgL(-1), respectively. Results indicate that industrial areas like the European Continent act as source of PFCs, while ocean water is an important as a sink as well as the transport medium of these compounds. Interestingly, in the equator area the summation operatorPFC concentration increased, which indicates that there exists an atmospheric or other unknown input source of PFCs. In the Southern Ocean only PFOS was detected which could be caused by atmospheric transport of its precursors.				1					1	1											B	-		
81	ばく露	Ahrens, Lutz; Gerwinski, Wolfgang; Theobald, Norbert; Ebinghaus, Ralf	Sources of polyfluoroalkyl compounds in the N	2010	Mar Pollut Bull. 2010 Feb;60(2):255-60. doi: 10.1016/j.marpolbul.2009.09.013. Epub 2009 Oct 8.	The spatial distribution of 15 polyfluoroalkyl compounds (PFCs) in surface water was investigated in the North Sea, Baltic Sea and Norwegian Sea. In addition, an interlaboratory comparison of the sampling techniques and analysis was conducted. Highest concentration in the North Sea was found near the coast, whereas the summation operatorPFC concentration decreased rapidly from 18.4 to 0.07 ng l(-1) towards the open North Sea. The river Elbe could identify as a local input source for PFCs into the North Sea, whereas perfluorobutanoic acid (PFBA) was transported into the sampling area with the easterly current. In contrast to the North Sea, the distribution of PFCs in the Baltic Sea was relatively homogenous, where diffuse sources dominated. In general, the composition profile was influenced from local sources caused by human activities, whereas atmospheric depositions of here analysed PFCs were negligible, but it could have possibly an influence on low contaminated sites like the open North Sea or Norwegian Sea.				1					1												B	-		
82	ばく露	Bao, Jia; Liu, Wei; Liu, Li; Jin, Yihe; Dai, Jiayin; Ran, Xiaorong; Zhang, Zhixu; Tsuda, Shuji	Perfluorinated compounds in the environment	2011	Environ Sci Technol. 2011 Oct 1;45(19):8075-80. doi: 10.1021/es102610x. Epub 2010 Oct 21.	A fluorochemical industrial park was built in 2004 in Fuxin, China, for the production of polytetrafluoroethylene (PTFE) and perfluorobutane sulfonate (PFBS). Yet little is known about the distribution of fluorochemicals in the environment and in people living in and around the park. In this study, environmental samples were collected from 22 sites in Fuxin to investigate the extent of perfluorinated compound (PFC) contamination in the environment around the park, and in drinking water from the public water supply system and groundwater in shallow aquifers from private wells near the park. Serum samples were also collected from nonoccupationally exposed residents living in Fuxin to determine the PFC load of local residents. As the dominant contaminant of eight target PFCs, the maximum concentrations of perfluorooctanoic acid (PFOA) in sediment and river water of the River Xi along the industrial park were 48 ng/g dry weight and 668 ng/L, respectively; the highest PFOA concentration in groundwater beneath the park was 524 ng/L; and the PFOA levels in drinking water from the public water supply system ranged between 1.3 and 2.7 ng/L. In human serum, PFOA had the geometric mean at 4.3 ng/mL, ranging from 0.02 to 93 ng/mL. This study serves to document what should be the beginning of a long-term surveillance effort to minimize potential exposure of residents living in Fuxin.				1					1												B	-		
83	ばく露	Bao, Jia; Yu, Wen-Jing; Liu, Yang; Wang, Xin; Jin, Yi-He; Dong, Guang-Hui	Perfluoroalkyl substances in groundwater and	2019	Ecotoxicol Environ Saf. 2019 Apr 30;171:199-205. doi: 10.1016/j.ecoenv.2018.12.086. Epub 2018 Dec 31.	High-level contaminations of perfluoroalkyl substances (PFASs) were determined in both surface water and groundwater around a fluorochemical industrial park (FIP) in Fuxin, China, over the past few years. Yet little is known about whether groundwater PFAS contaminations in Fuxin could be introduced into home-produced vegetables and eggs in local residences via the application of groundwater for the irrigation or feeding purposes. In the present study, ten PFAS analytes were analyzed via high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) to investigate the extent of PFAS contaminations in the groundwater, soil, and home-produced vegetable and egg samples derived from Fuxin. As the predominant PFAS contaminants, perfluorobutane sulfonate (PFBS) and perfluorooctanoic acid (PFOA) were observed in groundwater beneath the Fuxin FIP with the maximum concentrations of 21.2 and 2.51 μg/L, respectively, which were 24-fold and 5-fold higher individually compared to those reported previously. Both of them were also higher than the updated health advisories for PFBS and PFOA in drinking water issued by the Minnesota Department of Health and the US Environmental Protection Agency. In addition, short-chain PFASs involving perfluorobutanoic acid (PFBA) and PFBS were found to be the major contaminants in both home-produced vegetables and eggs from the residential gardens around the FIP. Statistically significant relationships were determined between the levels of PFBA, PFOA, and PFBS in local groundwater and those observed in home-produced vegetables ($p = 0.003$, $p = 0.025$, and $p < 0.001$), suggesting potential entry ofthose PFAS contaminants into home-produced vegetables via irrigation with groundwater beneath the FIP.	1		1						1											B	-		
84	ばく露	Bohlin-Nizzetto, P., Hanssen, L. & Herzke, D., Norwegian Environment Agency	PFASs in house dust (M-430)	2015	Norwegian Environment Agency (2015). https://www.miljodirektoratet.no/globalassets/publikasjoner/m430/m430.pdf	NILU has, on behalf of the Norwegian Environment Agency, performed sampling and analysis of house dust from Norwegian households. The goal was to study concentration ranges, and variability between and within-houses of anionic and volatile per- and polyfluorinated alkyl substances (PFASs), including the regulated PFOA, as well as total extractable organic fluorine (TEOF). The sampling was done in six separate rooms in six different households. The analysis covered a suite of 20 targeted PFASs; ten of these were consistently detected in most samples, while the other ten were below detection limits in the major part of the samples. A range of the targeted PFASs were detected in all rooms except in one room in one household in which all PFASs, were below detection. The concentrations of individual PFASs as well as the sum of PFASs, were lower than in a previous study in Norway. The results show significant variability between houses for the anionic and volatile PFASs as well as for TEOF. For anionic PFASs, the results also indicate within house variability with higher concentrations in dust from bedrooms (children and parents) and living rooms than in dust from bathroom, kitchen and entrances. For the volatile PFASs and TEOF, no significant difference between rooms were found. These results indicate that factors like building materials and consumer products (e.g., furniture, textiles etc.) affect the levels of PFASs in house dust, but the reason for the findings are not further evaluated in this report. Anionic PFASs seem to contribute significantly to the TEOF (10-100%) in house dust.									1												B	-		
85	ばく露	Brandsma, S H; Koekkoek, J C; van Velzen, M J M; de Boer, J	The PFOA substitute GenX detected in the env	2019	Chemosphere. 2019 Apr;220:493-500. doi: 10.1016/j.chemosphere.2018.12.135. Epub 2018 Dec 27.	The ban on perfluorooctanoic acid (PFOA) has led to the production and use of alternative fluorinated compounds such as GenX. Limited information is available on the occurrence of this PFOA substitute. In this pilot study, we investigated the presence of GenX in/on grass and leaf samples collected near a fluoropolymer manufacturing plant in the Netherlands and in drinking water produced from surface and surface-water influenced groundwater intake points within 25 km from the plant. GenX was detected in/on all grass and leaf samples collected within 3 km north-east from the plant, with levels ranging from 1 to 27 ng/g wet weight (ww) and 4.3-86 ng/g ww, respectively. The PFOA levels in/on grass and leaves were lower, ranging from 0.7 to 11 ng/g ww and 0.9-28 ng/g ww, respectively. A declining concentration gradient of GenX and PFOA with increasing distance from the plant was observed, which suggests that the plant is a point source of GenX and was a point source for PFOA in the past. In all drinking water samples, GenX and PFOA were detected with levels ranging from 1.4 to 8.0 ng/L and 1.9-7.1 ng/L, respectively. The detection of GenX, which is only used since 2012, in/on grass and leaves and in drinking water indicates that GenX is now distributed through the environment. The presence of GenX and PFOA in/on grass and leaves within 3 km north-east of the plant also suggests that these chemicals could also be present on the locally grown food in gardens around the factory.				1					1		1									B	-		
86	ばく露	Brumovský, Miroslav; Karásková, Pavlína; Borghini, Mireno; Nizzetto, Luca	Per- and polyfluoroalkyl substances in the Wes	2016	Chemosphere. 2016 Sep;159:308-316. doi: 10.1016/j.chemosphere.2016.06.015. Epub 2016 Jun 14.	The spatial and temporal distribution of per- and polyfluoroalkyl substances (PFASs) in the open Western Mediterranean Sea waters was investigated in this study for the first time. In addition to surface water samples, a deep water sample (1390 m depth) collected in the center of the western basin was analyzed. Perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorohexanesulfonate (PFHxS) and perfluorooctanesulfonate (PFOS) were detected in all samples and were the dominant PFASs found. The sum of PFAS concentrations (ΣPFASs) ranged 246-515 pg/L for surface water samples. PFASs in surface water had a relatively homogeneous distribution with levels similar to those previously measured in the Atlantic near the Strait of Gibraltar, in water masses feeding the inflow to the Mediterranean Sea. Higher concentrations of PFHxA, PFHpA and PFHxS were, however, found in the present study. Inflowing Atlantic water and river/coastal discharges are likely the major sources of PFASs to the Western Mediterranean basin. Slightly lower (factor of 2) ΣPFASs was found in the deep water sample (141 pg/L). Such a relatively high contamination of deep water is likely to be linked to recurring deep water renewal fed by downwelling events in the Gulf of Lion and/or Ligurian Sea.				1					1												B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
87	ばく露	Busch, Jan; Ahrens, Lutz; Sturm, Renate; Ebinghaus, Ralf	Polyfluoroalkyl compounds in landfill leachates	2010	Environ Pollut. 2010 May;158(5):1467-71. doi: 10.1016/j.envpol.2009.12.031. Epub 2010 Jan 6.	Polyfluoroalkyl compounds (PFCs) are widely used in industry and consumer products. These products could end up finally in landfills where their leachates are a potential source for PFCs into the aqueous environment. In this study, samples of untreated and treated leachate from 22 landfill sites in Germany were analysed for 43 PFCs. SigmaPFC concentrations ranged from 31 to 12,819 ng/L in untreated leachate and 4-8060 ng/L in treated leachate. The dominating compounds in untreated leachate were perfluorobutanoic acid (PFBA) (mean contribution 27%) and perfluorobutane sulfonate (PFBS) (24%). The discharge of PFCs into the aqueous environment depended on the cleaning treatment systems. Membrane treatments (reverse osmosis and nanofiltrations) and activated carbon released lower concentrations of PFCs into the environment than cleaning systems using wet air oxidation or only biological treatment. The mass flows of summation operatorPFCs into the aqueous environment ranged between 0.08 and 956 mg/day.	1			1						1	1										B	-		
88	ばく露	Cai, Minghong; Yang, Haizhen; Xie, Zhiyong; Zhao, Zhen; Wang, Feng; Lu, Zhibo; Sturm, Renate; Ebinghaus, Ralf	Per- and polyfluoroalkyl substances in snow, la	2012	J Hazard Mater. 2012 Mar 30;209-210:335-42. doi: 10.1016/j.jhazmat.2012.01.030. Epub 2012 Jan 16.	The multi-matrices samples from snow (n=4), lake water (n=4), surface runoff water (SRW) (n=1) and coastal seawater (n=10) were collected to investigate the spatial distribution and the composition profiles of per- and polyfluoroalkyl substances (PFASs) in Fildes Peninsula, King George Island, Antarctica in 2011. All samples were prepared by solid-phase extraction and analyzed by using high performance liquid chromatography/negative electrospray ionization-tandem mass spectrometry (HPLC/(-)ESI-MS/MS). 14 PFASs in snow, 12 PFASs in lake water, 9 PFASs in SRW and 13 PFASs in coastal seawater were quantified, including C(4), C(7), C(8), C(10) PFSAs, C(4)-C(9), C(11)-C(14), C(16) PFCAs, and FOSA. PFOA was detected in all samples with the highest concentration (15,096 pg/L) in coastal seawater indicating a possible influence of local sewage effluent. High concentration and mostly frequency of PFBA occurred in snow (up to 1112 pg/L), lake water (up to 2670 pg/L) and SRW (1431 pg/L) while detected in the range of method detection limited (MDL) in the coastal seawaters indicate that PFBA is mainly originated from atmospheric dust contamination and also affected by the degradation of their precursors. No geographical differences in PFOS concentrations (n=8, 18 ± 3 pg/L) were measured in all snow and lake water samples also suggests that PFOS could be originated from the degradation of their precursors which can transported by long-range atmospheric route, but in a very low level.				1						1										B	-		
89	ばく露	Cai, Minghong; Zhao, Zhen; Yin, Zhigao; Ahrens, Lutz; Huang, Peng; Cai, Minggang; Yang, Haizhen; He, Jianfeng; Sturm, Renate; Ebinghaus, Ralf; Xie, Zhiyong	Occurrence of perfluoroalkyl compounds in sur	2012	Environ Sci Technol. 2012 Jan 17;46(2):661-8. doi: 10.1021/es2026278. Epub 2011 Dec 14.	Perfluoroalkyl compounds (PFCs) were determined in 22 surface water samples (39-76° N) and three sea ice core and snow samples (77-87° N) collected from North Pacific to the Arctic Ocean during the fourth Chinese Arctic Expedition in 2010. Geographically, the average concentration of ΣPFC in surface water samples were 560 ± 170 pg L(-1) for the Northwest Pacific Ocean, 500 ± 170 pg L(-1) for the Arctic Ocean, and 340 ± 130 pg L(-1) for the Bering Sea, respectively. The perfluoroalkyl carboxylates (PFCAs) were the dominant PFC class in the water samples, however, the spatial pattern of PFCs varied. The C(5), C(7) and C(8) PFCAs (i.e., perfluoropentanoate (PFPA), perfluoroheptanoate (PFHpA), and perfluorooctanoate (PFOA)) were the dominant PFCs in the Northwest Pacific Ocean while in the Bering Sea the PFPA dominated. The changing in the pattern and concentrations in Pacific Ocean indicate that the PFCs in surface water were influenced by sources from the East-Asian (such as Japan and China) and North American coast, and dilution effect during their transport to the Arctic. The presence of PFCs in the snow and ice core samples indicates an atmospheric deposition of PFCs in the Arctic. The elevated PFC concentration in the Arctic Ocean shows that the ice melting had an impact on the PFC levels and distribution. In addition, the C(4) and C(5) PFCAs (i.e., perfluorobutanoate (PFBA), PFPA) became the dominant PFCs in the Arctic Ocean indicating that PFBA is a marker for sea ice melting as the source of exposure.				1						1										B	-		
90	ばく露	Campo, Julian; Pérez, Francisca; Masiá, Ana; Picó, Yolanda; Farré, Marinella; Barceló, Damià	Perfluoroalkyl substance contamination of the	2015	Sci Total Environ. 2015 Jan 15;503-504:48-57. doi: 10.1016/j.scitotenv.2014.05.094. Epub 2014 Jun 14.	The occurrence and sources of 21 perfluoroalkyl substances (PFASs: C4-C14, C16, C18 carboxylate, C4, C6-C8 and C10 sulfonates and C8 sulfonamide) were determined in water, sediment, and biota of the Llobregat River basin (NE Spain). Analytes were extracted by solid phase extraction (SPE) and determined by liquid chromatography triple quadrupole mass spectrometer (LC-QqQ-MS). All samples were contaminated with at least one PFAS, being the most frequently found perfluorobutanoate (PFBA), perfluorooctanoate (PFOA) and perfluorooctane sulfonate (L-PFOS). In general, mean PFAS concentrations measured in sediments (0.01-3.67 ng g(-1)) and biota (0.79-431 μg kg(-1)) samples were higher than those found in water (0.01-233 ng L(-1)). L-PFOS presented very high levels in biota and water, particularly in the Anoia River where a maximum concentration of 2.71 μg L(-1) was related to important industrial activities. However, this pollution does not extend down the Llobregat River according to cumulated values. None of the hazard quotients (HQ) calculated indicate potential risk for the different tropic levels considered (algae, Daphnia sp. and fish). According to Maximum Allowable Concentration (MAC) proposed by the European Commission (L-PFOS) and to Provisional Health Advisory (PHA) values (PFOA, L-PFOS) established by the United States Environmental Protection Agency (US EPA), only two water samples exceeded PHA concentration for L-PFOS.	1			1						1									1	B	-		
91	ばく露	Castiglioni, Sara; Valsecchi, Sara; Polesello, Stefano; Rusconi, Marianna; Melis, Manuela; Palmiotto, Marinella; Manenti, Angela; Davoli, Enrico; Zuccato, Ettore	Sources and fate of perfluorinated compounds	2015	J Hazard Mater. 2015 Jan 23;282:51-60. doi: 10.1016/j.jhazmat.2014.06.007. Epub 2014 Jun 13.	Perfluorinated substances are listed among emerging contaminants because they are globally distributed, environmentally persistent, bioaccumulative and potentially harmful. In a three-year monitoring campaign (2010-2013) we investigated the occurrence, sources and fate of nine perfluoroalkylcarboxylic acids and three perfluoroalkylsulfonic acids, in the most industrialized region of Italy. Composite samples were collected in influents and effluents of wastewater treatment plants (WWTPs), in the main rivers flowing through the basin, and in raw groundwater and finished drinking water. Samples were analyzed by liquid chromatography tandem mass spectrometry. Perfluorinated substances were not removed in WWTPs and those receiving industrial wastes discharged up to 50 times the loads of WWTPs receiving municipal wastes. The mass balance of the emissions in the River Lambro basin showed continuously increasing contamination from north to south and differences in the composition of homologues in the west and east sides of the basin. Ground and drinking water were contaminated in industrial areas, but these substances were removed well in Milan. Contamination from industrial sources was prevalent over urban sources, contributing to 90% of the loads measured at the closure of the basin. The River Lambro was confirmed as one of the main sources of contamination in the Po River.				1						1										B	-		
92	ばく露	Chen, Hong; Sun, Ruijun; Zhang, Can; Han, Jianbo; Wang, Xiaomeng; Han, Gengchen; He, Xin	Occurrence, spatial and temporal distributions	2016	Environ Pollut. 2016 Dec;219:389-398. doi: 10.1016/j.envpol.2016.05.017. Epub 2016 May 25.	In this study, surface seawater and sediment samples were collected from Bohai Sea, China, to investigate the temporal and spatial distributions of perfluoroalkyl substances (PFASs) in that area. The total concentrations of PFASs in seawater and sediment samples ranged from below method limit of quantification (<MLQ) to 99.4 ng/L, and from 0.33 to 2.78 ng/g dw, respectively. PFOA was the predominant PFASs in both of surface seawater and sediment samples, with a median concentration of 4.97 ng/L in seawater and 0.24 ng/g dw in sediment sampled in July, respectively. Seasonal variation of the total PFAS concentrations was found in seawater samples, but not in the sediments. The concentrations of the total measured PFASs in water samples from drain outlets ranged from 103 ng/L to 443 ng/L, which was four times higher than that in seawater from the Bohai Sea, suggesting that discharge of wastewater from drain outlets was responsible for the contamination of PFASs in Bohai Sea area.				1						1										B	-		
93	ばく露	D'Agostino, Lisa A; Mabury, Scott A	Certain Perfluoroalkyl and Polyfluoroalkyl Subs	2017	Environ Sci Technol. 2017 Dec 5;51(23):13603-13613. doi: 10.1021/acs.est.7b03994. Epub 2017 Nov 17.	The presence of perfluoroalkyl and polyfluoroalkyl substances (PFASs) commonly associated with aqueous film forming foams (AFFFs) at sites without known AFFF contamination is a largely unexplored area, which may reveal widespread environmental contaminants requiring further investigation. Sensitive liquid chromatography-tandem mass spectrometry (LC-MS/MS) screening for 23 classes of PFASs, followed by quantitative analysis was used to investigate surface waters from rural, urban, and AFFF-impacted sites in Canada. The PFASs detected included perfluorohexane sulfonamide (FHxSA), 6:2 fluorotelomer sulfonamide (FTSAm), fluorotelomer sulfonamide alkylbetaines (FTABs), fluorotelomer betaines (FTBs), 6:2 fluorotelomer mercaptoalkylamido sulfonate sulfone (FTSAS-SO(2)), 6:2 fluorotelomerthiohydroxyl ammonium sulfoxide (FTSHA-SO), 6:2 fluorotelomer sulfonamide alkylamine (FTAA) and C3 to C6 perfluoroalkane sulfonamido amphoterics. Detection of FHxSA in all urban and AFFF-impacted sites (0.04-19 ng/L) indicates the widespread presence of rarely considered perfluorohexanesulfonate (PFHxS) precursors in Canadian waters. FTABs and FTBs were especially abundant with up to 16-33 ng/L of 6:2 FTAB in urban and AFFF-impacted water suggesting it may have additional applications, while FTBs were only in AFFF-impacted sites (qualitative; ΣFTBs 80 ng/L). The distributions of PFASs moving downstream along the AFFF-impacted Welland River and between water and sediment suggested differences in the persistence of various AFFF components and enhanced sorption of long-chain fluorotelomer betaines. Totalorganofluorine combustion-ion chromatography (TOF-CIC) revealed that fluorotelomer betaines were a substantial portion of the organofluorine in some waters and 36-99.7% of the total organofluorine was not measured in the targeted analysis.				1						1				1	1					B	-		
94	ばく露	D'Hollander, Wendy; Roosens, Laurence; Covaci, Adrian; Cornelis, Christa; Reynders, Hans; Campenhout, Karen Van; Voogt, Pim de; Bervoets, Lieven	Brominated flame retardants and perfluorinate	2010	Chemosphere. 2010 Sep;81(4):478-87. doi: 10.1016/j.chemosphere.2010.07.043. Epub 2010 Aug 14.	The increasing time spent indoors combined with the abundant usage of diverse indoor chemicals led to concerns involving the impact of these compounds on human health. The current study focused on two groups of important indoor contaminants i.e. Brominated flame retardants (BFRs) and Perfluorinated compounds (PFCs). Concentrations of both compound classes have been measured in Flemish indoor dust samples from homes and offices. ΣPolybrominated diphenyl ethers (PBDEs) (BDE 47, 99, 100, 154, 153, 197, 196 and 203) and BDE 209 in homes ranged between 4-1214 ng g(-1)dw (median 35) and <5-5295 ng g(-1)dw (median 313), respectively. Hexabromocyclododecane (ΣHBCD) levels ranged from 5 to 4,2692 ng g(-1)dw (median 130), with α-HBCD being the major isomer (mean 59%). In addition, tetrabromobisphenol A (TBBPA) ranged between <3 and 419 ng g(-1)dw (median 12). For all BFRs, median levels in office dust were up to an order of magnitude higher than in home dust. ΣPFCs (sum of perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA)) concentrations in homes ranged from 0.2 to 336 ng g(-1) (median 3.0 ng g(-1)). Levels in office dust were higher ($p<0.01$) than in house dust with ΣPFCs ranging between 2.2 and 647 ng g(-1) (median 10 ng g(-1)) and median (PFOA) and perfluorooctane sulfonate values of 2.9 and 2.2 ng g(-1), respectively. The congener pattern was dominated by PFOA, followed by PFOS. Calculated humanexposure was below the reference dose values set by the US-EPA for BDE 209, HBCD and below the provisional tolerable daily intakes proposed by European Food Safety Authority for PFOS and PFOA.				1						1										B	-		
95	ばく露	Ding, Guanghui; Xue, Huanhuan; Yao, Ziwei; Wang, Ying; Ge, Linke; Zhang, Jing; Cui, Fuxu	Occurrence and distribution of perfluoroalkyl s	2018	Chemosphere. 2018 Jun;200:116-123. doi: 10.1016/j.chemosphere.2018.02.093. Epub 2018 Feb 16.	In the present study, the contamination level and spatial distribution of PFASs in the water dissolved phase and suspended particulate matter (SPM) phase of the Dalian Bay, and the SPM-water partition behavior were investigated. The total concentrations of PFASs (ΣPFASs) in the water dissolved phase ranged from 6.9 to 17.1 ng L(-1), with perfluorooctanoic acid (PFOA), perfluorobutanoic acid, and perfluorobutane sulfonate (PFBS) as the predominant PFASs, while ΣPFASs in SPM ranged from 1.7 to 27.5 ng g(-1) dw with higher contributions from PFBS, perfluorooctane sulfonic acid and PFOA. As for the pollution distribution, the concentrations of PFASs inside the Dalian Bay were higher than those outside the bay. For perfluoroalkyl carboxylic acid (PFCAs) and perfluoroalkane sulfonic acids (PFSAs), the suspended particulate matter-water partition coefficient (log K(d)) values ranged from 2.62 to 3.76, and from 3.39 to 3.56, respectively. The log K(d) values of PFASs generally increased with the increasing perfluorinated carbon chain length. Short-chain PFCAs were mostly detected in the water dissolved phase, while long-chain PFCAs and PFSAs appeared to bind more strongly to SPM phase. The contamination level of long-chain PFCAs and PFSAs could be underestimated if only the water dissolved phase were measured. Therefore, further investigations should consider the role of SPM on the environmental behavior and fate of PFASs in the aquatic environment.	1			1						1										B	-		
96	ばく露	Ding, Guanghui; Xue, Huanhuan; Zhang, Jing; Cui, Fuxu; He, Xin	Occurrence and distribution of perfluoroalkyl s	2018	Mar Pollut Bull. 2018 Feb;127:285-288. doi: 10.1016/j.marpolbul.2017.12.020. Epub 2017 Dec 21.	In the present study, the spatial distributions and vertical variations of PFASs in the sediments of the Dalian Bay were investigated. The total concentrations of PFASs (ΣPFASs) in surface sediments of Dalian Bay ranged from 1.49 to 2.66ngg(-1) dw. The predominant PFASs in surface sediments were PFOA, PFBS and PFBA with the concentration ranges of 0.50 to 0.95, 0.21 to 0.94, and 0.035 to 0.32ngg(-1) dw, respectively. For the two sediment cores, ΣPFASs ranged from 1.20 to 2.00 and from 1.37 to 2.06ngg(-1) dw, respectively. There was a maximum ΣPFASs concentration value near the surface. In general, ΣPFASs gradually decreased with increasing sampling depth after reaching the maximum. PFOA, PFBS and PFBA were also the predominant PFASs in the two sediment cores. It is recommended that the monitoring and risk assessment of short-chain PFAS should be taken into consideration, and further researches are needed to understand the transportation and fate of these chemicals in the aquatic environment.				1						1										B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
97	ばく露	Domingo, José L.; Ericson-Jogsten, Ingrid; Perelló, Gemma; Nadal, Martí; Van Bavel, Bert; Kärrman, Anna	Human exposure to perfluorinated compounds	2012	J Agric Food Chem. 2012 May 2;60(17):4408-15. doi: 10.1021/jf300355c. Epub 2012 Apr 17.	In this study, the concentrations of 15 perfluorinated compounds (PFCs) were analyzed in 30 water samples collected in Catalonia (Spain) at three stages of the drinking water treatment process in several water purification plants. In addition, the concentrations of 13 PFCs were determined in samples of fish and shellfish collected from coastal areas of Catalonia. The intake of PFCs through both pathways, drinking water intake and fish and shellfish consumption, was also estimated. In water samples, the highest mean concentrations corresponded to perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) (1.81 and 2.40 ng/L, respectively), whereas perfluorodecanosulfonate (PFDS) and perfluorotetradecanoic acid (PFTDA) were under their respective limits of detection in all analyzed samples. The results show that although the current treatment processes caused slight reductions in PFC concentrations, these processes did not mean significant changes in the amounts of PFCs already contained in the raw water. Among the analyzed PFCs in fish and shellfish, only seven compounds could be detected in at least one composite sample. PFOS showed the highest mean concentration (2.70 ng/g fw), being detected in all species with the exception of mussels. With regard to PFOA (mean, 0.074 ng/g fw), the highest concentrations were detected in prawn and hake (0.098 and 0.091 ng/g fw, respectively). The current exposure to PFCs through consumption of fish and shellfish indicates that it should not be of concern for the consumers. The amounts ingested are well below the recommended tolerable daily intakes, at leastfor those PFCs for which information is available.				1						1					1						B	-			
98	ばく露	Ericson, Ingrid; Domingo, José L.; Nadal, Marti; Bigas, Esther; Llebaria, Xavier; van Bavel, Bert; Lindström, Gunilla	Levels of perfluorinated chemicals in municipa	2009	Arch Environ Contam Toxicol. 2009 Nov;57(4):631-8. doi: 10.1007/s00244-009-9375-y. Epub 2009 Aug 15.	In this study, the concentrations of 13 perfluorinated compounds (PFCs) (PFBuS, PFHxS, PFOS, THPFOS, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTDA, and PFOSA) were analyzed in municipal drinking water samples collected at 40 different locations from 5 different zones of Catalonia, Spain. Detection limits ranged between 0.02 (PFHxS) and 0.85 ng/L (PFOA). The most frequent compounds were PFOS and PFHxS, which were detected in 35 and 31 samples, with maximum concentrations of 58.1 and 5.30 ng/L, respectively. PFBuS, PFHxA, and PFOA were also frequently detected (29, 27, and 26 samples, respectively), with maximum levels of 69.4, 8.55, and 57.4 ng/L. In contrast, PFDoDA and PFTDA could not be detected in any sample. The most contaminated water samples were found in the Barcelona Province, whereas none of the analyzed PFCs could be detected in two samples (Banyoles and Lleida), and only one PFC could be detected in four of the samples. Assuming a human water consumption of 2 L/day, the maximum daily intake of PFOS and PFOA from municipal drinking water would be, for a subject of 70 kg of body weight, 1.7 and 1.6 ng/kg/day. This is clearly lower than the respective Tolerable Daily Intake set by the European Food Safety Authority. In all samples, PFOS and PFOA also showed lower levels than the short-term provisional health advisory limit for drinking water (200 ng PFOS/L and 400 ng PFOA/L) set by the US Environmental Protection Agency. Although PFOS and PFOA concentrations found in drinking water in Catalonia are not expected to pose human health risks, safety limits for exposure to the remaining PFCs are clearly necessary, as health-baseddrinking water concentration protective for lifetime exposure is set to 40 ng/L for PFOA.				1						1					1						B	-			
99	ばく露	Eriksson, Ulrika; Kärrman, Anna	World-Wide Indoor Exposure to Polyfluoroalkyl	2015	Environ Sci Technol. 2015 Dec 15;49(24):14503-11. doi: 10.1021/acs.est.5b00679. Epub 2015 Jun 2.	Human exposure to perfluorooctanoic acid (PFOA) and other per- and polyfluoroalkyl substances (PFASs) is ongoing and in some cases increasing, despite efforts made to reduce emissions. The role of precursor compounds such as polyfluorinated phosphate esters (PAPs) has received increasing attention, but there are knowledge gaps regarding their occurrence and impact on human exposure. In this study, mono-, di-, and triPAPs, perfluorinated alkyl acids (PFAAs), saturated, and unsaturated fluorotelomer carboxylic acids (FTCA/FTUCAs), perfluoroalkane sulfonamides, and sulfonamidethanols (FOSA/FOSEs), and one fluorotelomer sulfonic acid (FTSA)) were compared in household dust samples from Canada, the Faroe Islands, Sweden, Greece, Spain, Nepal, Japan, and Australia. Mono-, di-, and triPAPs, including several diPAP homologues, were frequently detected in dust from all countries, revealing an ubiquitous spread in private households from diverse geographic areas, with significant differences between countries. The median levels of monoPAPs and diPAPs ranged from 3.7 ng/g to 1 023 ng/g and 3.6 ng/g to 692 ng/g, respectively, with the lowest levels found in Nepal and the highest in Japan. The levels of PAPs exceeded those of the other PFAS classes. These findings reveal the importance of PAPs as a source of PFAS exposure worldwide.				1						1					1						B	-			
100	ばく露	Eriksson, Ulrika; Haglund, Peter; Kärrman, Anna	Contribution of precursor compounds to the re	2017	J Environ Sci (China). 2017 Nov;61:80-90. doi: 10.1016/j.jes.2017.05.004. Epub 2017 May 10.	Per- and polyfluoroalkyl substances (PFASs) are ubiquitous in sludge and water from waste water treatment plants, as a result of their incorporation in everyday products and industrial processes. In this study, we measured several classes of persistent PFASs, precursors, transformation intermediates, and newly identified PFASs in influent and effluent sewage water and sludge from three municipal waste water treatment plants in Sweden, sampled in 2015. For sludge, samples from 2012 and 2014 were analyzed as well. Levels of precursors in sludge exceeded those of perfluoroalkyl acids and sulfonic acids (PFCAs and PFSAs), in 2015 the sum of polyfluoroalkyl phosphoric acid esters (PAPs) were 15-20ng/g dry weight, the sum of fluorotelomer sulfonic acids (FTSAs) was 0.8-1.3ng/g, and the sum of perfluorooctane sulfonamides and ethanols ranged from non-detected to 3.2ng/g. Persistent PFSAs and PFCAs were detected at 1.9-3.9ng/g and 2.4-7.3ng/g dry weight, respectively. The influence of precursor compounds was further demonstrated by an observed substantial increase for a majority of the persistent PFCAs and PFSAs in water after waste water treatment. Perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), and perfluorooctane sulfonic acid (PFOS) had a net mass increase in all WWTPs, with mean values of 83%, 28%, 37% and 58%, respectively. The load of precursors and intermediates in influent water and sludge combined with net mass increase support the hypothesis that degradation of precursor compounds is a significant contributor to PFAS contamination in the environment.		1		1						1											B	-			
101	ばく露	Eschauzier, Christian; Beerendonk, Erwin; Scholte-Veenendaal, Petra; De Voogt, Pim	Impact of treatment processes on the removal	2012	Environ Sci Technol. 2012 Feb 7;46(3):1708-15. doi: 10.1021/es201662b. Epub 2012 Jan 13.	The behavior of polyfluoralkyl acids (PFAAs) from intake (raw source water) to finished drinking water was assessed by taking samples from influent and effluent of the several treatment steps used in a drinking water production chain. These consisted of intake, coagulation, rapid sand filtration, dune passage, aeration, rapid sand filtration, ozonation, pellet softening, granular activated carbon (GAC) filtration, slow sand filtration, and finished drinking water. In the intake water taken from the Lek canal (a tributary of the river Rhine), the most abundant PFAA were PFBA (perfluorobutanoic acid), PFBS (perfluorobutane sulfonate), PFOS (perfluorooctane sulfonate), and PFOA (perfluorooctanoic acid). During treatment, longer chain PFAA such as PFNA (perfluorononanoic acid) and PFOS were readily removed by the GAC treatment step and their GAC effluent concentrations were reduced to levels below the limits of quantitation (LOQ) (0.23 and 0.24 ng/L for PFOS and PFNA, respectively). However, more hydrophilic shorter chain PFAA (especially PFBA and PFBS) were not removed by GAC and their concentrations remained constant through treatment. A decreasing removal capacity of the GAC was observed with increasing carbon loading and with decreasing carbon chain length of the PFAAs. This study shows that none of the treatment steps, including softening processes, are effective for PFAA removal, except for GAC filtration. GAC can effectively remove certain PFAA from the drinking water cycle.The enrichment of branched PFOS and PFOA isomers relative to non branched isomers during GAC filtration was observed during treatment. The finished watercontained 26 and 19 ng/L of PFBA and PFBS. Other PFAAs were present in concentrations below 4.2 ng/L The concentrations of PFAA observed in finished waters are no reason for concern for human health as margins to existing guidelines are sufficiently large.	1		1	1						1	1									B	-			
102	ばく露	Eschauzier, Christian; Haftka, Joris; Stuyfzand, Pieter J; de Voogt, Pim	Perfluorinated compounds in infiltrated river rh	2010	Environ Sci Technol. 2010 Oct 1;44(19):7450-5. doi: 10.1021/es100471z.	Different studies have shown that surface waters contain perfluorinated compounds (PFCs) in the low ng/L range. Surface waters are used to produce drinking water and PFCs have been shown to travel through the purification system and form a potential threat to human health. The specific physicochemical properties of PFCs cause them to be persistent and some of them to be bioaccumulative and toxic in the environment. This study investigates the evolvement of PFC concentrations in Rhine water and rainwater during dune water infiltration processes over a transect in the dune area of the western part of The Netherlands. The difference between infiltrated river water and rainwater in terms of PFC composition was investigated. Furthermore, isomer profiles were investigated. The compound perfluorobutanesulfonate (PFBS) was found at the highest concentrations of all PFCs investigated, up to 37 ng/L in infiltrated river water (71 ± 13% of ΣPFCs). This is in contrast with the predominant occurrence of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonate (PFOS) reported in literature. The concentrations of PFBS found in infiltrated river Rhine water were significantly higher than those in infiltrated rainwater. For perfluorohexanesulfonate (PFHxS) the opposite was found: infiltrated rainwater contained more than infiltrated river water. The concentrations of PFOA, perfluorohexanoic acid (PFHxA), perfluoroheptanoic acid (PFHpA), PFBS, PFOS, and PFHxS in infiltrated river water showed an increasing trend with decreasing age of the water. The relative contribution of the branched PFOA and PFOS isomers to total concentrations ofPFOA and PFOS showed a decreasing trend with decreasing age of the water.				1						1										B	-			
103	ばく露	Eschauzier, Christian; Raat, Klaasjan J; Stuyfzand, Pieter J; De Voogt, Pim	Perfluorinated alkylated acids in groundwater a	2013	Sci Total Environ. 2013 Aug 1;458-460:477-85. doi: 10.1016/j.scitotenv.2013.04.066. Epub 2013 May 18.	Human exposure to perfluorinated alkylated acids (PFAA) occurs primarily via the dietary intake and drinking water can contribute significantly to the overall PFAA intake. Drinking water is produced from surface water and groundwater. Waste water treatment plants have been identified as the main source for PFAA in surface waters and corresponding drinking water. However, even though groundwater is an important source for drinking water production, PFAA sources remain largely uncertain. In this paper, we identified different direct and indirect sources of PFAA to groundwater within the catchment area of a public supply well field (PSWF) in The Netherlands. Direct sources were landfill leachate and water draining from a nearby military base/urban area. Indirect sources were infiltrated rainwater. Maximum concentrations encountered in groundwater within the landfill leachate plume were 1.8 μg/L of non branched perfluorooctanoic acid (L-PFOA) and 1.2 μg/L of perfluorobutanoic acid (PFBA). Sum concentrations amounted to 4.4 μg/L total PFAA. The maximum concentration of ΣPFAA in the groundwater originating from the military camp was around 17 ng/L. Maximum concentrations measured in the groundwater halfway the landfill and the PWSF (15 years travel distance) were 29 and 160 ng/L for L-PFOA and PFBA, respectively. Concentrations in the groundwater pumping wells (travel distance >25 years) were much lower: 0.96 and 3.5 ng/L for L-PFOA and PFBA, respectively. The chemical signature of these pumping wells corresponded to the signature encountered in other wells sampled which were fed by water that had not been in contact withpotential contaminant sources, suggesting a widespread diffuse contamination from atmospheric deposition.				1						1	1						1			B	-			
104	ばく露	Harrad, Stuart; Drage, Daniel S; Sharkey, Martin; Berresheim, Harald	Brominated flame retardants and perfluoroalky	2019	Sci Total Environ. 2019 Dec 10;695:133810. doi: 10.1016/j.scitotenv.2019.133810. Epub 2019 Aug 6.	Between June and November 2017, leachate samples were collected from 40 landfills across the Republic of Ireland. Concentrations of perfluoroalkyl substances (PFASs), polybrominated diphenyl ethers (PBDEs), and hexabromocyclododecane (HBCDD) determined in these samples were within the range previously reported in other countries. Average concentrations of PFASs exceeded those of PBDEs and HBCDD; likely due to the higher water solubility of PFASs. Log-transformed concentrations of BDEs-47, 100, 153, and 183, as well as perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorobutane sulfonate (PFBS) were significantly ($p < 0.05$) higher in leachate from newer, lined landfills than in samples from unlined landfills. These higher concentrations in lined landfills are likely related to the fact that lined landfills are found to retain organic matter leading to a higher organic content of leachate from such landfills. This is evidenced by the significant ($p < 0.05$) correlation between log-transformed concentrations in leachate of most of the same contaminants and those of chemical oxygen demand (COD). Concentrations of the less water-soluble, higher molecular weight BDE-209 were not correlated with leachate COD, nor landfill age or the presence of a landfill liner. This suggests that the presence of BDE-209 in landfill leachate is driven more by physical abrasion of particles and fibres from waste articles, than dissolution into the aqueous phase. The higher concentrations of some PFASs and PBDEs in leachate from lined landfills present a challenge with respect to leachate disposal, when leachate is sent to wastewatertreatment plants that do not necessarily have mechanisms in place to remove or destroy these chemicals prior to discharge into the environment. Moreover, the presence of these persistent organic chemicals in leachate from unlined landfills raises concerns about releases to the environment including groundwater over the lifetime of such landfills and beyond.				1						1										B	-			
105	ばく露	Haug, Line S; Huber, Sandra; Schlabach, Martin; Becher, Georg; Thomsen, Cathrine	Investigation on per- and polyfluorinated comp	2011	Environ Sci Technol. 2011 Oct 1;45(19):7991-8. doi: 10.1021/es103456h. Epub 2011 Mar 18.	Per- and polyfluorinated compounds (PFCs) have been found to be ubiquitously distributed in human populations, however the sources of human exposure are not fully characterized. A wide range of PFCs were determined in paired samples of indoor air and dust from 41 Norwegian households. Up to 18 ionic and 9 neutral PFCs were detected. The concentrations found are comparable to or lower than what has previously been reported in North America, Europe, and Asia. The highest median concentrations in dust were observed for perfluorohexanoic acid (28 ng/g), perfluorononanoic acid (23 ng/g), perfluorododecanoic acid (19 ng/g), and perfluorooctanoic acid (18 ng/g). However, perfluoroalkyl sulfonic acids (PFSAs) were also frequently detected. Fluortelomer alcohols were the most prominent compounds found in indoor air, with median concentrations for 8:2 fluortelomer alcohol, 10:2 fluortelomer alcohol, and 6:2 fluortelomer alcohol of 5173, 2822, and 933 pg/m(3) air, respectively. All perfluoroalkyl sulfonamides and sulfonamidoethanols (FOSA/FOSEs) were detected in more than 40% of the air samples. For the first time, significant positive correlations ($p < 0.05$) between PFSAs in house dust and FOSA/FOSEs in the indoor air have been shown, supporting the hypothesis that FOSA/FOSEs may be transformed to PFSAs. Further, we found the age of the residence to be a predictor of PFC concentrations in both indoor air and house dust. These results are important for estimating the exposure to PFCs from the indoor environment and for characterization of exposure pathways.				1						1							1			B	-			

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
106	ばく露	Huset, Carin A; Chiaia, Aurea C; Barofsky, Douglas F; Jonkers, Niels; Kohler, Hans-Peter E; Ort, Christoph; Giger, D Walter; Field, Jennifer A	Occurrence and mass flows of fluorochemicals	2008	Environ Sci Technol. 2008 Sep 1;42(17):6369-77. doi: 10.1021/es703062f.	Fluorochemicals are persistent contaminants that are globally distributed in air, water, sediments, and biota. Wastewater treatment plants (WWTPs) play an important role in mitigating pollutant releases from municipalities to aquatic and terrestrial environments. However, because WWTPs are point sources of fluorochemicals, it is important to understand their contribution to fluorochemical burdens in the greater context of watersheds. To this end, over a 1 week period, the mass flows of 11 fluorochemicals from seven WWTPs that discharge effluent into the Glatt River in Switzerland were measured and compared to the measured mass flows within the Glatt River. Overall, the fluorochemicals were not removed efficiently during wastewater treatment. Effluents from WWTPs and Glatt River water were dominated by perfluorooctane sulfonate, which was detected in all samples, followed by perfluorohexane sulfonate and perfluorooctanoate. The mass flows of fluorochemicals emanating from WWTPs were found to be conserved within the 35 km Glatt River, which indicates that input from the WWTPs is additive and that removal within the Glatt River is not significant. Per capita discharges of fluorochemicals were calculated from the populations served by the WWTPs studied; the values determined also account for the fluorochemical content of Lake Greifen (Greifensee), which is a lake at the headwaters of the Glatt River that also receives treated wastewater.				1						1											B	-		
107	ばく露	Joerss, Hanna; Apel, Christina; Ebinghaus, Ralf	Emerging per- and polyfluoroalkyl substances	2019	Sci Total Environ. 2019 Oct 10;686:360-369. doi: 10.1016/j.scitotenv.2019.05.363. Epub 2019 May 24.	Along with the phase-out of legacy long-chain perfluoroalkyl carboxylic acids (PFCAs), perfluoroalkane sulfonic acids (PFSAs) and their precursors, attention has been drawn to emerging per- and polyfluoroalkyl substances (PFASs). This study is aimed at investigating the importance of selected emerging PFASs as pollutants in European coastal environments and a possible transition from legacy long-chain PFCAs and PFSAs to replacement compounds. Therefore, the spatial distribution of 29 PFASs was analysed in surface water and sediment of the North and Baltic Seas sampled in 2017. Levels of the replacement compound HFPO-DA were approximately three times higher than those of its predecessor PFOA in surface water from the North Sea, which is characterised by the influence of point sources and constant exchange with open water. Reanalysis of sample extracts from the last decade showed that HFPO-DA had already been present in 2011, when it had not yet been in focus. In the Baltic Sea with a limited water exchange and dominance of diffuse sources, the proportion of HFPO-DA was negligible, whereas long-chain PFCAs and PFSAs still contributed to ∑PFASs with about 30%. The emerging cyclic compound perfluoro-4-ethylcyclohexanesulfonate (PFECHS), which has not yet been reported in European coastal environments, was detected in 86% of the Baltic Sea samples. Influenced by sediment characteristics in addition to source-specific contributions, the spatial distribution of PFASs in surface sediments was more variable than for water samples. The linear isomer of the long-chain legacy substance PFOS was the predominant compound found over theentire study area. Of the emerging PFASs, 6:6 and 6:8 perfluoroalkyl phosphinic acids (PFPiAs) were identified close to potential industrial inputs and in sedimentation areas. The results show that particular emerging PFASs play a relevant role in the investigated coastal environments and that a shift to replacements is dependent on sources and geographical conditions.				1						1											B	-		
108	ばく露	Ericson Jogsten, I; Nadal, M; van Bavel, B; Lindström, G; Domingo, J L	Per- and polyfluorinated compounds (PFCs) in	2012	Environ Int. 2012 Feb;39(1):172-80. doi: 10.1016/j.envint.2011.09.004. Epub 2011 Dec 3.	A total of 27 per- and polyfluorinated compounds (PFCs) were determined in both house dust (n=10) and indoor air (n=10) from selected homes in Catalonia, Spain. Concentrations were found to be similar or lower than those previously reported for household microenvironments in other countries. Ten PFCs were detected in all house dust samples. The highest mean concentrations corresponded to perfluorodecanoic acid (PFDA) and perfluorononanoic acid (PFNA), 10.7 ng/g (median: 1.5 ng/g) and 10.4 ng/g (median: 5.4 ng/g), respectively, while the 8:2 fluorotelomer alcohol (FTOH) was the dominating neutral PFC at a concentration of 0.41 ng/g (median: 0.35 ng/g). The indoor air was dominated by the FTOHs, especially the 8:2 FTOH at a mean (median) concentration of 51 pg/m(3) (median: 42 pg/m(3)). A limited number of ionic PFCs were also detected in the indoor air samples. Daily intakes of PFCs were estimated for average and worst case scenarios of human exposure from indoor sources. For toddlers, this resulted in average intakes of ∑ionic PFCs of 4.9ng/day (0.33 ng/kg(bw)/day for a 15 kg toddlers) and ∑neutral PFCs of 0.072 ng/day (0.005 ng/kg(bw)/day) from house dust. For adults, the average daily intakes of dust were 3.6 and 0.053 ng/day (0.05 and 0.001 ng/kg(bw)/day for a 70 kg adult) for ∑ionic and ∑neutral PFCs, respectively. The average daily inhalation of ∑neutral PFCs was estimated to be 0.9 and 1.3 ng/day (0.06 and 0.02 ng/kg(bw)/day) for toddlers and adults, respectively. For PFOS, the main ionic PFC detected in indoor air samples, the median intakes (based on those samples where PFOS was detected), resulted inindoor exposures of 0.06 and 0.11 ng/day (0.004 and 0.002 ng/kg(bw)/day) for toddlers and adults, respectively. Based on previous studies on dietary intake and drinking water consumption, both house dust and indoor air contribute significantly less to PFC exposure within this population.				1						1									1		B	-		
109	ばく露	Kaboré, Hermann A; Vo Duy, Sung; Munoz, Gabriel; Méité, Ladji; Desrosiers, Mélanie; Liu, Jinxia; Sory, Traoré Karim; Sauvé, Sébastien	Worldwide drinking water occurrence and leve	2018	Sci Total Environ. 2018 Mar;616-617:1089-1100. doi: 10.1016/j.scitotenv.2017.10.210.	In the last decade or so, concerns have arisen with respect to the widespread occurrence of perfluoroalkyl acids (PFAAs) in the environment, food, drinking water, and humans. In this study, the occurrence and levels of a large range of perfluoroalkyl and polyfluoroalkyl substances (PFASs) were investigated in drinking water (bottled and tap water samples) from various locations around the world. Automated off-line solid phase extraction followed by ultra-high-performance liquid chromatography coupled to high-resolution mass spectrometry was used to analyze PFASs of various chain lengths and functional groups. In total, 29 target and 104 suspect-target PFASs were screened in drinking water samples (n=97) from Canada and other countries (Burkina Faso, Chile, Ivory Coast, France, Japan, Mexico, Norway, and the USA) in 2015-2016. Out of the 29 PFASs quantitatively analyzed, perfluorocarboxylates (PFCAs: C(4/14)), perfluoroalkane sulfonates (PFSAs: C(4), C(6), C(8)), and perfluoroalkyl acid precursors (e.g., 5:3 fluorotelomer carboxylate (5:3 FTCA)) were recurrently detected in drinking water samples (concentration range: <LOD to 39ngL(-1)). Tap water samples from Canada showed noteworthy differences depending on their source; for instance, ∑(29)PFASwas significantly greater in those produced from the Great Lakes/St. Lawrence River ecosystem than those produced from other types of sources (14 versus 5.3ngL(-1), respectively). A suspect-target screening approach indicated that other perfluoroalkane sulfonamides (FBSA, FHxSA), perfluoroethyl cyclohexane sulfonate (PFECHS), ultrashort chain (C(2)-C(3)) PFSAs(PFEtS, PFPrS), and two additional PFSAs (PFPeS (C(5)) and PFHpS (C(7))) were repeatedly present in tap water samples (concentration ranges: <LOD to 4.0ngL(-1)). To the authors' best knowledge, this constitutes the first observation of a cyclic perfluoroalkane sulfonate (PFECHS) and C(4)-C(6) perfluoroalkane sulfonamides (FBSA, FHxSA) in drinking water. According to the newly updated US EPA health advisory for PFOS and PFOA (70ngL(-1)), the drinking water samples collected in the present monitoring would not pose a health risk to consumers as regards PFAA levels.				1						1					1	1					B	-		
110	ばく露	Kwok, Karen Y; Wang, Xin-Hong; Ya, Miaolei; Li, Yongyu; Zhang, Xiao-Hua; Yamashita, Nobuyoshi; Lam, James C W; Lam, Paul K S	Occurrence and distribution of conventional ar	2015	J Hazard Mater. 2015 Mar 21;285:389-97. doi: 10.1016/j.jhazmat.2014.10.065. Epub 2014 Dec 12.	Concentrations of 23 per- and polyfluoroalkyl substances (PFASs), including new classes of PFASs, in seawater samples were investigated for their occurrence and the interaction of the ocean currents with the distribution of PFASs in the South China Sea. This study revealed that socio-economic development was associated with the PFAS contamination in coastal regions of South China. Significant correlations between concentration of total PFASs with gross domestic product (GDP) per capita and population density were found in the areas, suggesting that the influence of intense human activities in these areas may have resulted in higher PFAS contamination to the adjacent environment. Di-substituted polyfluoroalkyl phosphate (diPAP), one of the potential replacements for PFASs, was only detected in the heavily developed region, namely Pearl River Delta (PRD). Total PFAS concentrations, ranging from 195 to 4925 pg/L, were detected at 51 sampling stations of the South China Sea. The results also confirmed that PFAS contamination in the South China Sea is strongly affected by the ocean currents. In comparison to perfluoroactane sulfonate (PFOS) concentrations measured nine years ago at the same locations, the concentrations in this study were found to be two times higher. This indicated that the use and production of perfluoroalkyl sulfonates (PFSAs) has been continuing in the region.				1						1											B	-		
111	ばく露	Li, Xiaomin; Gao, Ke; Dong, Shujun; Liu, Xian; Fu, Kehan; Wang, Peilong; Zhang, Aiqian; Su, Xiaoou; Fu, Jianjie	Length-specific occurrence and profile of perfl	2019	J Hazard Mater. 2019 Jul 5;373:224-231. doi: 10.1016/j.jhazmat.2019.03.074. Epub 2019 Mar 19.	Animal protein supplement feeds (APFs) are susceptible to perfluoroalkyl acids (PFAAs) and could be the main sources for raised animals, thereafter causing further human exposure through the farm-to-fork pathway. However, the occurrence of PFAAs has been rarely evaluated in various APFs, especially for emerging short-chain PFAAs. In the present study, we collected the most prevalent APFs (blood meal, meat meal, feather meal, soybean meal and DDGS) and found that ∑(16)PFAAs ranged from undetectable to 37.1 ng/g dry weight (dw) (average: 7.23 ng/g dw). Blood meal contained the highest PFAA levels, and results revealed that some terrestrial-derived APFs might be present at levels on par with the marine-derived feed. Animal-derived APFs (mean 10.9 ng/g dw) possessed higher ∑PFAAs than plant-derived APFs (0.75 ng/g dw). Length-specific PFAA profiles were specified between terrestrial-origin and marine-origin feeds in addition to animal-derived and plant-derived feeds. Short-chain PFAAs (PFBA, PFBS and PFHxS) were primarily found in blood meal, meat meal, soybean meal and DDGS, while the long-chain counterparts dominated in feather meal. It is of great concern that feed exposure to emerging contaminants has not drawn enough attention.	1			1						1											B	-		
112	ばく露	Lin, Angela Yu-Chen; Panchangam, Sri Chandana; Tsai, Yu-Ting; Yu, Tsung-Hsien	Occurrence of perfluorinated compounds in the	2014	Environ Monit Assess. 2014 May;186(5):3265-75. doi: 10.1007/s10661-014-3617-9. Epub 2014 Jan 26.	The current article maps perfluoroalkyl acids (PFAAs) contamination in the largest Science Park of Taiwan. The occurrence of ten target PFAAs in the effluent of an industrial wastewater treatment plant (IWWTP), its receiving rivers, rainwater, sediment, and the muscles and livers of fish was investigated. All target PFAAs were found in effluent of IWWTP, in which perfluorooctane sulfonate (PFOS) (6,930 ng/L), perfluorohexyl sulfonate (PFHxS) (2,662 ng/L) and perfluorooctanoic acid (PFOA) (3,298 ng/L) were the major constituents. Concentrations of PFBS and PFOS in the IWWTP downstream areas have exceeded safe concentration levels of avian and aquatic life, indicating a potential risk to wildlife in those areas. In sediment samples, predominant contaminants were PFOS (1.5-78 ng/g), PFOA (0.5-5.6 ng/g), and perfluorododecanoic acid (PFDoA) (nd-5.4 ng/g). In biological tissue samples, concentrations as high as 28,933 ng/g of PFOS were detected in tilapia and catfish liver samples. A positive correlation for log (C sediment/C water) and log (C tissue/C water) was found. The concentration and proportion (percentage of all PFAAs) of PFOS found in biotissue samples from the Keya River (which receives industrial wastewater) were found to be much greater (200 times) than those of samples from the Keelung River (which receives mainly domestic wastewater). These findings suggest that the receiving aquatic environments and, in turn, the human food chain can be significantly influenced by industrial discharges.				1						1											B	-		
113	ばく露	Liu, Yunqing; Zhang, Ying; Li, Jiafu; Wu, Nan; Li, Wenpeng; Niu, Zhiguang	Distribution, partitioning behavior and positive	2019	Environ Pollut. 2019 Mar;246:34-44. doi: 10.1016/j.envpol.2018.11.113. Epub 2018 Dec 1.	The concentrations and spatial occurrences of 17 legacy per- and polyfluoroalkyl substances (PFAS) and 4 emerging PFAS in the coastal water-dissolved phase, surface sediment phase and suspended particulate matter (SPM) in the coastal areas of Bohai Bay were investigated. In addition, the partition behaviors of PFAS in the water-SPM system and water-sediment system and the potential sources of PFAS in the marine environment were revealed. The total concentrations of PFAS (∑PFAS) in the water-dissolved phase, surface sediment and SPM were 20.5-684 ng/L, 2.69-25.0 ng/g dry weight (dw) and 4.39-527 ng/g dw, respectively. The level of PFAS contamination in the coastal areas of Shandong Province was higher than that in other areas. The average partition coefficients (log K(d)) of PFAS in the water-SPM system and water-sediment system were 1.56-3.57 and 0.72-2.95, respectively. Long-chain PFAS and PFECHS (perfluoroethylcyclohexane sulfonate) have a higher log K(d) than that of short-chain PFAS. PFAS with short carbon chains were mainly detected in the water-dissolved phase, but long-chain PFAS mainly occurred in the surface sediment and SPM phases. Source analysis based on the positive matrix factorization (PMF) model found that erosion inhibitor factories, aqueous film-forming foam factories, metal plating plants, fluoropolymer chemical manufacture and food contact materials were the main sources of PFAS in Bohai Bay. These results improved our understanding of the partitioning behavior and sources of PFAS in aquatic environments.				1						1											B	-		
114	ばく露	Llorca, Marta; Farré, Marinella; Tavano, Má ximo Sebastián; Alonso, Bruno; Koremblit, Gabriel; Barceló, Damià	Fate of a broad spectrum of perfluorinated con	2012	Environ Pollut. 2012 Apr;163:158-66. doi: 10.1016/j.envpol.2011.10.027. Epub 2012 Jan 12.	In this study, the presence of 18 perfluorinated compounds was investigated in biota and environmental samples from the Antarctica and Tierra de Fuego, which were collected during a sampling campaign carried out along February and March 2010. 61 samples were analysed including fish, superficial soils, guano, algae, dung and tissues of Papua penguin by liquid chromatography coupled to tandem mass spectrometry. The concentrations of PFCs were ranging from 0.10 to 240 ng/g for most of the samples except for penguin dung, which presented levels between 95 and 603 ng/g for perfluorooctane sulfonate, and guano samples from Ushuaia, with concentration levels of 1190-2480 ng/g of perfluorohexanoic acid. PFCs acids presented, in general, the highest levels of concentration and perfluorooctanesulfonate was the most frequently found compound. The present study provides a significant amount of results, which globally supports the previous studies, related to the transport, deposition, biodegradation and bioaccumulation patterns of PFCs.				1						1	1									B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
115	ばく露	Loi, Eva I H; Yeung, Leo W Y; Taniyasu, Sachi; Lam, Paul K S; Kannan, Kurunthachalam; Yamashita, Nobuyoshi	Trophic magnification of poly- and perfluorinat	2011	Environ Sci Technol. 2011 Jul 1;45(13):5506-13. doi: 10.1021/es200432n. Epub 2011 Jun 6.	Perfluorinated compounds (PFCs) are known to biomagnify in temperate and Arctic food webs, but little is known about their behavior in subtropical systems. The environmental distribution and biomagnification of PFCs, extractable organic fluorine (EOF), and total fluorine were investigated in a subtropical food web. Surface water, sediment, phytoplankton, zooplankton, gastropods, worms, shrimps, fishes, and waterbirds collected in the Mai Po Marshes Nature Reserve in Hong Kong were analyzed. Trophic magnification was observed for perfluorooctanesulfonate (PFOS), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), and perfluorododecanoate (PFDoDA) in this food web. Risk assessment results for PFOS, PFDA, and perfluorooctanoate (PFOA) suggest that current PFC concentrations in waterbird livers are unlikely to pose adverse biological effects to waterbirds. All hazard ratio (HR) values reported for PFOS and PFOA are less than one, which suggests that the detected levels will not cause any immediate health effects to the Hong Kong population through the consumption of shrimps and fishes. However, only 10-12% of the EOF in the shrimp samples was comprised of known PFCs, indicating the need for further investigation to identify unknown fluorinated compounds in wildlife.				1						1						1					C	-	PFOS, PFDA, PFUnDA, PFDoDA	
116	ばく露	Loos, Robert; Locoro, Giovanni; Comero, Sara; Contini, Serafino; Schwesig, David; Werres, Friedrich; Balsaa, Peter; Gans, Oliver; Weiss, Stefan; Blaha, Ludek; Bolchi, Monica; Gawlik, Bernd Manfred	Pan-European survey on the occurrence of sel	2010	Water Res. 2010 Jul;44(14):4115-26. doi: 10.1016/j.watres.2010.05.032. Epub 2010 Jun 1.	This study provides the first pan-European reconnaissance of the occurrence of polar organic persistent pollutants in European ground water. In total, 164 individual ground-water samples from 23 European Countries were collected and analysed (among others) for 59 selected organic compounds, comprising pharmaceuticals, antibiotics, pesticides (and their transformation products), perfluorinated acids (PFAs), benzotriazoles, hormones, alkylphenolics (endocrine disrupters), Caffeine, Diethyltoluamide (DEET), and Triclosan. The most relevant compounds in terms of frequency of detection and maximum concentrations detected were DEET (84%; 454 ng/L), Caffeine (83%; 189 ng/L), PFOA (66%; 39 ng/L), Atrazine (56%; 253 ng/L), Desethylatrazine (55%; 487 ng/L), 1H-Benzotriazole (53%; 1032 ng/L), Methylbenzotriazole (52%; 516 ng/L), Desethylterbutylazine (49%; 266 ng/L), PFOS (48%, 135 ng/L), Simazine (43%; 127 ng/L), Carbamazepine (42%; 390 ng/L), nonylphenoxy acetic acid (NPE(1)C) (42%; 11 microg/L), Bisphenol A (40%; 2.3 microg/L), PFHxS (35%; 19 ng/L), Terbutylazine (34%; 716 ng/L), Bentazone (32%; 11 microg/L), Propazine (32%; 25 ng/L), PFHpA (30%; 21 ng/L), 2,4-Dinitrophenol (29%; 122 ng/L), Diuron (29%; 279 ng/L), and Sulfamethoxazole (24%; 38 ng/L). The chemicals which were detected most frequently above the European ground water quality standard for pesticides of 0.1 microg/L were Chloridazon-desphenyl (26 samples), NPE(1)C (20), Bisphenol A (12), Benzotriazole (8), N,N'-Dimethylsulfamid (DMS) (8), Desethylatrazine (6), Nonylphenol (6), Chloridazon-methyldesphenyl (6), Methylbenzotriazole (5), Carbamazepine (4), andBentazone (4). However, only 1.7% of all single analytical measurements (in total 8000) were above this threshold value of 0.1 microg/L; 7.3% were > than 10 ng/L.				1						1	1							1			B	-		
117	ばく露	Mak, Yim Ling; Taniyasu, Sachi; Yeung, Leo W Y; Lu, Guohui; Jin, Ling; Yang, Yongliang; Lam, Paul K S; Kannan, Kurunthachalam; Yamashita, Nobuyoshi	Perfluorinated compounds in tap water from C	2009	Environ Sci Technol. 2009 Jul 1;43(13):4824-9. doi: 10.1021/es900637a.	The recent development of a sensitive and accurate analytical method for the analysis of 20 perfluorinated compounds (PFCs), including several short-chain PFCs, has enabled their quantification in tap water collected in China, Japan, India, the United States, and Canada between 2006 and 2008. Of the PFCs measured, PFOS, PFHxS, PFBS, PFPrS, PFEtS, PFOSA, N-EtFOSAA, PFDoDA, PFUnDA, PFDA, PFNA, PFHpA, PFHxA, PFPeA, PFBA, and PFPrA were found at detectable concentrations in the tap water samples. The water samples from Shanghai (China) contained the greatest concentrations of total PFCs (arithmetic mean = 130 ng/L), whereas those from Toyama (Japan) contained only 0.62 ng/L. In addition to PFOS and PFOA, short-chain PFCs such as PFHxS, PFBS, PFHxA, and PFBA were found to be prevalent in drinking water. According to the health-based values (HBVs) and advisory guidelines derived for PFOS, PFOA, PFBA, PFHxS, PFBS, PFHxA, and PFPeA by the U.S.EPA and the Minnesota Department of Health, tap water may not pose an immediate health risk to consumers.	1	1	1	1							1						1			B	-		
118	ばく露	Moody, Cheryl A; Hebert, Gretchen N; Strauss, Steven H; Field, Jennifer A	Occurrence and persistence of perfluorooctane	2003	J Environ Monit. 2003 Apr;5(2):341-5. doi: 10.1039/b212497a.	Various formulations of fire-extinguishing materials, including aqueous film-forming foams (AFFFs), were used as part of fire-training exercises conducted at Wurtsmith Air Force Base (WAFB) in northeastern Michigan from the 1950s until the base was decommissioned in 1993. As a result of past fire-training exercises, AFFF-laden wastewater containing fuels, solvents, and other materials directly entered groundwater without prior treatment. Perfluorinated surfactants are key components in some AFFF formulations. In this study, groundwater was analyzed for perfluoroalkanesulfonates and perfluorocarboxylates. Perfluoroalkanesulfonates were directly detected using negative-ion electrospray ionization mass spectrometry. Derivatized perfluorocarboxylates were detected using electron impact gas chromatography-mass spectrometry. Groundwater from wells around fire-training area FTA-02 at WAFB contained four perfluorinated surfactants ranging in concentration from 3 to 120 microg L(-1): perfluorooctanesulfonate (PFOS); perfluorohexanesulfonate; perfluorooctanoate; and perfluorohexanoate. This is the first report demonstrating that PFOS, recently shown to be toxic to organisms ranging from zooplankton to primates, is still present in groundwater in measurable quantities five or more years after its last known use.				1						1	1										B	-		
119	ばく露	Möller, Axel; Ahrens, Lutz; Surm, Renate; Westerveld, Joke; van der Wielen, Frans; Ebinghaus, Ralf; de Voogt, Pim	Distribution and sources of polyfluoroalkyl sub	2010	Environ Pollut. 2010 Oct;158(10):3243-50. doi: 10.1016/j.envpol.2010.07.019. Epub 2010 Aug 7.	The concentration profile of 40 polyfluoroalkyl substances (PFAS) in surface water along the River Rhine watershed from the Lake Constance to the North Sea was investigated. The aim of the study was to investigate the influence of point as well as diffuse sources, to estimate fluxes of PFAS into the North Sea and to identify replacement compounds of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). In addition, an interlaboratory comparison of the method performance was conducted. The PFAS pattern was dominated by perfluorobutane sulfonate (PFBS) and perfluorobutanoic acid (PFBA) with concentrations up to 181 ng/L and 335 ng/L, respectively, which originated from industrial point sources. Fluxes of SigmaPFAS were estimated to be approximately 6 tonnes/year which is much higher than previous estimations. Both, the River Rhine and the River Scheldt, seem to act as important sources of PFAS into the North Sea.				1						1								1			B	-		
120	ばく露	Nguyen, Minh A; Wiberg, Karin; Ribeli, Erik; Josefsson, Sarah; Futter, Martyn; Gustavsson, Jakob; Ahrens, Lutz	Spatial distribution and source tracing of per-	2017	Environ Pollut. 2017 Jan;220(Pt B):1438-1446. doi: 10.1016/j.envpol.2016.10.089. Epub 2016 Nov 11.	The impact of point and diffuse sources for 26 per- and polyfluoroalkyl substances (PFASs) in northern Europe were investigated by studying Swedish rivers (n = 40) and recipient seawater (Baltic Sea and Kattegat; n = 18). Different composition profiles were observed in the rivers, with ten rivers having a remarkably high fraction of perfluoroalkane sulfonic acids (PFSAs; 65% of the ΣPFASs) as compared to other rivers (19%) suggesting major impact of one or several source types dominated by PFSAs. Population density and low latitude (south) were strongly correlated to the widely used perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) as well as to perfluorohexanesulfonic acid (PFHxS). Significant relationships between several PFCAs and PFSAs (i.e. perfluorobutanoic acid (PFBA), perfluoroheptanoic acid (PFHpA), PFOA, perfluorobutanesulfonic acid (PFBS), and PFHxS) and dissolved organic carbon (DOC) were detected ($p < 0.05$), indicating chemical binding and co-transport with DOC in fresh water and seawater. Partial least squares regression analysis showed that perfluoroalkyl carboxylic acids (PFCAs) were related to latitude according to their perfluorocarbon chain length (C(3), C(7), C(8), C(9), C(10) and C(11)), with longer chains associated with higher latitudes. This suggests the presence of mechanisms promoting higher prevalence of longer chained PFCAs in the north, e.g. precursor degradation, and/or aerosol associated stabilization of PFCAs and their precursors.				1						1											B	-		
121	ばく露	Nguyen, H. T.; Kaserzon, S. L.; Thai, P. K.; Vijayasarathy, S.; Bräunig, J.; Crosbie, N. D.; Bignert, A.; Mueller, J. F.	Temporal trends of per- and polyfluoroalkyl sul	2019	Emerging Contaminants, 5, 211-218. doi: 10.1016/j.emcon.2019.05.006	Per- and polyfluoroalkyl substances (PFAS) are found ubiquitously in wastewater treatment plants (WWTPs) due to their multiple sources in industry and consumer products. In Australia, limited spatial data are available on PFAS levels in WWTPs influent, while no temporal data have been reported. The aim of this study was to investigate the occurrence and temporal trend of PFAS in the influent of two large WWTPs in Australia (WWTP A and B) over a four-year period. Daily influent samples were collected over one week at different seasons from 2014 to 2017. Eleven perfluoroalkyl acids (PFAA) (i.e. seven perfluoroalkyl carboxylic acids (PFCAs) and four perfluoroalkyl sulfonic acids (PFSA)) were detected with mean Σ11PFAA concentrations of 57 ± 3.3–94 ± 17 ng/L at WWTP A, and 31 ± 6.1–142 ± 73 ng/L at WWTP B. The highest mean concentrations were observed for perfluorohexanoate (PFHxA) (20 ± 2 ng/L) in WWTP A, and perfluorooctane sulfonate (PFOS) (17 ± 13 ng/L) in WWTP B. The precursor 6:2 fluorotelomer sulfonate was detected over five sampling periods from Aug 2016 to Oct 2017, with mean concentrations of 37 ± 18–138 ± 51 ng/L for WWTP A and 8.8 ± 4.5–29 ± 5.1 ng/L for WWTP B. Higher concentration of 6:2 FTS (1.8–11 folds) than those of PFOA and PFOS in WWTP A indicate a likely substitution of C8 PFAA by fluorotelomer-based PFAS in this catchment. Temporal trends (annual and seasonal) in per-capita mass load were observed for some PFAA, increasing for PFPeA, PFHxA, PFHpA, PFNA, and PFHxS, while decreasing for PFBS and PFOS in either WWTPs. Notably, elevated levels of PFOS in October 2017 were observed at both WWTPs with the highest per capita mass load of up to 67 μg/day/inhabitant. For some PFAS release trends, longer sampling periods would be required to achieve acceptable statistical power.				1						1											B	-		
122	ばく露	partment of Environmental Health Sciences, S.,ofPHandHS; Sinno, P. P.; Department of Environmental Health Sciences, S.,ofPHandHS; Jacobs, H. M.; Department of Environmental Health Sciences, S.,ofPHandHS; Timme-Laragy, A. R. Department of Environmental Health Sciences, S.,ofPHandHS; Department of Chemistry, M. U.; Criscitiello, A. S.; Department of Earth and Atmospheric Sciences, U.,ofA; Spencer, C.; Aquatic Contaminants Research Division, E.,andCCC; Sharp, M. J.; Department of Earth and Atmospheric Sciences,	Continuous non-marine inputs of per- and poly	2018	Atmos Chem Phys. 18(7):5045-5058. doi: 10.5194/acp-18-5045-2018	Perfluoroalkyl acids (PFAAs) are persistent, in some cases, bioaccumulative compounds found ubiquitously within the environment. They can be formed from the atmospheric oxidation of volatile precursor compounds and undergo long-range transport (LRT) through the atmosphere and ocean to remote locations. Ice caps preserve a temporal record of PFAA deposition making them useful in studying the atmospheric trends in LRT of PFAAs in polar or mountainous regions, as well as in understanding major pollutant sources and production changes over time. A 15 m ice core representing 38 years of deposition (1977–2015) was collected from the Devon Ice Cap in Nunavut, providing us with the first multi-decadal temporal ice record in PFAA deposition to the Arctic. Ice core samples were concentrated using solid phase extraction and analyzed by liquid and ion chromatography methods. Both perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs) were detected in the samples, with fluxes ranging from < LOD to 141 ng m<inline-formula>-2</inline-formula> yr<inline-formula>-1</inline-formula>. Our results demonstrate that the PFCAs and perfluorooctane sulfonate (PFOS) have continuous and increasing deposition on the Devon Ice Cap, despite recent North American and international regulations and phase-outs. We propose that this is the result of on-going manufacture, use and emissions of thesecompounds, their precursors and other newly unidentified compounds in regions outside of North America. By modelling air mass transport densities, and comparing temporal trends in deposition with production changes of possible sources, we find that Eurasian sources, particularly from Continental Asia, are large contributors to the global pollutants impacting the Devon Ice Cap. Comparison of PFAAs to their precursors and correlations of PFCA pairs showed that deposition of PFAAs is dominated by atmospheric formation from volatile precursor sources. Major ion analysis confirmed that marine aerosol inputs are unimportant to the long-range transport mechanisms of these compounds. Assessments of deposition, homologue profiles, ion tracers, air mass transport models, and production and regulation trends allow us to characterize the PFAA depositional profile on the Devon Ice Cap and further understand the LRT mechanisms of these persistent pollutants.				1						1											B	-		
123	ばく露	Rostkowski, Pawel; Yamashita, Nobuyoshi; So, Iris Man Ka; Taniyasu, Sachi; Lam, Paul Kwan Sing; Falandysz, Jerzy; Lee, Kyu Tae; Kim, Seung Kyu; Khim, Jong Seong; Im, Sook Hyeon; Newsted, John L; Jones, Paul D; Kannan, Kurunthachalam; Giesy, John P	Perfluorinated compounds in streams of the St	2006	Environ Toxicol Chem. 2006 Sep;25(9):2374-80. doi: 10.1897/05-627r.1.	Concentrations of perfluorinated alkyl compounds (PFAs), including perfluorooctane sulfonate (PFOS), perfluorohexanesulfonate, perfluorobutanesulfonate, perfluorooctanesulfonamide, perfluorodecanoate, perfluorononanoic acid, perfluorooctanoate (PFOA), perfluoroheptanoate, and perfluorohexanoate, were measured in the streams of the Shihwa and Banweol industrial areas on the west coast of South Korea as well as the adjacent Lake Shihwa (an artificial lake) and Gyeonggi Bay. Perfluorinated alkyl compounds were concentrated from water using solid-phase extraction and were identified and quantified by liquid chromatography/ triple-quadrapole tandem mass spectrometry. Of the PFAs measured, PFOS and PFOA occurred at the greatest concentrations. Concentrations of PFOS ranged from 2.24 to 651 ng/L, and concentrations of PFOA ranged from 0.9 to 62 ng/L. The concentrations of PFOS observed in Lake Shihwa were among the greatest ever measured in the environment. These results suggest local industrial sources of PFOS and PFOA as well as other PFAs. Because of dilution, the greatest concentrations occur in a rather restricted area, near the points of discharge of the streams that empty into the lake. The greatest measured concentration of PFOS exceeded the threshold for effects predicted for predatory birds consuming aquatic organisms continuously exposed to this level.				1						1											B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
124	ばく露	Saez, M., Moreno, D. V., Jimenez, B. & Leeuwen, S. v.	Uncommon PFC-profile in Arctic ice samples fr	2008	Organohalogen Compounds, 70, 1870-1873.	Per- and polyfluorinated compounds (PFCs) have recently emerged as important pollutants. During the last decade, they have gained attention due to their toxicity and global distribution. PFCs compile a broad group of chemicals with a wide range of uses in consumer and industrial products1,2. PFCs are found in the environment in populated and industrialised areas3-5. However, similar to other persistent organic pollutants, but via different processes due to their different properties, long range transport processes may lead to pollution of areas with little to none human activities. The presence of PFCs in remote areas, like Artic environment has been demonstrated from North of Canada to Norway6,7. However, no information is available yet on the environmental presence of PFCs in the Polar Region of Russia. The Polar Regions are very restricted areas and difficult to access. To better understand the environmental processes that govern their distribution and fate, especially in these fragile environments, research is needed. The objective of our work is to study the presence of PFCs in the ice from the North Russian Federation within the North Pole Region in order to shed some light on inputs of PFCs, potentially from long range transportation.										1													B	-			
125	ばく露	Schwanz, Thiago G; Llorca, Marta; Farré, Marinella; Barceló, Damià	Perfluoroalkyl substances assessment in drink	2016	Sci Total Environ. 2016 Jan 1;539:143-152. doi: 10.1016/j.scitotenv.2015.08.034. Epub 2015 Sep 8.	Human exposure to perfluoroalkyl substances (PFASs) occurs primarily via dietary intake and drinking water. In this study, 16 PFASs have been assessed in 96 drinking waters (38 bottled waters and 58 samples of tap water) from Brazil, France and Spain. The total daily intake and the risk index (RI) of 16 PFASs through drinking water in Brazil, France and Spain have been estimated. This study was carried out using an analytical method based on an online sample enrichment followed by liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS). The quality parameters of the analytical method were satisfactory for the analysis of the 16 selected compounds in drinking waters. Notably, the method limits of detection (MLOD) and method limits of quantification (MLOQ) were in the range of 0.15 to 8.76ng/l and 0.47 to 26.54ng/l, respectively. The results showed that the highest PFASs concentrations were found in tap water samples and the more frequently found compound was perfluorooctanesulfonic acid (PFOS), with mean concentrations of 7.73, 15.33 and 15.83ng/l in French, Spanish and Brazilian samples, respectively. In addition, PFOS was detected in all tap water samples from Brazil. The highest level of PFASs contamination in a single sample was 140.48ng/l in a sample of Spanish tap water. In turn, in bottled waters the highest levels were detected in a French sample with 116ng/l as the sum of PFASs. Furthermore, the most frequent compounds and those at higher concentrations were perfluoroheptanoic acid (PFHpA) with a mean of frequencies in the three countries of 51.3%, followed by perfluorobutanesulfonic acid (PFBS) (27.2%) andperfluorooctanoic acid (PFOA) (23.0%). Considering that bottled water is approximately 38% of the total intake, the total PFASs exposure through drinking water intake for an adult man was estimated to be 54.8, 58.0 and 75.6ng/person per day in Spain, France and Brazil, respectively. However, assuming that the water content in other beverages has at least the same levels of contamination as in bottled drinking water, these amounts were increased to 72.2, 91.4 and 121.0ng/person per day for an adult man in Spain, France and Brazil, respectively. The results of total daily intake in different gender/age groups showed that children are the most exposed population group through hydration with maximum values in Brazil of 2.35 and 2.01ng/kg body weight (BW)/day for male and female, respectively. Finally, the RI was calculated. In spite of the highest values being found in Brazil, it was demonstrated that, in none of the investigated countries, drinking water pose imminent risk associated with PFASs contamination.				1							1												B	-			
126	ばく露	Skutlarek, Dirk; Exner, Martin; Färber, Harald	Perfluorinated surfactants in surface and drink	2006	Environ Sci Pollut Res Int. 2006 Sep;13(5):299-307. doi: 10.1065/espr2006.07.326.	GOAL, SCOPE AND BACKGROUND: In this paper recent results are provided of an investigation on the discovery of 12 perfluorinated surfactants (PS) in different surface and drinking waters (Skutlarek et al. 2006 a, Skutlarek et al. 2006 b). In the last years, many studies have reported ubiquitous distribution of this group of perfluorinated chemicals, especially perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in the environment, particularly in wildlife animal and human samples (Giesy and Kannan 2001, Houde et al. 2006, Prevedouros et al. 2006). Perfluorinated surfactants (e.g. PFOS and PFOA) have shown different potentials for reproductory interference and carcinogenity in animal experiments as well as partly long half-lives in humans (Guruge et al. 2006, FSA UK 2006a, FSA UK 2006b, 3M 2005, OECD 2002, Yao and Zhong 2005). They possess compound-dependent extreme recalcitrance against microbiological and chemical degradation and, in addition, they show variable potentials for bioaccumulation in animals and humans (Houde et al. 2006). METHODS: Surface and drinking water samples were collected from different sampling sites: Surface waters: samples taken from the rivers Rhine, Ruhr, Moehne and some of their tributaries. Further samples were taken from the Rhine-Herne-Canal and the Wesel-Datteln-Canal. Drinking waters: samples taken in public buildings of the Rhine-Ruhr area. After sample clean-up and concentration by solid-phase extraction, the perfluorinated surfactants were determined using HPLC-MS/MS. RESULTS: All measured concentrations (sum of seven mainly detected components) in the Rhine river andits main tributaries (mouths) were determined below 100 ng/L. The Ruhr river (tributary of the Rhine) showed the highest concentration (94 ng/L), but with a completely different pattern of components (PFOA as major component), as compared with the other tributaries and the Rhine river. Further investigations along the Ruhr river showed remarkably high concentrations of PS in the upper reaches of the Ruhr river and the Moehne river (tributary of the Ruhr) (Ruhr: up to 446 ng/L, Moehne: up to 4385 ng/L). The maximum concentration of all drinking water samples taken in the Rhine-Ruhr area was determined at 598 ng/L with the major component PFOA (519 ng/L). DISCUSSION: The surface water contaminations most likely stem from contaminated inorganic and organic waste materials (so-called 'Abfallgemisch'). This waste material was legally applied to several agricultural areas on the upper reaches of the Moehne. Perfluorinated surfactants could be detected in some suchlike soil samples. They contaminated the river and the reservoir belonging to it, likely by superficial run-off over several months or probably years. Downstream, dilution effects are held responsible for decreasing concentrations of PS in surface waters of the Moehne and the Ruhr river. In analogy to the surface water samples, PS (major component PFOA) can be determined in many drinking water samples of the Rhine-Ruhr area where the water supplies are mainly based on bank filtration and artificial recharge. CONCLUSIONS: The concentrations found in drinking waters decreased with the concentrations of the corresponding raw water samples along the flow direction of the Ruhr river (from east to west) and were not significantly different from surface water concentrations. This indicates that perfluorinated surfactants are at present not successfully removed by water treatment steps. RECOMMENDATIONS AND PERSPECTIVES: Because of their different problematic properties (persistence, mobility, toxicity, bioaccumulation), the concentrations of specific perfluorinated surfactants and their precursors in drinking waters and food have to be minimised. Therefore, it is of utmost importance to take the initiative to establish suitable legal regulations (limitations/ban) concerning the production and use of these surfactants and their precursors.				1							1	1											B	-			
127	ばく露	de la Torre, Adrián; Navarro, Irene; Sanz, Paloma; Martínez, María de Los Ángeles	Occurrence and human exposure assessment	2019	Sci Total Environ. 2019 Oct 1;685:308-314. doi: 10.1016/j.scitotenv.2019.05.463. Epub 2019 May 31.	65 house dust samples from three European countries (Belgium, Italy and Spain) were evaluated for the presence of 20 polyflouroalkyl substances (PFASs) including perfluoroalkane sulfonic acids (PFSAs), perfluoroalkyl carboxylic acid (PFCAs) and perfluoroalkane sulfonamides (PFOSAs). The three countries presented similar PFAS levels ranging from 3.13 to 155 ng/g (12.9 ng/g; median), but in all cases PFCAs concentrations (6.92, 15.2 and 8.68 ng/g; median for Belgium, Italy and Spain) were higher than those obtained for PFSAs (2.30, 1.76 and 2.68 ng/g). Interestingly, in comparison to previously published data exhibited an increase in perfluorobutanesulfonate (PFBS) concentrations in Belgian house dust. On the other hand, levels of perfluorooctanesulfonate (PFOS) decreased in Spanish case. Data were examined for relationships between PFAS house dust levels, building and outdoor surrounding characteristics and occupant habits. Main findings revealed a positive association between PFOS concentrations and the building edification age, which could highlight a decrease in the use of this chemical in Europe. Similarly, perfluorohexanesulfonate (PFHxS) levels correlated with the percentage of the floor covered by textiles. Homes located in industrial sites showed higher PFCA levels compared to urban or agricultural locations, revealing the industrial processes as a potential source of these chemicals in Europe. Data obtained were used to perform human exposure assessment for dust intake via oral ingestion. Estimated daily intakes, calculated for toddlers and adults at median and worst case scenarios, were below oral Reference Dose (RfD) and tolerable daily intakes(TDI). However, in perfluorooctanoic acid (PFOA) case, dust ingestion significance to total dietary exposure reached values of 51% for toddlers in the worst case scenario.				1							1												B	-			
128	ばく露	Ullah, Shahid; Alsberg, Tomas; Berger, Urs	Simultaneous determination of perfluoroalkyl p	2011	J Chromatogr A. 2011 Sep 16;1218(37):6388-95. doi: 10.1016/j.chroma.2011.07.005. Epub 2011 Jul 8.	A trace analytical method based on high performance liquid chromatography coupled to quadrupole time-of-flight high resolution mass spectrometry was developed for simultaneous determination of perfluoroalkyl phosphonates (PFPAs, carbon chain lengths C6,8,10), perfluoroalkyl carboxylates (PFCAs, C5-12), and perfluoroalkyl sulfonates (PFSAs, C4,6,8,10) in drinking water (tap water). Analytes were enriched on a mixed mode co-polymeric sorbent (C8+quaternary amine) using solid phase extraction. Chromatographic separation was achieved on a Zorbax Extend C18 reversed phase column using a mobile phase gradient consisting of water, methanol, and acetonitrile containing 2mM ammonium acetate and 5 mM 1-methyl piperidine. The mass spectrometer was operated in electrospray negative ion mode. Use of 1-methyl piperidine in the mobile phase resulted in a significant increase in instrument sensitivity for PFPAs through improved chromatographic resolution, background suppression, and increased ionization efficiency. Method detection limits for extraction of 500 mL tap water were in the ranges of 0.095-0.17 ng/L, 0.027-0.17 ng/L, and 0.014-0.052 ng/L for PFPAs, PFCAs, and PFSAs, respectively. Whole method recoveries at a spiking level of 0.5 ng/L to 500 mL HPLC grade water were 40-56%, 56-97%, and 55-77% for PFPAs, PFCAs, and PFSAs, respectively. A matrix effect (signal enhancement) was observed in the detection of PFPAs in tap water extracts, leading to calculated recoveries of 249-297% at a 0.5 ng/L spiking level. This effect resulted in an additional improvement of method sensitivity for PFPAs. To compensate for the matrix effect, PFPAs in tap waterwere quantified using matrix-matched and extracted calibration standards. The method was successfully applied to the analysis of drinking water collected from six European countries. PFPAs were not detected except for perfluorooctyl phosphonate (PFOPA) at close to the detection limit of 0.095 ng/L in two water samples from Amsterdam, the Netherlands. Highest levels were found for perfluorobutane sulfonate (PFBS, 18.8 ng/L) and perfluorooctanoate (PFOA, 8.6 ng/L) in samples from Amsterdam as well as for perfluorooctane sulfonate (PFOS, 8.8 ng/L) in tap water from Stockholm, Sweden.				1							1	1											B	-			
129	ばく露	Valsecchi, Sara; Rusconi, Marianna; Mazzoni, Michela; Viviano, Gaetano; Pagnotta, Romano; Zaghi, Carlo; Serrini, Giuliana; Polesello, Stefano	Occurrence and sources of perfluoroalkyl acids	2015	Chemosphere. 2015 Jun;129:126-34. doi: 10.1016/j.chemosphere.2014.07.044. Epub 2014 Aug 6.	This paper presents a survey on the occurrence and sources of 11 perfluoroalkyl acids (PFAA) in the main river basins in Italy, covering about 40% of the Italian surface area and 45% of the Italian population. Total concentrations of PFAA ranged from<LOD to 8 μ gL(-1), the highest concentrations being measured in the rivers impacted by industrial discharges. Among the rivers directly flowing into the sea, Brenta, Po and Arno present significant concentrations, while concentrations in Tevere and Adige, which are not impacted by relevant industrial activities, are almost all below the detection limits. The total estimated PFAA load of the five rivers was 7.5ty(-1) with the following percentage distribution: 39% PFBS, 32% PFOA, 22% short chain perfluorocarboxylic acids (PFCA), 6% PFOS and 1% long chain PFCA. PFOA and PFOS loads, evaluated in the present work, represent 10% and 2% of the estimated European loads, respectively. In Italy the most important sources of PFAA are two chemical plants which produce fluorinated polymers and intermediates, sited in the basin of rivers Po and Brenta, respectively, whose overall emission represents 57% of the total estimated PFAA load. Both rivers flow into the Adriatic Sea, raising concern for the marine ecosystem also because a significant PFOS load (0.3ty(-1)) is still present. Among the remaining activities, tanneries and textile industries are relevant sources of respectively PFBS and PFOA, together with short chain PFCA. As an example, the total PFAA load (0.12ty(-1)) from the textile district of Prato is equivalent to the estimated domestic emission of the whole population in all thestudied basins.				1							1												B	-			
130	ばく露	Veillette, J.; Muir, D. C. G.; Antoniades, D.; Small, J. M.; Spencer, C.; Loewen, T. N.; Babaluk, J. A.; Reist, J. D.; Vincent, W. F.	Perfluorinated Chemicals in Meromictic Lakes	2012	Arctic, 65(3), 245-256. doi: 10.14430/arctic4213	Perfluorinated chemicals (PFCs) have been recorded in many types of marine and freshwater ecosystems. The aim of the present study was to examine meromictic lakes and their catchments on the far northern coast of Ellesmere Island, Nunavut, Canada, and to evaluate the results in the context of climate change. Our analyses revealed the presence of several PFCs in catchment snowpack, inflowing streams, lake water, and the aquatic food web of Lake A (83 degrees 00'N, 75 degrees 30'W), showing that dispersal of these contaminants reaches the northern limit of the terrestrial High Arctic. However, the concentrations were low (total PFCs: 27-754 pg L-1 for water, 134-848 pg L-1 for melted snow, 91068 pg g(-1) wet weight for fish; PFOS: 66 pg g(-1) dry weight in surficial sediments) and at or below values reported to date in the literature for other remote lakes. PFHpA, PFOA, and PFNA were the main compounds detected in water and melted snow, while PFNA, PFDA, and PFUnA were the predominant compounds in the aquatic biota, indicating their bioaccumulative potential. Salinity-temperature-depth profiles suggested that most of the present contaminant load enters the lake via streams and flows directly under the lake ice to the ocean. The onsetof summer open water in this perennially ice-covered lake in response to climate warming, and the increased duration of open water in recent years; have implications for the distribution, transport, and retention of PFCs in Arctic lakes.				1							1												B	-			

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
131	ばく露	Wang, Pei; Lu, Yonglong; Wang, Tieyu; Zhu, Zhaoyun; Li, Qifeng; Meng, Jing; Su, Hongqiao; Johnson, Andrew C; Sweetman, Andrew J	Coupled production and emission of short chai	2016	Environ Pollut. 2016 Nov;218:1234-1244. doi: 10.1016/j.envpol.2016.08.079. Epub 2016 Aug 31.	Short chain perfluoroalkyl acids (PFAAs) have been developed since 2002 by the major manufacturers to replace the conventional C8 and higher homologues, with much of the world production shifted to China in recent years. In this study, we conducted a continuous monitoring program over the period 2011-2014 with seasonal monitoring in 2013 for PFAAs emitted from two rapidly developing fluorochemical industry parks located in the Daling River Basin, Northern China. The trend of PFAA contamination was identified, dominated by perfluorobutane sulfonic acid (PFBS), perfluorobutanoic acid (PFBA) and perfluorooctanoic acid (PFOA), with the maximum concentrations of 3.78 μg/L, 3.70 μg/L, and 1.95 μg/L, respectively. Seasonal monitoring uncovered the occasional emission of perfluorooctane sulfonic acid (PFOS). Construction trends of new facilities and associated manufacturing capacity of the main products were also analyzed to assess correlations with PFAA emissions. An assessment of the data over the period 2011-2014 found a positive correlation with fluorocarbon alcohol (FCA) production and emission of PFAAs. Groundwater and tap water around the main source indicated that the dominant PFAAs had different diffusion behaviors. PFBS levels were higher in surface water, while PFBA was dominant in groundwater and tap water, with PFOA levels being higher in downstream groundwater. Considering the continuous expansion and development of fluorochemical industry in the Daling River Basin, this study will provide abundant information on the effectiveness of risk assessment and management.	1			1						1												B	-			
132	ばく露	Wilhelm, Michael; Bergmann, Sabine; Dieter, Hermann H	Occurrence of perfluorinated compounds (PFC	2010	Int J Hyg Environ Health. 2010 Jun;213(3):224-32. doi: 10.1016/j.ijheh.2010.05.004.	After detection of perfluorooctanoate (PFOA) in drinking water at concentrations up to 0.64 microg/l in Arnsberg, Sauerland, Germany, the German Drinking Water Commission (TWK) assessed perfluorinated compounds (PFCs) in drinking water and set for the first time worldwide in June 2006 a health-based guide value for safe lifelong exposure at 0.3 microg/l (sum of PFOA and perfluorooctanesulfonate, PFOS). PFOA and PFOS can be effectively removed from drinking water by percolation over granular activated carbon. Additionally, recent EU-regulations require phasing out use of PFOS and ask to voluntarily reduce the one of PFOA. New and shorter-chained PFCs (C4-C7) and their mixtures are being introduced as replacements. We assume that some of these "new" compounds could be main contributors to total PFC levels in drinking water in future, especially since short-chained PFCs are difficult to remove from drinking water by common treatment techniques and also by filtration over activated carbon. The aims of the study were to summarize the data from the regularly measured PFC levels in drinking water and in the drinking water resources in North Rhine-Westphalia (NRW) for the sampling period 2008-2009, to give an overview on the general approach to assess PFC mixtures and to assess short-chained PFCs by using toxicokinetic instead of (sub)chronic data. No general increase of substitutes for PFOS and PFOA in wastewater and surface water was detected. Present findings of short-chained PFC in drinking waters in NRW were due to extended analysis and caused by other impacts. Additionally, several PFC contamination incidents indrinking water resources (groundwater and rivers) have been reported in NRW. The new approach to assess short-chained PFCs is based on a ranking of their estimated half-lives for elimination from the human body. Accordingly, we consider the following provisional health-related indication values (HRIV) as safe in drinking water for lifelong exposure: perfluorobutanoate (PFBA) 7 microg/l, perfluoropentanoate (PFPA) 3 microg/l, perfluorohexanoate (PFHxA) 1 microg/l, perfluoroheptanoate (PFHpA) 0.3 microg/l, perfluorobutanesulfonate (PFBS) 3 microg/l, perfluoropentanesulfonate (PFPS) 1 microg/l, perfluorohexanesulfonate (PFHxS) 0.3 microg/l and perfluoroheptanesulfonate (PFHpS) 0.3 microg/l. For all PFCs the long-term lowest maximal quality goal (general precautionary value, PVg) in drinking water is set to ~0.1 microg/l.				1						1	1										B	-			
133	ばく露	Wong, F., Shoeib, M., Katsoyiannis, A., Eckhardt, S., Stohl, A., Bohlin-Nizzetto, P., Lid, H., Fellind, P., Su, Y. & Hung, H.	Assessing temporal trends and source regions	2018	Atmospheric Environment, 172, 65-73. doi: 10.1016/j.atmosenv.2017.10.028	Long-term Arctic air monitoring of per- and polyfluoroalkyl substances (PFASs) is essential in assessing their long-range transport and for evaluating the effectiveness of chemical control initiatives. We report for the first time temporal trends of neutral and ionic PFASs in air from three arctic stations: Alert (Canada, 2006–2014); Zeppelin (Svalbard, Norway, 2006–2014) and Andøya (Norway, 2010–2014). The most abundant PFASs were the perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorobutanoic acid (PFBA), and fluorotelomer alcohols (FTOHs). All of these chemicals exhibited increasing trends at Alert with doubling times (t2) of 3.7 years (y) for PFOA, 2.9 y for PFOS, 2.5 y for PFBA, 5.0 y for 8:2 FTOH and 7.0 y for 10:2 FTOH. In contrast, declining or non-changing trends, were observed for PFOA and PFOS at Zeppelin (PFOA, half-life, t1/2 = 7.2 y; PFOS t1/2 = 67 y), and Andøya (PFOA t1/2 = 1.9 y; PFOS t1/2 = 11 y). The differences in air concentrations and in time trends between the three sites may reflect the differences in regional regulations and source regions. We investigate the source region for particle associated compounds using the Lagrangian particle dispersion model FLEXPART. Model results showed that PFOA and PFOS are impacted by air masses originating from the ocean or land. For instance, PFOA at Alert and PFOS at Zeppelin were dominated by oceanic air masses whereas, PFOS at Alert and PFOA at Zeppelin were influenced by air masses transported from land.				1						1											B	-			
134	ばく露	Yamashita, Nobuyoshi; Taniyasu, Sachi; Petrick, Gert; Wei, Si; Gamo, Toshitaka; Lam, Paul K S; Kannan, Kurunthachalam	Perfluorinated acids as novel chemical tracers	2008	Chemosphere. 2008 Jan;70(7):1247-55. doi: 10.1016/j.chemosphere.2007.07.079. Epub 2007 Sep 12.	Perfluorinated acids (PFAs) such as perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) are global environmental contaminants. The physicochemical properties of PFAs are unique in that they have high water solubilities despite the low reactivity of carbon-fluorine bond, which also imparts high stability in the environment. Because of the high water solubilities, the open-ocean water column is suggested to be the final sink for PFOS and PFOA. However, little is known on the distribution of PFAs in the oceans around the world. Here we describe the horizontal (spatial) and vertical distribution of PFAs in ocean waters worldwide. PFOS and PFOA concentrations in the North Atlantic Ocean ranged from 8.6 to 36pg l(-1) and from 52 to 338pg l(-1), respectively, whereas the corresponding concentrations in the Mid Atlantic Ocean were 13-73pg l(-1) and 67-439pg l(-1). These were completely different from the surface waters of the South Pacific Ocean and the Indian Ocean (overall range of <5-11pg l(-1) for PFOS and PFOA). Vertical profiles of PFAs in the marine water column were associated with the global ocean circulation theory. Vertical profiles of PFAs in water columns from the Labrador Sea reflected the influx of the North Atlantic Current in surface waters, the Labrador Current in subsurface waters, and the Denmark Strait Overflow Water in deep layers below 2000m. Striking differences in the vertical and spatial distribution of PFAs, depending on the oceans, suggest that these persistent acids can serve as useful chemical tracers to allow us to study oceanic transportation by major water currents. Theresults provide evidence that PFA concentrations and profiles in the oceans adhere to a pattern consistent with the global "Broecker's Conveyor Belt" theory of open ocean water circulation.				1						1					1					B	-			
135	ばく露	Yeung, Leo W Y; Dassuncao, Clifton; Mabury, Scott; Sunderland, Elsie M; Zhang, Xianming; Lohmann, Rainer	Vertical Profiles, Sources, and Transport of PF	2017	Environ Sci Technol. 2017 Jun 20;51(12):6735-6744. doi: 10.1021/acs.est.7b00788. Epub 2017 Jun 5.	The relative importance of atmospheric versus oceanic transport for poly- and perfluorinated alkyl substances (PFASs) reaching the Arctic Ocean is not well understood. Vertical profiles from the Central Arctic Ocean and shelf water, snow and meltwater samples were collected in 2012; 13 PFASs (C6-C12 PFCAs; C6, 8, 10 PFSAs; MeFOSAA and EtFOSAA; and FOSA) were routinely detected (range: <5-343 pg/L). PFASs were only detectable above 150 m depth in the polar mixed layer (PML) and halocline. Enhanced concentrations were observed in snow and meltpond samples, implying atmospheric deposition as an important source of PFASs. Model results suggested atmospheric inputs to account for 34-59% (~11-19 pg/L) of measured PFOA concentrations in the PML (mean 32 ± 15 pg/L). Modeled surface and halocline measurements for PFOS based on North Atlantic inflow (11-36 pg/L) agreed with measurements (mean, 17, range <5-41 pg/L). Modeled deep water concentrations below 200 m (5-15 pg/L) were slightly higher than measurements (<5 pg/L), suggesting the lower bound of PFAS emissions estimates from wastewater and rivers may provide the best estimate of inputs to the Arctic. Despite low concentrations in deep water, this reservoir is expected to contain most of the PFOS mass in the Arctic (63-180 Mg) and is projected to continue increasing to 2038.				1						1					1					B	-			
136	ばく露	Yin, Tingru; Chen, Huiting; Reinhard, Martin; Yi, Xinzhu; He, Yiliang; Gin, Karina Yew-Hoong	Perfluoroalkyl and polyfluoroalkyl substances r	2017	Water Res. 2017 Nov 15;125:418-426. doi: 10.1016/j.watres.2017.08.071. Epub 2017 Sep 1.	Landfill leachate is often an important source of emerging organic contaminants including perfluoroalkyl and polyfluoroalkyl substances (PFASs) requiring proper treatment to protect surface water and groundwater resources. This study investigated the occurrence of PFASs in the leachate of a capped landfill site in Singapore and the efficacy of PFASs removal during flow through a constructed wetland (CW) treatment system. The CW treatment system consists of equalization tank, aeration lagoons, sedimentation tank, reed beds and polishing ponds. Target compounds included 11 perfluoroalkyl acids (PFAAs) (7 perfluoroalkyl carboxylic acids (PFCAs) and 4 perfluoroalkane sulfonates (PFSAs)) and 7 PFAA precursors. Although total PFASs concentrations in the leachate varied widely (1269 to 7661 ng/L) over the one-year sampling period, the PFASs composition remained relatively stable with PFCAs consistently being predominant (64.0 ± 3.8%). Perfluorobutane sulfonate (PFBS) concentrations were highly correlated with total PFASs concentrations and could be an indicator for the release of PFASs from this landfill. The release of short-chain PFAAs strongly depended on precipitation whereas concentrations of the other PFASs appeared to be controlled by partitioning. Overall, the CW treatment system removed 61% of total PFASs and 50-96% of individual PFASs. PFAAs were removed most efficiently in the reed bed (42-49%), likely due to the combination of sorption to soils and sediments and plant uptake, whereas most of the PFAA precursors (i.e. 5:3 fluorotelomer carboxylate (5:3 acid), N-substituted perfluorooctane sulfonamides (N-MeFOSAA andN-EtFOSAA)) were removed in the aeration lagoon (>55%) by biodegradation. The sedimentation tank and polishing ponds were relatively inefficient, with only 7% PFASs removal.				1						1										B	-			
137	ばく露	Benskin, Jonathan P; Li, Belinda; Ikonomou, Michael G; Grace, John R; Li, Loretta Y	Per- and polyfluoroalkyl substances in landfill l	2012	Environ Sci Technol. 2012 Nov 6;46(21):11532-40. doi: 10.1021/es302471n. Epub 2012 Oct 23.	Concentrations and isomer profiles for 24 per- and polyfluoroalkyl substances (PFASs) were monitored over 5 months (February-June, 2010) in municipal landfill leachate. These data were used to assess the role of perfluoroalkyl acid (PFAA) precursor degradation on changes in PFAA concentrations over time. The influence of total organic carbon, total suspended solids, pH, electrical conductivity (EC), leachate flow rates, and meteorological data (precipitation, air temperature) on leachate PFAS concentrations was also investigated. Perfluoropentanoate and perfluorohexanoate were typically the dominant PFASs in leachate, except for March-April, when concentrations of perfluorooctane sulfonate, perfluorooctanoate, and numerous PFAA-precursors (i.e., (N-alkyl) perfluorooctane sulfonamides and fluorotelomer carboxylic acids) increased by a factor of 2-10 (~4 μg/L to ~36 μg/L ΣPFASs). During this time, isomer profiles of PFOA became increasingly dominated by the linear isomer, likely from transformation of linear, telomer-manufactured precursors. While ΣPFAA-precursors accounted for up to 71% of ΣPFASs (molar basis) in leachate from this site, leachate from a second landfill displayed only low concentrations of precursors (<1% of ΣPFASs). Overall, degradation of PFAA-precursors and changes in leachate pH, EC, and 24-h precipitation were important factors controlling PFAS occurrence in leachate. Finally, 8.5-25 kg/yr (mean 16 kg/yr) of ΣPFASs was estimated to leave the landfill via leachate for subsequent treatment at a wastewater treatment plant.	1									1										B	-			
138	ばく露	Benskin, Jonathan P; Muir, Derek C G; Scott, Brian F; Spencer, Christine; De Silva, Amila O; Kylin, Henrik; Martin, Jonathan W; Morris, Adam; Lohmann, Rainer; Tomy, Gregg; Rosenberg, Bruno; Taniyasu, Sachi; Yamashita, Nobuyoshi	Perfluoroalkyl acids in the Atlantic and Canadi	2012	Environ Sci Technol. 2012 Jun 5;46(11):5815-23. doi: 10.1021/es300578x. Epub 2012 May 14.	We report here on the spatial distribution of C(4), C(6), and C(8) perfluoroalkyl sulfonates, C(6)-C(14) perfluoroalkyl carboxylates, and perfluorooctanesulfonamide in the Atlantic and Arctic Oceans, including previously unstudied coastal waters of North and South America, and the Canadian Arctic Archipelago. Perfluorooctanoate (PFOA) and perfluorooctanesulfonate (PFOS) were typically the dominant perfluoroalkyl acids (PFAAs) in Atlantic water. In the midnorthwest Atlantic/Gulf Stream, sum PFAA concentrations (ΣPFAAs) were low (77-190 pg/L) but increased rapidly upon crossing into U.S. coastal water (up to 5800 pg/L near Rhode Island). ΣPFAAs in the northeast Atlantic were highest north of the Canary Islands (280-980 pg/L) and decreased with latitude. In the South Atlantic, concentrations increased near Rio de la Plata (Argentina/Uruguay; 350-540 pg/L ΣPFAAs), possibly attributable to insecticides containing N-ethyl perfluorooctanesulfonamide, or proximity to Montevideo and Buenos Aires. In all other southern hemisphere locations, ΣPFAAs were <210 pg/L. PFOA/PFOS ratios were typically ≥1 in the northern hemisphere, ~1 near the equator, and ≤1 in the southern hemisphere. In the Canadian Arctic, ΣPFAAs ranged from 40 to 250 pg/L, with perfluoroheptanoate, PFOA, and PFOS among the PFAAs detected at the highest concentrations. PFOA/PFOS ratios (typically ≫1) decreased from Baffin Bay to the Amundsen Gulf, possibly attributable to increased atmospheric inputs. These data help validate global emissions models and contribute to understanding of long-range transport pathways and sources of PFAAs to remote regions.	1									1										B	-			
139	ばく露	Boiteux, Virginie; Dauchy, Xavier; Bach, Cristina; Colin, Adeline; Hemard, Jessica; Sagres, Vé ronique; Rosin, Christophe; Munoz, Jean-François	Concentrations and patterns of perfluoroalkyl a	2017	Sci Total Environ. 2017 Apr 1;583:393-400. doi: 10.1016/j.scitotenv.2017.01.079. Epub 2017 Jan 20.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are emerging contaminants that have been detected in the environment, biota and humans. Drinking water is a route of exposure for populations using water contaminated by PFAS discharges. This research entailed measuring concentrations, mass flows and investigating the fate of dozens PFASs in a river receiving effluents from a fluorochemical manufacturing facility. To measure the total concentration of perfluoroalkyl carboxylic acid (PFCA) precursors, an oxidative conversion method was used. Several dozen samples were collected in the river (water and sediment), in drinking water resources and at different treatment steps on four sampling dates. One PFCA and three fluorotelomers (FTs) were detected up to 62km downstream from the manufacturing facility. 6:2 Fluorotelomer sulfonamide alkylbetaine (6:2 FTAB) was the predominant PFAS with a mass flow of 3830g/day 5.2km downstream from the facility. At all sampling points, PFAS concentrations in sediment were quite low (<6ng/g dw). Five of the 11 investigated wells showed detectable concentrations of PFASs. Interestingly, their profile patterns were different from those observed in the river, suggesting a transformation of PFCA precursors in the sediments of alluvial groundwater. Conventional drinking water treatments (aeration, sand or granular activated carbon filtration, ozonation or chlorination) did not efficiently remove PFASs. Furthermore, an increase in concentration of certain PFASs was observed after ozonation, suggesting that some FTs such as 6:2 FTAB can break down. Only nanofiltration was able to remove allthe analyzed PFASs. In the treated water, total PFAS concentrations never exceeded 60ng/L. The oxidative conversion method revealed the presence of unidentified PFCA precursors in the river. Therefore, 18 to 77% of the total PFCA content after oxidation consisted of unidentified chemical species. In the treated water, these percentages ranged from 0 to 29%, relatively and reassuringly low values.	1									1										B	-			

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
140	ばく露	Gellrich, Vanessa; Brunn, Hubertus; Stahl, Thorsten	Perfluoroalkyl and polyfluoroalkyl substances (	2013	J Environ Sci Health A Tox Hazard Subst Environ Eng. 2013;48(2):129-35. doi: 10.1080/10934529.2013.719431.	The aims of the present study were to determine PFAS (perfluoroalkyl and polyfluoroalkyl substances) concentrations in various sources of water intended for human consumption, use these data to calculate the possible uptake via water as well as to estimate the water related health risk to consumers. A total of 177 water samples (119 mineral waters, 26 tap water samples, 18 spring water samples and 14 raw (untreated) water samples) were analyzed using liquid chromatography tandem mass spectrometry for the presence of 10 or 19 PFASs, respectively. PFAS concentrations above the limit of detection of 1 ng/L were found in 52% of all samples. Short-chain PFASs with less than 8 carbon atoms were responsible for 58% of the total PFAS contamination. The highest concentration (sum of PFASs) of 42.7 ng/L was detected in tap water. The calculated maximum uptake of both components for which a tolerable daily intake (TDI) level exists were 0.17 ng/kg bodyweight/day for PFOS (perfluorooctane sulfonic acid) and 0.21 ng/kg bodyweight/day for PFOA (perfluorooctane carboxylic acid). In regard to the model calculations made here (TDI for adults and for infants), the uptake of PFOS and PFOA via consumption of water can be considered negligible. Supplemental materials are available for this article. Go to the publisher's online edition of Journal of Environmental Science and Health, Part A to view the supplemental file.		1								1					1					B	-		
141	ばく露	Haug, Line Småstuen; Salihovic, Samira; Jogsten, Ingrid Ericson; Thomsen, Cathrine; van Bavel, Bert; Lindström, Gunilla; Becher, Georg	Levels in food and beverages and daily intake	2010	Chemosphere. 2010 Aug;80(10):1137-43. doi: 10.1016/j.chemosphere.2010.06.023.	Perfluorinated compounds (PFCs) have been determined in 21 samples of selected food and beverages such as meat, fish, bread, vegetables, milk, drinking water and tea from the Norwegian marked. Up to 12 different PFCs were detected in the samples. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) were found in concentrations similar to or lower than what has been observed in other studies world-wide. Differences in the relative proportion of PFOA and PFOS between samples of animal origin and samples of non-animal origin were observed and support findings that PFOS has a higher bioaccumulation potential in animals than PFOA. Based on these 21 measurements and consumption data for the general Norwegian population, a rough estimate of the total dietary intake of PFCs was found to be around 100 ng d(-1). PFOA and PFOS contributed to about 50% of the total intake. When dividing the population in gender and age groups, estimated intakes were decreasing with increasing age and were higher in males than females. The estimated intakes of PFOS and PFOA in the present study are lower than what has been reported in studies from Spain, Germany, United Kingdom, Canada and Japan. This study illustrates that by improving the analytical methods for determination of PFC in food samples, a broad range of compounds can be detected, which is important when assessing dietary exposure.		1								1					1					B	-		
142	ばく露	Lin, Angela Yu-Chen; Panchangam, Sri Chandana; Lo, Chao-Chun	The impact of semiconductor, electronics and	2009	Environ Pollut. 2009 Apr;157(4):1365-72. doi: 10.1016/j.envpol.2008.11.033. Epub 2008 Dec 30.	This study provides the first evidence on the influence of the semiconductor and electronics industries on perfluorinated chemicals (PFCs) contamination in receiving rivers. We have quantified ten PFCs, including perfluoroalkyl sulfonates (PFASs: PFBS, PFHxS, PFOS) and perfluoroalkyl carboxylates (PFCAs: PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoA) in semiconductor, electronic, and optoelectronic industrial wastewaters and their receiving water bodies (Taiwan's Keya, Touchien, and Xiaoli rivers). PFOS was found to be the major constituent in semiconductor wastewaters (up to 0.13 mg/L). However, different PFC distributions were found in electronics plant wastewaters; PFOA was the most significant PFC, contributing on average 72% to the effluent water samples, followed by PFOS (16%) and PFDA (9%). The distribution of PFCs in the receiving rivers was greatly impacted by industrial sources. PFOS, PFOA and PFDA were predominant and prevalent in all the river samples, with PFOS detected at the highest concentrations (up to 5.4 microg/L).		1	1	1						1									B	-		
143	ばく露	Llorca, Marta; Farré, Marinella; Picó, Yolanda; Müller, Jutta; Knepper, Thomas P; Barceló, Damià	Analysis of perfluoroalkyl substances in waters	2012	Sci Total Environ. 2012 Aug 1;431:139-50. doi: 10.1016/j.scitotenv.2012.05.011. Epub 2012 Jun 7.	Water has been identified as one of the main routes of human exposure to perfluoroalkyl substances (PFASs). This work assessed the presence of 21 PFASs along the whole water cycle using a new fast and cost effective analytical method based on an online sample enrichment followed by liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS). The method was validated for different types of matrices (ultrapure water, tap water and treated wastewater). The quality parameters for the 21 selected compounds presented good limits of detection (LOD) and quantification (LOQ) ranging, in general, from 0.83-10 ng/L to 2.8-50 ng/L, respectively. The method was applied to assess the occurrence of PFASs in 148 water samples of different steps along the whole water cycle, including: mineral bottled water, tap water, river water and treated effluent wastewater, from Germany to Spain. In addition, in order to prove the good performance of the online analytical method, the analysis of PFASs was carried out in parallel using a method based on offline anionic solid phase extraction (SPE) followed by LC-MS/MS. Consistent results were obtained using both approaches. The more frequently found compounds were perfluoroalkyl acids, such as the perfluorobutanoic acid which was in the 54% of the tap water samples investigated with concentrations in the range between 2.4 and 27 ng/L, the perfluoroheptanoic acid (0.23-53 ng/L) and perfluorooctanoic acid (0.16-35 ng/L), and the sulphonate perfluorooctanesulfonate (0.04-258 ng/L) which was the second more frequent compound and also the compound found in with the higher concentration. It shouldbe remarked that the 88% of the samples analyzed presented at least one of the compounds at quantifiable concentrations. In addition, PFASs including short chain compounds were proved to be prevalent in drinking water, and the 50% of the drinking water samples showed quantifiable concentrations of PFASs. It should be said that the great majority of the samples may not pose an immediate health risk to consumers, and just 6 of the drinking water samples presented concentrations of PFOS exceeding the Provisional Health Advisory (PHA) level established by the Office of Water from the USEPA for PFOS, which was set in 200 ng/L.		1								1									B	-	ドイツ・スペイン、21PFAS、ミネラルウォーター・水道水・河川・排水処理場放流水	
144	ばく露	Loos, Robert; Carvalho, Raquel; António, Diana C; Comero, Sara; Locoro, Giovanni; Tavazzi, Simona; Paracchini, Bruno; Ghiani, Michela; Lettieri, Teresa; Blaha, Ludek; Jarosova, Barbora; Voorspoels, Stefan; Servaes, Kelly; Haglund, Peter; Fick, Jerker; Lindberg, Richard H; Schwesig, David; Gawlik, Bernd M	EU-wide monitoring survey on emerging polar	2013	Water Res. 2013 Nov 1;47(17):6475-87. doi: 10.1016/j.watres.2013.08.024. Epub 2013 Sep 15.	In the year 2010, effluents from 90 European wastewater treatment plants (WWTPs) were analyzed for 156 polar organic chemical contaminants. The analyses were complemented by effect-based monitoring approaches aiming at estrogenicity and dioxin-like toxicity analyzed by in vitro reporter gene bioassays, and yeast and diatom culture acute toxicity optical bioassays. Analyses of organic substances were performed by solid-phase extraction (SPE) or liquid-liquid extraction (LLE) followed by liquid chromatography tandem mass spectrometry (LC-MS-MS) or gas chromatography high-resolution mass spectrometry (GC-HRMS). Target microcontaminants were pharmaceuticals and personal care products (PPCPs), veterinary (antibiotic) drugs, perfluoroalkyl substances (PFASs), organophosphate ester flame retardants, pesticides (and some metabolites), industrial chemicals such as benzotriazoles (corrosion inhibitors), iodinated x-ray contrast agents, and gadolinium magnetic resonance imaging agents; in addition biological endpoints were measured. The obtained results show the presence of 125 substances (80% of the target compounds) in European wastewater effluents, in concentrations ranging from low nanograms to milligrams per liter. These results allow for an estimation to be made of a European median level for the chemicals investigated in WWTP effluents. The most relevant compounds in the effluent waters with the highest median concentration levels were the artificial sweeteners acesulfame and sucralose, benzotriazoles (corrosion inhibitors), several organophosphate ester flame retardants and plasticizers (e.g. tris(2-chloroisopropyl)phosphate; TCPP),pharmaceutical compounds such as carbamazepine, tramadol, telmisartan, venlafaxine, irbesartan, fluconazole, oxazepam, fexofenadine, diclofenac, citalopram, codeine, bisoprolol, eprosartan, the antibiotics trimethoprim, ciprofloxacine, sulfamethoxazole, and clindamycine, the insect repellent N,N'-diethyltoluamide (DEET), the pesticides MCPA and mecoprop, perfluoroalkyl substances (such as PFOS and PFOA), caffeine, and gadolinium.		1								1									B	-		
145	ばく露	Lorenzo, María; Campo, Julián; Farré, Marinella; Pérez, Francisca; Picó, Yolanda; Barceló, Damià	Perfluoroalkyl substances in the Ebro and Gua	2016	Sci Total Environ. 2016 Jan 1;540:191-9. doi: 10.1016/j.scitotenv.2015.07.045. Epub 2015 Aug 4.	Mediterranean rivers are characteristically irregular with changes in flow and located in high population density areas. This affects the concentration of pollutants in the aquatic environments. In this study, the occurrence and sources of 21 perfluoroalkyl substances (PFASs) were determined in water, sediment and biota of the Ebro and Guadalquivir river basins (Spain). In water samples, of 21 analytes screened, 11 were found in Ebro and 9 in Guadalquivir. In both basins, the most frequents were PFBA, PFPeA and PFOA. Maximum concentration was detected for PFBA, up to 251.3 ng L(-1) in Ebro and 742.9 ng L(-1) in Guadalquivir. Regarding the sediments, 8 PFASs were detected in the samples from Ebro and 9 in those from Guadalquivir. The PFASs most frequently detected were PFBA, PFPeA, PFOA and PFOS. Maximum concentration in Ebro samples was, in dry weight, for PFOA (32.3 ng g(-1)) and in Guadalquivir samples for PFBA (63.8 ng g(-1)). For biota, 12 PFASs were detected in fish from the Ebro River and only one (PFOS) in that from Guadalquivir. In the Ebro basin, the most frequents were PFBA, PFHxA, PFOA, PFBS, PFOS and PFOSA. Maximum concentration in Ebro samples was, in wet weight, for PFHxA with 1280.2 ng g(-1), and in Guadalquivir samples for PFOS with 79.8 ng g(-1). These compounds were detected in the whole course of the rivers including the upper parts. In some points contamination was due to point sources mostly related to human activities (e.g. ski resorts, military camps, urban areas.). However, there are also some areas clearly affected by diffuse sources as atmospheric deposition.		1								1					1				B	-		
146	ばく露	Nilsson, Helena; Kärrman, Anna; Rotander, Anna; van Bavel, Bert; Lindström, Gunilla; Westberg, Håkan	Inhalation exposure to fluorotelomer alcohols y	2010	Environ Sci Technol. 2010 Oct 1;44(19):7717-22. doi: 10.1021/es101951t.	Levels of perfluorinated carboxylates (PFCAs) in different environmental and biological compartments have been known for some time, but the routes of exposure still remain unclear. The opinions are divergent whether the exposure to general populations occurs mainly indirect through precursor compounds or direct via PFCAs. Previous results showed elevated blood levels of PFCAs in ski wax technicians compared to a general population. The objective of this follow-up study was to determine concentrations of PFCAs, perfluorosulfonates (PFSAs), and fluorotelomer alcohols (FTOHs), precursor compounds that are known to degrade to PFCAs, in air collected in the breathing zone of ski wax technicians during work. We collected air samples by using ISOLUTE ENV+ cartridges connected to portable air pumps with an air flow of 2.0 L min(-1). PFCAs C5-C11 and PFSAs C4, C6, C8, and C10 were analyzed using LC-MS/MS and FTOHs 6:2, 8:2, and 10:2 with GC-MS/MS. The results show daily inhalation exposure of 8:2 FTOH in μg/m(3) air which is up to 800 times higher than levels of PFOA with individual levels ranging between 830-255000 ng/m(3) air. This suggests internal exposure of PFOA through biotransformation of 8:2 FTOH to PFOA and PFNA in humans.		1								1					1				B	-		
147	ばく露	Sun, Hongwen; Li, Fasong; Zhang, Tao; Zhang, Xianzhong; He, Na; Song, Qi; Zhao, Lijie; Sun, Lina; Sun, Tieheng	Perfluorinated compounds in surface waters a	2011	Water Res. 2011 Oct 1;45(15):4483-90. doi: 10.1016/j.watres.2011.05.036. Epub 2011 Jun 7.	Concentrations of 10 perfluorinated chemicals (PFCs) were investigated in the Hun River (HR), four canals, ten lakes, and influents and effluents from four main municipal wastewater treatment plants (WWTPs) in Shenyang, China. Mass flows of four main PFCs were calculated to elucidate the contribution from different sections of the HR. Overall, perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) were the major PFCs in the HR, with ranges of 2.68-9.13 ng/L, and 2.12-11.3 ng/L, respectively, while perfluorooctane sulfonate (PFOS) was detected at lower levels, ranging from 0.40 to 3.32 ng/L. The PFC concentrations in the HR increased after the river passes through two cities (Shenyang and Fushun), indicating cities are an important contributor for PFCs. Mass flow analysis in the HR revealed that PFC mass flows from Fushun are 1.65-5.50 kg/year for C6-C8 perfluorinated acids (PFCAs) and 1.29 kg/year for PFOS, while Shenyang contributed 2.83-5.18 kg C6-C8 PFCAs/year, and 3.65 kg PFOS/year. The concentrations of PFCs in four urban canals were higher than those in the HR, with the maximum total PFCs of 240 ng/L. PFOA and PFOS showed different trends along these canals, suggesting different sources for the two PFCs. Total PFCs in ten lakes from Shenyang were at low levels, with the greatest concentration (56.2 ng/L) detected in a heavily industrialized area. The PFC levels in WWTP effluents were higher than those in surface waters with concentrations ranging from 18.4 to 41.1 ng/L for PFOA, and 1.69-3.85 ng/L for PFOS. Similar PFC profiles between effluents from WWTPs and urban surface waters were found. Theseresults indicate that WWTPs are an important PFC source in surface water. Finally, we found that the composition profiles of PFCs in surface waters were similar to those in tap water, but not consistent with those in adult blood from Shenyang. The calculation on total daily intake of PFOS by adults from Shenyang showed that the contribution of drinking water to human exposure was minor.		1								1									B	-		
148	ばく露	Takemine, Shusuke; Matsumura, Chisato; Yamamoto, Katsuya; Suzuki, Motoharu; Tsurukawa, Masahiro; Imaishi, Hiromasa; Nakano, Takeshi; Kondo, Akira	Discharge of perfluorinated compounds from ri	2014	Environ Pollut. 2014 Jan;184:397-404. doi: 10.1016/j.envpol.2013.09.016. Epub 2013 Oct 8.	The aim of this study was to investigate 12 perfluorinated compounds (PFCs) including perfluorinated carboxylates (C4-C12) and perfluorinated alkyl sulfonates (C4, C6, and C8) in river and seawater samples to determine contamination levels in the aquatic environment of Hyogo prefecture, Japan. High levels of perfluorohexanoic acid (PFHxA; 2300-16,000 ng/L) were detected in the Samondogawa River at Tatsumi Bridge downstream of a PFC production facility; this location also had the highest mass flow rate of PFCs (3900-29,000 kg/y). Widespread contamination of coastal waters was confirmed with PFHxA as the dominant compound. Perfluorooctanoic acid was also prevalent in coastal waters. The concentration of PFHxA in coastal seawater and the distance from the mouth of the Samondogawa River were inversely related. This discharge of high concentrations of PFHxA from the Samondogawa River may have affected concentrations of PFCs in Osaka Bay.		1								1									B	-	日本の河川	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
149	ばく露	von der Trenck, Karl Theo; Konietzka, Rainer; Biegel-Engler, Annegret; Brodsky, Jan; Hädicke, Andrea; Quadflieg, Arnold; Stockerl, Rudolf; Stahl, Thorsten	Significance thresholds for the assessment of	2018	Environ Sci Eur. 2018;30(1):19. doi: 10.1186/s12302-018-0142-4. Epub 2018 Jun 7.	BACKGROUND: Per- and polyfluorinated chemicals (PFC) do not occur naturally in the environment and are, therefore, of anthropogenic origin. As a consequence of their wide range of everyday applications and their extreme persistence in the environment, PFC have become ubiquitous in nature and can, therefore, be detected in groundwater as well as in many other environmental matrices. The German States' Water and Soil Consortia have compiled 'significance thresholds' (GFS) to assess groundwater contaminated with PFC. The GFS serve as criteria for the decision whether actions to remediate polluted groundwater are necessary. Thirteen of these PFC had been detected in groundwater at levels above their limit of quantitation and were assigned first priority. RESULTS: The data regarding human health effects were sufficient to derive guide values according to the criteria of the German Drinking Water Ordinance for 7 of the 13 first-priority PFC. With regard to available ecotoxicological data, predicted no-effect concentration values from official risk assessments existed for 2 of the 13 first-priority PFC. A predicted no-effect concentration for protection of the aquatic biocenosis could be derived for eight more substances. CONCLUSIONS: After evaluation of data from available literature regarding both human health and ecotoxicological effects, significance thresholds ranging from 0.06 to 10.0 µg/L could be derived for 7 of the 13 priority PFC in groundwater. As a practical guide valid solely for human health-based values, a summation rule was proposed for exposures to mixtures of these seven PFC.			1									1										B	-			
150	ばく露	Heydebreck, F.; Tang, J.; Xie, Z.; Ebinghaus, R.	Alternative and Legacy Perfluoroalkyl Substan	2015	Environ Sci Technol. 2015 Jul 21;49(14):8386-95. doi: 10.1021/acs.est.5b01648. Epub 2015 Jul 7.	The production and use of long-chain perfluoroalkyl substances (PFASs) must comply with national and international regulations. Driven by increasingly stringent regulations, their production has been outsourced to less regulated countries in Asia. In addition, the fluoropolymer industry started to use fluorinated alternatives, such as 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid (HFPO-DA). Between August 2013 and September 2014, we investigated the occurrence and distribution of HFPO-DA and legacy PFASs in surface waters of the following river/estuary systems: the Elbe and Rhine Rivers in Germany, the Rhine-Meuse delta in The Netherlands, and the Xiaoqing River in China. Distinct differences were revealed among the study areas; notably, the Chinese samples were highly polluted by an industrial point source discharging mainly perfluorooctanoic acid (PFOA). This particular point source resulted in concentrations more than 6000 times higher than an industrial point source observed in the Scheur River, where HFPO-DA was the dominant compound with a concentration of 73.1 ng/L. Moreover, HFPO-DA was detected in all samples along the coastline of the North Sea, indicating that the compound may be transported from the Rhine-Meuse delta into the German Bight via the water current. To the best of our knowledge, the fluorinated alternative, HFPO-DA, was detected for the first time insurface waters of Germany and China.					1							1								No. 58と重複		B	-			
151	ばく露	Crone, Brian C; Speth, Thomas F; Wahman, David G; Smith, Samantha J; Abulikemu, Gulizhaer; Kleiner, Eric J; Pressman, Jonathan G	Occurrence of Per- and Polyfluoroalkyl Substa	2019	Crit Rev Environ Sci Technol. 2019 Jun;49(24):2359-2396. doi: 10.1080/10643389.2019.1614848.	Per-and polyfluoroalkyl substances (PFAS) occurrence in drinking water and treatment methods for their removal are reviewed. PFAS are fluorinated substances whose unique properties make them effective surface-active agents with uses ranging from stain repellants to fire-fighting foams. In response to concerns about drinking water contamination and health risks from PFAS exposure, the United States Environmental Protection Agency published Health Advisories (HAs) for perfluorooctanoic acid and perfluorooctane sulfonic acid. The occurrence of six PFAS in drinking water has been reported in the Third Unregulated Contaminant Monitoring Rule (UCMR3), and subsequent analysis of the dataset suggested that four percent of water systems reported at least one detectable PFAS compound and 1.3 percent of water systems reported results above the HAs. Many treatment technologies have been evaluated in the literature, with the most promising and readily applied treatment technologies being activated carbon, anion exchange resins, and high-pressure membrane systems. From these data and literature reports, research and data gaps were identified and suggestions for future research are provided.				1	1										1						B	-	総説		
152	ばく露	Guelfo, Jennifer L; Adamson, David T	Evaluation of a national data set for insights in	2018	Environ Pollut. 2018 May;236:505-513. doi: 10.1016/j.envpol.2018.01.066.	The United States Environmental Protection Agency (USEPA) completed nationwide screening of six perfluoroalkyl substances in U.S. drinking water from 2013 to 2015 under the Third Unregulated Contaminant Monitoring Rule (UCMR3). UCMR3 efforts yielded a dataset of 36,139 samples containing analytical results from >5000 public water systems (PWSs). This study used UCMR3 data to investigate three aspects of per- and polyfluoroalkyl substances (PFASs) in drinking water: the occurrence of PFAS and co-contaminant mixtures, trends in PFAS detections relative to PWS characteristics and potential release types, and temporal trends in PFAS occurrence. This was achieved through bivariate and multivariate analyses including categorical analysis, concentration ratios, and hierarchical cluster analysis. Approximately 50% of samples with PFAS detections contained ≥2 PFASs, and 72% of detections occurred in groundwater. Large PWSs (>10,000 customers) were 5.6 times more likely than small PWSs (≤10,000 customers) to exhibit PFAS detections; however, when detected, median total PFAS concentrations were higher in small PWSs (0.12 μg/L) than in large (0.053 μg/L). Bivariate and multivariate analyses of PFAS composition suggested PWSs reflect impacts due to firefighting foam use and WWTP effluent as compared to other source types for which data were available. Mann-Kendall analysis of quarterly total PFAS detection rates indicated an increasing trend over time ($p = 0.03$). UCMR3 data provide a foundation for tiered design of targeted sampling and analysis plans to address remaining knowledge gaps in the sources, composition, and concentrations of PFASsin U.S. drinking water.				1	1										1						B	-	米国のUCMR3の調査結果。PFNA、PFBS含まれる。下限値が現在多くで使用されている方法に比べると高い点が気になる		
153	ばく露	Herrick, Robert L; Buckholz, Jeanette; Biro, Frank M; Calafat, Antonia M; Ye, Xiaoyun; Xie, Changchun; Pinney, Susan M	Polyfluoroalkyl substance exposure in the Mid-	2017	Environ Pollut. 2017 Sep;228:50-60. doi: 10.1016/j.envpol.2017.04.092. Epub 2017 May 13.	BACKGROUND: Industrial discharges of perfluorooctanoic acid (PFOA) to the Ohio River, contaminating water systems near Parkersburg, WV, were previously associated with nearby residents' serum PFOA concentrations above US general population medians. Ohio River PFOA concentrations downstream are elevated, suggesting Mid-Ohio River Valley residents are exposed through drinking water. OBJECTIVES: Quantify PFOA and 10 other per- and polyfluoroalkyl substances (PFAS) in Mid-Ohio River Valley resident sera collected between 1991 and 2013 and determine whether the Ohio River and Ohio River Aquifer are exposure sources. METHODS: We measured eleven PFAS in 1608 sera from 931 participants. Serum PFOA concentration and water source associations were assessed using linear mixed-effects models. We estimated between-sample serum PFOA using one-compartment pharmacokinetics for participants with multiple samples. RESULTS: In serum samples collected as early as 1991, PFOA (median = 7.6 ng/mL) was detected in 99.9% of sera; 47% had concentrations greater than US population 95th percentiles. Five other PFAS were detected in greater than 82% of samples; median other PFAS concentrations were similar to the US general population. Serum PFOA was significantly associated with water source, sampling year, age at sampling, tap water consumption, pregnancy, gravidity and breastfeeding. Serum PFOA was 40-60% lower with granular activated carbon (GAC) use. Repeated measurements and pharmacokinetics suggest serum PFOA peaked 2000-2006 for participants using water without GAC treatment; where GAC was used, serum PFOA concentrations decreasedfrom 1991 to 2012. CONCLUSIONS: Mid-Ohio River Valley residents appear to have PFOA, but not other PFAS, serum concentrations above US population levels. Drinking water from the Ohio River and Ohio River Aquifer, primarily contaminated by industrial discharges 209-666 km upstream, is likely the primary exposure source. GAC treatment of drinking water mitigates, but does not eliminate, PFOA exposure.				1											1	1					B	-			
154	ばく露	Kleywegt, Sonya; Raby, Melanie; McGill, Stephanie; Helm, Paul	The impact of risk management measures on t	2020	Sci Total Environ. 2020 Dec 15;748:141195. doi: 10.1016/j.scitotenv.2020.141195. Epub 2020 Jul 25.	Risk management measures (RMMs) are a broad set of tools used in global treaties and national regulations to manage, ban or restrict the use of toxic chemicals. Per- and polyfluoroalkyl substances (PFAS) are a group of chemicals that are persistent, bioaccumulate, biomagnify and are inherently toxic to the environment and human health. For these reasons global RMMs have been imposed on the manufacture and use of select PFAS. To evaluate the occurrence and potential current risk of PFAS in the Ontario environment, PFAS were quantitatively measured in source waters pre- (2005-2007) and post- (2012-2016, 2018-2019) implementation of RMMs. Source water samples were collected pre- (n = 105), and post-RMMs (n = 326) from lake, river and groundwater and analyzed for up to 14 PFAS. Pre-RMMs, the most frequently detected PFAS in source water were perfluorooctanoic acid (PFOA; 83%) and perfluorooctane sulfonate (PFOS; 76%) followed by perfluorohexane sulfonate (PFHxS; 47%) and the maximum ΣPFAS(10) was 42.1 ng/L. Post-RMMs, the maximum ΣPFAS(10) (which includes PFOS) was statistically significantly reduced to 15.5 ng/L, well below the Federal Environmental Quality Guidelines for PFOS. To evaluate post-RMMs risk to human health, 226 drinking water samples were collected from 25 drinking water systems with conventional and advanced treatment. All individual (or ΣPFAS) concentrations are well below current and proposed Health advisory levels or regulatory guidelines/standards for PFAS in drinking water with calculated Risk Quotients (RQ) <0.02. This survey indicates that the implementation of RMMs forselect PFAS have made a significant difference to the concentrations detected in source waters in Ontario, Canada.	1	1	1	1									1						B	-	環境水、水道水の調査。データ数は多いが、オンタリオ州に限ったデータのため。		
155	ばく露	Kubwabo, Cariton; Stewart, Brian; Zhu, Jiping; Marro, Leonora	Occurrence of perfluorosulfonates and other p	2005	J Environ Monit. 2005 Nov;7(11):1074-8. doi: 10.1039/b507731c. Epub 2005 Sep 19.	A series of perfluorinated compounds (PFCs) including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) have been recently measured in a variety of environmental samples and biological matrices. In order to better understand the human exposure routes of these chemicals, levels of PFOS, PFOA, perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHS) and perfluorooctane sulfonamide (PFOSA) in house dust samples were investigated. The data revealed a correlation between the concentrations of PFCs and the percentage of carpeting in the house; older houses tended to have less carpeting, hence lower levels of these perfluorinated compounds in their dust.					1									1	1					B	-	環境中のPFAS、データが古い		
156	ばく露	Lalonde, Benoit; Garron, Christine	Perfluoroalkyl Substances (PFASs) in the Cana	2022	Arch Environ Contam Toxicol. 2022 May;82(4):581-591. doi: 10.1007/s00244-022-00922-x. Epub 2022 Mar 26.	Per- and polyfluoroalkyl substances (PFASs) are anthropogenic substances that are very stable in the receiving environment. Legacy perfluoroalkane sulfonates (PFSAs) and perfluoroalkyl carboxylic acids (PFCAs) are especially persistent and resistant to typical environmental degradation processes and therefore are distributed across all trophic levels and environmental compartments (soil, air, water). Since most uses of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and LC-long-chain PFCAs are banned in Canada, alternative PFASs have been in use for a number of years. Twenty-nine sites across Canada were sampled for PFASs to determine concentrations and trends. Overall, 13 PFASs were measured in 566 Canadian freshwater samples from 2013 to 2020 with a range from below the detection limit (LOD range: 0.4-1.6 ng/L) of the laboratory to a maximum of 138 ng/L (for PFBS). While PFOS and PFOA concentrations are declining significantly over time, other compounds such as PFPeA and PFBA have increased significantly over 2013-2020. Overall, the range of concentrations found in this study was similar to that of other Canadian and international studies. However, this study also found a higher frequency of detections of the replacement PFASs than that of the other, older, Canadian studies.	1	1		1									1						B	-	カナダ、土壌、空気、水中の13PFAS		
157	ばく露	DRBC	Contaminants of emerging concern in the tida	2013	Delaware River Basin Commission. http://www.nj.gov/drbc/library/documents/contaminants-of-emerging-concernAug2013rev.pdf. July 6, 2017.	Contaminants of emerging concern are unregulated substances that have entered the environment through human activities. Current regulatory approaches are inadequate to address these contaminants and the increasing public concern over their environmental and human health implications. A pilot multi-year survey of contaminants of emerging concern in the main stem of the tidal Delaware River sampled and analyzed ambient waters in 2007, 2008 and 2009 for pharmaceuticals and personal care products, as well as perfluoroalkyl and polyfluoroalkyl substances (PFASs) by liquid chromatography/tandem mass spectrometry (LC/MSMS); hormones, sterols and nonylphenols by gas chromatography/mass spectrometry (GC/MS); and polybrominated diphenyl ethers (PBDE) by high resolution gas chromatography/mass spectrometry (HRGC/MS). Pharmaceuticals and personal care products (PPCP) detected at concentrations of ng/L in the river were comparable to compounds and concentrations measured in other studies of ambient water with the exception of codeine and metformin. Fifteen PPCP were identified for focused study in surface waters (acetaminophen, carbamazepine, clarithromycin, codeine, dehydronifedipine, erythromycin-hydrate, fluoxetine, gemfibrozil, 2-hydroxy-ibuprofen, ibuprofen, lincomycin, metformin, sulfamethoxazole, thiabendazole, and triclocarban) based on the criteria of environmental occurrence, aquatic ecotoxicity, potential human health effects to sensitive populations, and analytical feasibility. In addition, PPCP reported in fish tissue in other locations should be assessed in the Delaware Estuary. Natural and synthetic hormones were detected in ng/L levels. Hormones detected at low concentrations and at limited locations included estrone, norethindrone, 17-alpha-ethynyl-estradiol, desogestrel and testosterone. Hormones have been ranked in the top of chemicals in U.S. surface waters for ecological effects and warrant further study. PFASs were measured in ng/L concentrations with perfluorononanoate (C9) measured at the highest concentration. Although concentrations of PFASs in water appear to be trending downward each year, additional ecotoxicology and bioaccumulation information is needed for these compounds especially on longer chain and sulfonated PFASs. Nonylphenol levels did not exceed current United States Environmental Protection Agency national water quality criteria. PBDE were measured in pg/L to ng/L concentrations with homolog distributions similar to those observed in other North American locations. Because of the low levels found in water, additional monitoring of PBDE by the DRBC will focus on bioaccumulation in fish tissue. The effects of PPCP in estuarine and coastal waters are not well studied. Future work in the Delaware River should evaluate the sources as well as the fate and effects of PPCP in the water column, sediments and biota.				1	1									1						B	-	デラウエア川、PFAS含む多数の化学物質		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
158	ばく露	Clara, M; Gans, O; Weiss, S; Sanz-Escribano, D; Scharf, S; Scheffknecht, C	Perfluorinated alkylated substances in the aqu	2009	Water Res. 2009 Oct;43(18):4760-8. doi: 10.1016/j.watres.2009.08.004. Epub 2009 Aug 7.	Perfluorinated alkylated substances (PFAS) are of global interest due to their occurrence and persistency in the environment. This study includes surface waters and sediments for the analysis of eleven PFAS. The PFAS studied can be grouped in perfluoroalkyl carboxylates (PFCAs), perfluoroalkyl sulfonates (PFS) and perfluoroalkyl sulfonamides (PFSA). The two most important compounds are perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS). These two substances showed the most significant values for surface water samples with maximum concentrations of 21 ng l(-1) for PFOA and 37 ng l(-1) for PFOS. Sediment samples from seven Austrian lakes and the river Danube were studied. Whereas PFSA and PFS were not detected in any sediment sample PFCAs were detected in most of the lake samples in concentrations up to 1.7 microg kg(-1) dry wt. PFOA, perfluorohexanoic acid (PFHxA) and perfluoroheptanoic acid (PFHpA) were detected in all Danube river sediment samples in concentrations varying from 0.1 up to 5.1 microg kg(-1) dry wt. For the various sampling points the proportional mass flows deriving from wastewater discharges were calculated. Whereas only up to 10% of the average flow is discharged wastewater up to more than 50% of the PFAS mass flows in the rivers can be attributed to wastewater discharges. Besides wastewater different other pathways as emissions from point sources, further degradation of precursor products, runoff from contaminated sites or surface runoff as well as dry and wet deposition have to be considered as relevant sources for PFAS contamination in surface waters.		1														1					B	-	オーストリア、河川、底質	
159	ばく露	Dauchy, Xavier; Boiteux, Virginie; Rosin, Christophe; Munoz, Jean-François	Relationship between industrial discharges and	2012	Bull Environ Contam Toxicol. 2012 Sep;89(3):525-30. doi: 10.1007/s00128-012-0704-x. Epub 2012 Jun 16.	Perfluorinated compounds (PFCs) have been recognized as global environmental pollutants. They are used in various applications and high levels have been found in water bodies located near highly industrialized sites. In the present study, 10 PFCs were quantitatively determined in water samples collected in the vicinity of a fluoropolymer manufacturing plant and in drinking water resources located downstream. The release of PFHxA and PFNA to the receiving river was estimated at 10 and 4.5 tons/year, respectively. PFHxA (0.058-0.156 μg/L), PFNA (0.013-0.035 μg/L) and PFOA (0.007-0.025 μg/L) were predominant and prevalent in all the studied drinking water resources, confirming with the composition profile the impact of the industrial park release.		1	1													1					B	-	水源、10PFAS	
160	ばく露	Jogsten, Ingrid Ericson; Perelló, Gemma; Llebaria, Xavier; Bigas, Esther; Marti-Cid, Roser; Kärrman, Anna; Domingo, José L	Exposure to perfluorinated compounds in Cata	2009	Food Chem Toxicol. 2009 Jul;47(7):1577-83. doi: 10.1016/j.fct.2009.04.004. Epub 2009 Apr 9.	In this study, the role that some food processing and packaging might play as a source of perfluorinated compounds (PFCs) through the diet was assessed. The levels of PFCs were determined in composite samples of veal steak (raw, grilled, and fried), pork loin (raw, grilled, and fried), chicken breast (raw, grilled, and fried), black pudding (uncooked), liver lamb (raw), marinated salmon (home-made and packaged), lettuce (fresh and packaged), pate of pork liver, foie gras of duck, frankfurt, sausages, chicken nuggets (fried), and common salt. Among the 11 PFCs analyzed, only PFHxS, PFOS, PFHxA, and PFOA were detected in at least one composite sample, while the levels of the remaining PFCs (PFBuS, PFHpA, PFNA, PFDA, PFUnDA, and PFDoDA) were under their respective detection limits. PFOS was the compound most frequently detected, being found in 8 of the 20 food items analyzed, while PFHxA was detected in samples of raw veal, chicken nuggets, frankfurt, sausages, and packaged lettuce. According to the results of the present study, it is not sufficiently clear if cooking with non-stick cookware, or packaging some foods, could contribute to a higher human exposure to PFCs.		1	1													1			1		B	-	スペイン、食品、11PFAS、食品データは限られているため	
161	ばく露	Konwick, Brad J; Tomy, Gregg T; Ismail, Nargis; Peterson, James T; Fauver, Rebecca J; Higginbotham, David; Fisk, Aaron T	Concentrations and patterns of perfluoroalkyl a	2008	Environ Toxicol Chem. 2008 Oct;27(10):2011-8. doi: 10.1897/07-659.1.	Perfluoroalkyl acids (PFAAs) are widespread contaminants emanating from, among other sources, the production/degradation of fluorinated chemicals used in surface repellant applications, such as carpet manufacturing. The goal of the present study was to assess the concentrations of PFAAs, including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUA), and perfluorooctane sulfonamide (PFOSA), in surface waters both near a wastewater land application system (LAS) in Dalton (GA, USA), home to North America's largest carpet manufacturing site, and distant to this location (Altamaha River, GA, USA) to understand the fate of PFAAs in freshwater. Levels of PFAAs were high in the Conasauga River (GA, USA) downstream of the LAS (PFOA, 253-1,150 ng/L; PFOS, 192-318 ng/L; PFNA, 202-369 ng/L; PFDA, 30.1-113 ng/L; PFUA, 58.0-99.2 ng/L; PFOSA, 162-283 ng/L) and in streams and ponds in Dalton (PFOA, 49.9-299 ng/L; PFOS, 15.8-120 ng/L), and were among the highest measured at a nonspill or direct-release location. Perfluoroalkyl acids in the Altamaha River were much lower (PFOA, 3.0-3.1 ng/L; PFOS, 2.6-2.7 ng/L), but were a source of PFAAs to Georgia's estuaries. A preliminary hazard assessment indicated that concentrations of PFOS at two sites in the Conasauga River exceeded the threshold effect predicted for birds consuming aquatic organisms that are exposed continuously to the PFOS levels at these sites. Assuming that toxicity for all PFAAs quantified is equal to that of PFOS, the sum total PFAAs at two siteswithin the Conasauga River exceeded PFOS thresholds for aquatic and avian species, warranting additional research.				1												1					B	-	米国、表流水、6PFAS	
162	ばく露	Liu X, Guo Z, Krebs KA, et al.	Concentrations and trends of perfluorinated ch	2014	Chemosphere. 2014 Mar;98:51-7. doi: 10.1016/j.chemosphere.2013.10.001. Epub 2013 Nov 19.	Certain perfluorinated chemicals (PFCs) in consumer products used indoors are potential indoor PFCs sources and have been associated with developmental toxicity and other adverse health effects in laboratory animals (Lao et al., 2007). The concentrations of selected PFCs including perfluorooctanoic acid (PFOA) and other perfluorocarboxylic acids (PFCAs), in 35 selected consumer products that are commonly used in indoors were measured from the year of 2007 through 2011. The products collected included carpet, commercial carpet-care liquids, household carpet/fabric-care liquids, treated apparel, treated home textiles, treated non-woven medical garments, floor waxes, food-contact paper, membranes for apparel, and thread-sealant tapes. They were purchased from retail outlets in the United States between March 2007 and September 2011. The perfluorocarboxylic acid (PFCA) contents in the products have shown an overall downward trend. However, PFOA (C8) could still be detected in many products that we analyzed. Reductions of PFCAs were shown in both short-chain PFCAs (sum of C4 to C7) and long-chain PFCAs (sum of C8 to C12) over the study period. There were no significant changes observed between short-chain PFCAs and long-chain PFCAs. Fourteen products were analyzed to determine the amounts of perfluoroalkyl sulfonates (PFASs) they contained. These limited data show the pronounced increase of perfluoro-butane sulfonate (PFBS), an alternative to perfluorooctanoic sulfonate (PFOS), in the samples. A longer and wider range of study will be required to confirm this observed trend.arrhythmias.					1											1					B	-	米国、家庭内35製品中、PFAS	
163	ばく露	Loganathan, Bommanna G; Sajwan, Kenneth S; Sinclair, Ewan; Senthil Kumar, Kurunthachalam; Kannan, Kurunthachalam	Perfluoroalkyl sulfonates and perfluorocarboxy	2007	Water Res. 2007 Dec;41(20):4611-20. doi: 10.1016/j.watres.2007.06.045. Epub 2007 Jun 22.	Discharge of effluents from municipal wastewater treatment plants (WWTPs) is a route for the introduction of certain organic contaminants into aquatic environments. Earlier studies have reported the occurrence of perfluorochemicals in effluents from WWTPs. In this study, contamination profiles of perfluorinated compounds (PFCs), including perfluoroalkyl sulfonates (PFASs; PFOS, PFOSA, PFHxS) and perfluoroalkyl carboxylates (PFACs; PFOA, PFNA, PFDA, PFDoDA, PFUnDA), were determined in samples collected at various stages of wastewater treatment during different seasons. The two WWTPs selected for this study represent rural (Plant A, Kentucky) and urban (Plant B, Georgia) areas. PFOS was a major contaminant in samples from Plant A (8.2-990 ng/g dry wt in solid samples and 7.0-149 ng/L in aqueous samples), followed by PFOA (8.3-219 ng/g dry wt in solid samples and 22-334 ng/L in aqueous samples). PFOA was the predominant contaminant in samples from Plant B (7.0-130 ng/g dry wt in solid samples and 1-227 ng/L in aqueous samples), followed by PFOS (<2.5-77 ng/g dry wt in solid samples and 1.8-22 ng/L in aqueous samples). PFHxS, PFNA, PFDA, and PFOSA were detected in most of the samples, whereas PFUnDA and PFDoDA were detected in very few samples. Concentrations of some PFCs, particularly PFOA, were slightly higher in effluent than in influent, suggesting that biodegradation of some precursors contributes to the increase in PFOA concentrations in wastewater treatment processes. No large-magnitude seasonal variations in concentrations were found, although mass flow of PFCs was higher in winter than in summer. In general, samples from therural plant in Kentucky contained greater concentrations of PFCs than did those from the urban plant in Georgia. Incineration of sludge reduced the PFC levels significantly. The mass flows of PFCs in these two plants were several hundreds of mg/day, comparable to flow values reported earlier.					1											1					B	-	米国、排水、10PFAS	
164	ばく露	Michigan DEQ.	Rule 57 water quality values	2016	Lansing, MI: Michigan Department of Environmental Quality. http://www.michigan.gov/documents/deq/wrd-swas-rule57_372470_7.pdf. December 18, 2017.	On March 23, 1995, the United States Environmental Protection Agency (U.S. EPA) issued the Final Water Quality Guidance for the Great Lakes System (Guidance). The Guidance instructs Great Lakes states and tribes to use the criteria, methods, policies, and procedures within to establish consistent, long-term protection for water quality in the Great Lakes and their tributaries. While the Guidance contained specific water quality criteria for certain pollutants, importantly it also included detailed methods to develop criteria for additional pollutants. The Department of Environment, Great Lakes, and Energy updated the Part 4 Rules, Water Quality Standards, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) to reflect this federal Guidance, including the narrative methods to develop water quality values protective of human health and aquatic life. On August 2, 2000, the U.S. EPA approved the revisions to Michigan's Part 4 Rules, including Rule 57 (R 323.1057), Toxic Substances. Rule 57 gives narrative procedures for calculating water quality values for toxic substances to protect humans, wildlife, and aquatic life, in keeping with the federal Guidance. These values apply to all surface waters in Michigan unless site specific values have been derived. Michigan's incorporation of a narrative process for developing water quality values within the Water Quality Standards, in keeping with the federal Guidance, allows the state to use a standardized, transparent process to develop and update water quality values when new toxicological data are available. The ability to routinely update water quality values when new toxicological data are available allows for final values to be developed using a more complete data set with reduced uncertainty in the values.																1					B	-	米国、環境水　アクセスできなかった	
165	ばく露	Mitro, Susanna D; Dodson, Robin E; Singla, Veena; Adamkiewicz, Gary; Elmi, Angelo F; Tilly, Monica K; Zota, Ami R	Consumer Product Chemicals in Indoor Dust: A	2016	Environ Sci Technol. 2016 Oct 4;50(19):10661-10672. doi: 10.1021/acs.est.6b02023. Epub 2016 Sep 14.	Indoor dust is a reservoir for commercial consumer product chemicals, including many compounds with known or suspected health effects. However, most dust exposure studies measure few chemicals in small samples. We systematically searched the U.S. indoor dust literature on phthalates, replacement flame retardants (RFRs), perfluoroalkyl substances (PFASs), synthetic fragrances, and environmental phenols and estimated pooled geometric means (GMs) and 95% confidence intervals for 45 chemicals measured in ≥3 data sets. In order to rank and contextualize these results, we used the pooled GMs to calculate residential intake from dust ingestion, inhalation, and dermal uptake from air, and then identified hazard traits from the Safer Consumer Products Candidate Chemical List. Our results indicate that U.S. indoor dust consistently contains chemicals from multiple classes. Phthalates occurred in the highest concentrations, followed by phenols, RFRs, fragrance, and PFASs. Several phthalates and RFRs had the highest residential intakes. We also found that many chemicals in dust share hazard traits such as reproductive and endocrine toxicity. We offer recommendations to maximize comparability of studies and advance indoor exposure science. This information is critical in shaping future exposures, and in providing evidence for intervention development and public policy.		1	1	1	1											1					B	-		
166	ばく露	Murakami, Michio; Imamura, Eiji; Shinohara, Hiroyuki; Kiri, Kentaro; Muramatsu, Yuki; Harada, Arata; Takada, Hideshige	Occurrence and sources of perfluorinated surfa	2008	Environ Sci Technol. 2008 Sep 1;42(17):6566-72. doi: 10.1021/es800353f.	We analyzed perfluorinated surfactants (PFSs) in 20 river samples and 5 wastewater secondary effluent samples in Japan to reveal their occurrence and sources. Nine PFS species were determined: perfluorooctanesulfonate (PFOS), perfluorooctane sulfonamide (FOSA), perfluoroheptanoate (PFHpA), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUA), perfluorododecanoate (PFDDA), and perfluorotridecanoate (PFTDA). PFSs were detected in all rivers, revealing nationwide contamination of rivers. In particular, 11 out of 20 river samples exceeded New Jersey guidance for PFOA in drinking water (40 ng/L). PFOS, PFHpA, PFOA, and PFNA were major species in Japan. Concentrations of PFOS, PFHpA, and PFNA in rivers were strongly correlated with population density, suggesting that the chemicals were derived from urban activities. PFOA showed a significant but weak correlation. We used crotamiton, a marker of sewage effluent, for further source analysis. Concentrations of PFOS, PFHpA, and PFNAwere strongly correlated with those of crotamiton, and plots of secondary effluents fell near the regression lines of rivers, indicating that the PFOS, PFHpA, and PFNA in rivers were derived from sewage effluent. On the other hand, PFOA was found at remarkably high levels (54-192 ng/L) in seven river samples containing low levels of crotamiton, suggesting that it was derived from nonsewage point sources, as well as sewage effluent. The total fluxes of sewage-derived PFOS, PFHpA, PFOA, and PFNA from Japan were estimated to be 3.6, 2.6, 5.6, and 2.6 t/year,respectively. This is the first report to identify PFOA in several rivers, derived from nonsewage point sources, by using a marker of sewage effluent.					1											1					B	-	日本、環境水、排水、総説	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
167	ばく露	Newton, Seth; McMahen, Rebecca; Stoeckel, James A; Chislock, Michael; Lindstrom, Andrew; Strynar, Mark	Novel Polyfluorinated Compounds Identified U	2017	Environ Sci Technol. 2017 Feb 7;51(3):1544-1552. doi: 10.1021/acs.est.6b05330. Epub 2017 Jan 13.	Concern over persistence, bioaccumulation, and toxicity has led to international regulation and phase-outs of certain perfluorinated compounds and little is known about their replacement products. High resolution mass spectrometry was used to investigate the occurrence and identity of replacement fluorinated compounds in surface water and sediment of the Tennessee River near Decatur, Alabama. Analysis of legacy Per- and polyfluoroalkyl substances (PFASs) revealed a marked increase in concentrations downstream of manufacturing facilities, with the most abundant compounds being perfluorooctanesulfonate (PFOS), perfluorobutanesulfonate (PFBS), and perfluorooctanoic acid (PFOA) as high as 220 ng L(-1), 160 ng L(-1), and 120 ng L(-1), respectively. A series of nine polyfluorinated carboxylic acids was discovered, each differing by CF(2)CH(2). These acids are likely products or byproducts of a manufacturing process that uses 1,1-difluoroethene, which is registered to a manufacturing facility in the area. Two other predominant compounds discovered have structures consistent with perfluorobutanesulfonate and perfluoroheptanoic acid but have a single hydrogen substituted for a fluorine someplace in their structure. A polyfluoroalkyl sulfate with differing mixes of hydrogen and fluorine substitution was also observed. N-methyl perfluorobutane sulfonamidoacetic acid (MeFBSAA) was observed at high concentrations and several other perfluorobutane sulfonamido substances were present as well.	1			1													1					B	-	米国、環境水	
168	ばく露	OECD	Results of the 2006 survey on production and u	2006	OECD Environment, Health and Safety Publications Series on Risk Management No. 22	Organisation for Economic Co-operation and Development.																1				D	-	OECDの調査、要約がないので詳細不明	
169	ばく露	Orata, Francis; Quinete, Natalia; Werres, Friedrich; Wilken, Rolf-Dieter	Determination of perfluorooctanoic acid and pe	2009	Bull Environ Contam Toxicol. 2009 Feb;82(2):218-22. doi: 10.1007/s00128-008-9543-1. Epub 2008 Sep 13.	In this study we present a report of investigation from the screening of perfluorooctanoic acid and perfluorooctane sulfonate in Lake Victoria Gulf and in its source rivers. The first determined levels of perfluorinated alkylated substances in Lake Victoria ecosystem are presented. Variability in the concentrations of perfluorooctanoic acid or perfluorooctane sulfonate in river waters (range perfluorooctanoic acid 400-96,400 and perfluorooctane sulfonate <400-13,230 pg/L) was higher than for Lake waters (range perfluorooctanoic acid 400-11,650 and perfluorooctane sulfonate <400-2,530 pg/L respectively) suggesting generalized point sources such as domestic and industrial waste. The lowest limit of quantification was 400 pg/L for both analytes and limit of detection were 75 and 40 pg/L for perfluorooctanoic acid and perfluorooctane sulfonate respectively. Typical values for precision obtained were 0.14-3.7%, with concentrations range from 400 pg/mL to 1 microg/mL).				1													1				C	-	アフリカ、環境水、PFOSとPFOA	
170	ばく露	Sinclair, Ewan; Kannan, Kurunthachalam	Mass loading and fate of perfluoroalkyl surfact	2006	Environ Sci Technol. 2006 Mar 1;40(5):1408-14. doi: 10.1021/es051798v.	Wastewater treatment plants have recently been identified as a significant pathway for the introduction of perfluoroalkyl surfactants (PASs) to natural waters. In this study, we measured concentrations and fate of several PASs in six wastewater treatment plants (WWTPs) in New York State. We also monitored and measured matrix effects (ionization suppression and enhancement) by postcolumn infusion and standard additions. Concentrations of perfluorooctanoate (PFOA) in effluents of the six WWTPs ranged from 58 to 1050 ng/L. Perfluorooctanesulfonate (PFOS) was also ubiquitous in effluents of these WWTPs, albeit at much lower concentrations (3-68 ng/L). Two of these WWTPs employed identical treatment processes, with similar hydraulic retentions, but differed only in that Plant B treated domestic and commercial waste, whereas Plant A had an additional industrial influence. We found that this industrial influence resulted in significantly greater mass flows of all of the PASs analyzed. Primary treatment was found to have no effect on the mass flows of PASs. Secondary treatment by activated sludge in Plant A significantly increased ($p < 0.05$) the mass flows of PFOS, PFOA, perfluorononanoate (PFNA), perfluorodecanoate (PFDA), and perfluoroundecanoate (PFUnDA). However, in Plant B, only the mass flow of PFOA was significantly increased. The observed increase in mass flow of several PASs may have resulted from biodegradation of precursor compounds such as fluorotelomer alcohols, which is supported by significant correlations in the mass flow of PFOA/PFNA and PFDA/PFUnDA. Furthermore, the masses of PFDA andPFUnDA were significantly correlated only after the secondary treatment. In Plant A, concentrations of odd-number PFCAs were greater than those of even-number PFCAs, and concentration decreased with increasing chain length (from C8 to C12). A different pattern was observed in sludge samples, in which the dominance of PFOA decreased, and PFDA and PFUnDA increased, suggesting preferential partitioning of longer-chain PFCAs to sludge.				1													1				B	-	米国、排水	
171	ばく露	Tao, L.; Kannan, K.; Wong, C. M.; Arcaro, K. F.; Butenhoff, J. L.	Perfluorinated compounds in human milk from	2008	Environ Sci Technol. 2008 Apr 15;42(8):3096-101. doi: 10.1021/es702789k.	Perfluorinated compounds (PFCs), notably perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA), have been reported in human blood. Furthermore, the occurrence of PFCs in the blood of newborn babies, coupled with the need to study the potential association of PFC exposure with birth outcomes in neonates, suggests the need for determining the sources and magnitude of exposure in infants. In this study, nine PFCs were measured in 45 human breast milk samples collected in 2004 from Massachusetts, U.S.A. PFOS and PFOA were the predominant PFCs found at mean concentrations of 131 and 43.8 pg/mL, respectively. Comparison of the ratio of PFOS to PFOA in human milk with the ratios published for human serum from the U.S. female population suggested preferential partitioning of PFOA to milk. Concentrations of PFOA were significantly higher in the milk of mothers nursing for the first time (n = 34) than in the milk of mothers who have previously nursed (n = 8). Based on the estimated body weight and milk intake, the average and highest daily intakes of total PFCs by infants were 23.5 and 87.1 ng/kg bw, respectively. We found that the daily ingestion rates of PFOS and PFOA did not exceed the tolerable daily intakerecommended by the U.K. Food Standards Agency. This is the first study to measure the occurrence of PFCs in human milk from the U.S.A.				1	1												1				B	-	米国、ミルク、9PFAS	
172	ばく露	Vestergren, Robin; Cousins, Ian T	Tracking the pathways of human exposure to p	2009	Environ Sci Technol. 2009 Aug 1;43(15):5565-75. doi: 10.1021/es900228k.	Recent analyses of perfluorooctanoate (PFOA) in human blood sera show that the background-exposed population in industrialized countries worldwide exhibits a narrow concentration range; arithmetic means of published studies range between 2 and 8 microg/L. PFOA, with the exception of a few outlier studies. The globally comparable human serum concentrations of PFOA and characteristic dominance of PFOA with respect to other perfluorocarboxylate (PFCA) homologues indicate that exposure pathways of humans differ from those of wildlife, where perfluorononanoate (PFNA) is often the dominant homologue. The observed correlations between perfluorooctane sulfonate (PFOS) and PFOA in human serum together with a simultaneous downward time trend of these compounds in human blood sera and blood spots from the year 2000 onward indicate a connection between historical perfluorooctanesulfonyl (PFOSF) production (phased out by the major manufacturer in 2000-2002) and exposure to both PFOS and PFOA. A comparison of estimated daily intakes to humans based on samples from exposure media (collected post 2000) indicates that food intake is the major contemporary exposure pathway for the background population, whereas drinking water exposure is dominant for populations near sources of contaminated drinking water. A one-compartment pharmacokinetic model used to back-calculate daily intakes from serum levels is shown to provide agreement within a factor of 1.5-5.5 of the daily intakes derived from exposure media, which provides further supporting evidence that dietary exposure is a major ongoing exposure pathway of PFOA to thebackground population.				1													1				B	-	ヒト血清	
173	ばく露	Yamashita, Nobuyoshi; Kannan, Kurunthachalam; Taniyasu, Sachi; Horii, Yuichi; Petrick, Gert; Gamo, Toshitaka	A global survey of perfluorinated acids in ocear	2005	Mar Pollut Bull. 2005;51(8-12):658-68. doi: 10.1016/j.marpolbul.2005.04.026.	Perfluorinated acids and their salts have emerged as an important class of global environmental contaminants. Biological monitoring surveys conducted using tissues of marine organisms reported the occurrence of perfluorooctanesulfonate (PFOS) and related perfluorinated compounds in biota from various seas and oceans, including the Arctic and the Antarctic Oceans. Occurrence of perfluorinated compounds in remote marine locations is of concern and indicates the need for studies to trace sources and pathways of these compounds to the oceans. Determination of sub-parts-per-trillion (ng/L) or parts-per-quadrillion (pg/L) concentrations of aqueous media has been impeded by relatively high background levels arising from procedural or instrumental blanks. Our research group has developed a reliable and highly sensitive analytical method by which to monitor perfluorinated compounds in oceanic waters. The method developed is capable of detecting PFOS, perfluorohexanesulfonate (PFHS), perfluorobutanesulfonate (PFBS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), and perfluorooctanesulfonamide (PFOSA) at a few pg/L in oceanic waters. The method was applied to seawater samples collected during several international research cruises undertaken during 2002-2004 in the central to eastern Pacific Ocean (19 locations), South China Sea and Sulu Seas (five), north and mid Atlantic Ocean (12), and the Labrador Sea (20). An additional 50 samples of coastal seawater from several Asian countries (Japan, China, Korea) were analyzed. PFOA was found at levels ranging from several thousands of pg/L in water samples collected from coastal areas in Japan to a few tens of pg/L in the central Pacific Ocean. PFOA was the major contaminant detected in oceanic waters, followed by PFOS. Further studies are being conducted to elucidate the distribution and fate of perfluorinated acids in oceans.			1	1												1				B	-	海洋、6PFAS	
174	ばく露	Zhao, Y G; Wan, H T; Wong, M H; Wong, Chris K C	Partitioning behavior of perfluorinated compou	2014	Mar Pollut Bull. 2014 Jun 15;83(1):148-54. doi: 10.1016/j.marpolbul.2014.03.060. Epub 2014 Apr 26.	Surface sediment and biota were collected from 12 sampling sites - seven along the Pearl River Delta and five along the Hong Kong coastline. Perfluorinated compound (PFC) concentrations were detected using a high-performance-liquid-chromatogram-tandem-mass-spectrometry system. Analytical results indicated that the total PFC concentrations were in the range of 0.15-3.11 ng/g dry weight in sediments, while the total PFC concentrations in oyster and mussel samples were between 0.46-1.96 and 0.66-3.43 ng/g wet weight, respectively. The major types of PFCs detected in the sediment samples were perfluorooctanesulfonic acid (PFOS) and perfluorobutanoic acid (PFBA), with concentrations ranging from low limits of quantification to 0.86 ± 0.12 ng/g dry weight and 1.50 ± 0.26 ng/g dry weight, respectively. In bivalve samples, PFOS was the dominant contaminant with concentrations ranging from 0.25 ± 0.09 to 0.83 ± 0.12 ng/g wet weight in oysters and 0.41 ± 0.14 to 1.47 ± 0.25 ng/g wet weight in mussels. An increase in PFC concentration was found to be correlated with increased human population density in the study areas.	1														1				B	-	香港、底泥、生物相	
175	ばく露	Campo, Julian; Masiá, Ana; Picó, Yolanda; Farré, Marinella; Barceló, Damià	Distribution and fate of perfluoroalkyl substanc	2014	Sci Total Environ. 2014 Feb 15;472:912-22. doi: 10.1016/j.scitotenv.2013.11.056. Epub 2013 Dec 15.	The concentrations of 21 perfluoroalkyl substances (PFASs: C4-C14, C16, C18 carboxylates, C4, C6-C8 and C10 sulfonates and C8 sulfonamide) were determined in influent, effluent and sludge from 16 different sewage treatment plants (STPs) located in the Ebro (6), Guadalquivir (5), Jucar (2) and Llobregat (3) Rivers, in two consecutive years (2010 and 2011). The analytes were extracted by solid phase extraction (SPE) and determined by Liquid Chromatography triple Quadrupole Mass Spectrometer (LC-QqQ-MS). All samples, except two sludges from Guadalquivir River STPs, were contaminated with at least one PFAS. Perfluorobutanoate (PFBA), perfluoropentanoate (PFPeA) and perfluorooctane sulfonate (L-PFOS) were the most frequently detected. The highest concentration in water was determined in 2010 in a Guadalquivir River STP (perfluorohexanoate, PFHxA: 5.60 μ gL(-1)) and, in 2011, in an Ebro River STP (perfluorobutane sulfonate, L-PFBS: 0.31 μ gL(-1)). In sludge samples, the maximum concentration in 2010 was 1.79 μ gg(-1)dry weight (dw) (L-PFOS, in a Llobregat River STP), and in 2011, 1.88 μ gg(-1)dw (PFBA, in one Guadalquivir River STP). High PFAS values in sludge could be related to positive removal efficiencies, and can be attributed to their adsorption. Distribution coefficients (Kd) were determined ranging between 0.32Lkg(-1) (perfluorohexane sulfonate, L-PFHxS) and 36.6 10(3)Lkg(-1) (PFBA). The total PFAS loads discharged into the basins showed high values for the Ebro River STPs (66.9gday(-1)) while in the others, the loads were between 3.97gday(-1), in the Jucar STPs, and 32.2gday(-1), in the Guadalquivir STPs.	1														1				B	-	スペイン、排水施設	
176	ばく露	Choi, Heeju; Bae, In-Ae; Choi, Jae Chun; Park, Se-Jong; Kim, MeeKyung	Perfluorinated compounds in food simulants af	2018	Food Addit Contam Part B Surveill. 2018 Dec;11(4):264-272. doi: 10.1080/19393210.2018.1499677. Epub 2018 Aug 10.	Perfluorinated compounds (PFCs) are used in manufacturing food contact materials, including non-stick cookware coatings and oil- and moisture-resistant paper coatings. The chemical stability of PFCs poses an issue for human safety, as they do not degrade well naturally and hence may accumulate in the body. In terms of food safety, since dietary intake is thought to be a major source of exposure to PFCs, it is necessary to assess the migration of PFCs from food packaging articles to food under typical cooking and storage conditions. An analytical method was developed for assessing the migration of 16 PFCs from food contact materials to food simulants using liquid chromatography-tandem mass spectrometry. The applicability of the method for regular inspection was assessed by monitoring 312 samples. Based on the results of the exposure assessment, all food contact materials deemed to be safe for use, which evaluated migrated concentrations and dietary food intake.				1													1				B	-	韓国、食品容器等、16PFAS	
177	ばく露	Del Vento S, Halsall C, Gioia R, Jones K and Dachs J.	Volatile per- and polyfluoroalkyl compounds in	2012	Atmospheric Pollution Research, 3, 450–455. doi: 10.5094/APR.2012.051	Volatile per– and polyfluoroalkyl compounds were measured in air in the vicinity of the Western Antarctic Peninsula during February 2009 (Austral summer). The 6:2, 8:2 and 10:2 fluorotelomer alcohols (FTOHs) were the most abundant compounds with 8:2 and 10:2 FTOH concentrations averaging 9.9 and 7.4 pg m−3 respectively, followed by the shorter chain (C4) compounds of methyl perfluorobutane sulfonamide (MeFBSA) and sulfonamidoethanol (MeFBSE) with average concentrations of ~3 to 4 pg m−3. Methyl/ethyl fluorooctane sulfonamides and sulfonamidoethanols (FOSA/Es) were <1 pg m−3 in all air samples (n = 8). The concentrations of FTOHs and FOSAs were in good agreement with a previous study (2007) that measured these chemicals in the background atmosphere of the Southern Ocean, although the levels of the MeFBSA/E were found to be ~ 10–fold higher and possibly indicative of the increased use of these chemicals. Air mass back trajectories revealed that air mass movement was from the Antarctic landmass or from the Southern Ocean, the latter in keeping with the prevailing direction of the Antarctic Circulation Current. Those samples corresponding to air passing over the Antarctic Peninsula did not show notable differences in chemical concentrations or profile indicating that the scientific bases located on or near the Peninsula did not appear to influence PFC levels in the regional atmosphere. Given the lack of air mass incursions from the north (i.e. from the South American continent) then the levels measured here are representative of background concentrations around Antarctica. However, the relatively high levels of MeFBSE were surprising given the reported reactivity of this chemical and short atmospheric residence time. It is likely that this compound, alongside MeFBSA, is providing a source of C2–C4 perfluoroalkyl acids (PFAs) to Antarctic surface waters. We recommend that long–term air monitoring be established in Antarctica for volatile PFCs and possibly accompanied by deposition monitoring for the PFAs.																1				B	-	西南極大気、FTOH、スルホンアミド、スルホンアミドエタノール	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
178	ばく露	EFSA	Perfluoroalkylated substances in food: occurre	2012	EFSA Journal 2012;10(6):2743, 55 pp. doi: 10.2903/j.efsa.2012.2743	Perfluoroalkylated substances (PFASs) are highly fluorinated aliphatic compounds with high thermal and chemical stability, as well as high surface activity. PFASs are used in a range of industrial and chemical applications e.g. textiles, paper, packaging materials, paint and varnish, and fire-extinguishing liquids. Several PFASs are recognised as environmentally persistent organic pollutants and are associated with adverse health effects. Diet is considered the main source of exposure to PFASs. In 2008, the EFSA Scientific Panel on Contaminants in the Food Chain (CONTAM Panel) performed a risk assessment for perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) concluding that it is unlikely that adverse effects of PFOS or PFOA are occurring in the general population. The CONTAM Panel acknowledged the limitation of available data and recommended further monitoring of PFAS in food. The present report summarises occurrence data for PFASs collected in 13 European countries during the period 2006 to 2012. A total of 54,195 analytical results covering a list of 27 substances were included in the assessment. The overall proportion of quantified results was very low. Across food groups, PFASs were found more frequently in fish and other seafood and in meat and meat products (liver in particular). For PFOS, the dietary exposure estimates in the adult population was < 3.5 % of the TDI for average consumers and < 6.7 % of the TDI in high consumers. For the same consumer groups, exposure to PFOA represented < 0.3 % and < 0.5 % of the TDI, respectively. Exposure in toddlers was two to three times higher compared to adults. For the other PFASs evaluated, daily dietary exposure was estimated to be in the low ng/kg b.w. range. The current review confirmed that dietary exposure to PFOS and PFOA is highly unlikely to exceed health-based guidance values.																					1	No. 48と重複		A	-	食事中のPFAS、EFSAのデータ 48番と同じ	
179	ばく露	Kato K, Ye X and Calafat AM.	PFASs in the general population	2015	In: De Witt JC, ed. Toxicological Effects of Perfluoroalkyl and Polyfluoroalkyl Substances. Series: Molecular and Integrative Toxicology. Springer International Publishing, Switzerland, 51–76. doi: 10.1007/978-3-319-15518-0_3	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) have been manufactured since the 1950s for use as surface protectants for textiles and leather treatment, as protection additives in food packaging and paper products, and in firefighting foams. Some PFASs are persistent in the environment and in people, and can be transported to remote regions. The main pathways of exposure to PFASs in humans include diet, drinking water, and indoor dust, but predictors of PFASs exposures are not clearly understood. Since 2002, changes in manufacturing practices appear to have reduced exposure to some of these PFASs both in the environment and in people,- but exposure to PFASs is still widespread. We review relevant research published up to the first quarter of 2014 to understand the demographic, geographic, and temporal differences that contribute to general population exposures to PFASs around the world. We also present data on exposures to PFASs in some vulnerable population groups (e.g., pregnant women, infants, young children).																					1			B	-	総説	
180	ばく露	Lange, F T; Wenz, M; Schmidt, C K; Brauch, H-J	Occurrence of perfluoroalkyl sulfonates and ca	2007	Water Sci Technol. 2007;56(11):151-8. doi: 10.2166/wst.2007.803.	Different homologues of C4 to C8 perfluoroalkyl carboxylates (PFCAs) and perfluoroalkyl sulfonates (PFASs) were detected in German surface waters, bank filtrates, artificially recharged groundwaters, and drinking waters. If no point sources are located nearby, the typically measured levels are in the low ng/L range. In the presence of point sources, such as a fluorochemical production site, a leaching agricultural fertilizer contaminated with PFCAs and PFASs, or drained PFC containing fire-fighting foams, much higher concentrations in the microg/L range occur. This situation is similar in Germany and other countries.				1															1			B	-	ドイツ、環境水・飲料水、PFCAとPFSA	
181	ばく露	Lu, Zhibo; Lu, Rong; Zheng, Hongyuan; Yan, Jing; Song, Luning; Wang, Juan; Yang, Haizhen; Cai, Minghong	Risk exposure assessment of per- and polyfluo	2018	Environ Sci Pollut Res Int. 2018 Apr;25(10):9311-9320. doi: 10.1007/s11356-017-0950-x. Epub 2017 Dec 17.	We examined per- and polyfluoroalkyl substances (PFASs) in air from eight cities, and in water from six drinking-water treatment plants (DWTPs), in central eastern China. We analyzed raw and treated water samples from the DWTPs for 17 ionic PFASs with high-performance liquid chromatography/negative-electrospray-ionization tandem mass spectrometry (HPLC/(-)ESI-MS/MS), and analyzed the gas and particle phases of atmospheric samples for 12 neutral PFASs by gas chromatography-mass spectrometry (GC-MS). Perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA) were the dominant compounds in drinking water, and fluorotelomer alcohols (FTOHs) dominated in atmospheric samples. Of all the compounds in the treated water samples, the concentration of PFOA, at 51.0 ng L-1, was the highest. Conventional treatments such as coagulation (COA), flocculation (FOC), sedimentation (SED), and sand filtration (SAF) did not remove PFASs. Advanced treatments, however, including ultrafiltration (UF) and activated carbon (AC), removed the majority of PFASs except for shorter-chain PFASs such as perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPA). We also investigated human exposure to PFASs via drinking water and the atmosphere and found that the mean daily intake of PFASs was 0.43 ng kg-1 day-1.		1															1			B	-	中国、大気・飲料水、29PFAS	
182	ばく露	Nilsson, Helena; Kärrman, Anna; Rotander, Anna; van Bavel, Bert; Lindström, Gunilla; Westberg, Håkan	Professional ski waxers' exposure to PFAS and	2013	Environ Sci Process Impacts. 2013 Apr;15(4):814-22. doi: 10.1039/c3em30739e.	Previous reports show that professional ski waxers have elevated blood levels of perfluorinated substances (PFAS) such as perfluorooctanoate (PFOA) and are exposed to very high concentrations of PFAS in air during ski waxing. Aerosol exposure increases the risk of cardiovascular disease, and PFOA is a potential hormonal disruptor and carcinogen, and can affect the fatty acid metabolism. Animal studies have shown that 8:2 FTOH can undergo biotransformation to PFOA. For the first time, this study presents an occupational scenario of professional ski waxers who are exposed to extremely high dust levels as well as per- and polyfluorinated compounds. Personal and fixed measurements of total aerosol, inhalable and respirable fractions were performed during World Cup events 2007-2010. The occupational exposure limit (OEL) is exceeded in 37% of the personal measurements with concentrations up to 15 mg m(-3) in air. There are differences between personal and area total aerosol concentrations with levels from personal measurements twice as high as those from the area measurements. The personal levels for FTOH ranged up to 996 μg m(-3) (mean = 114 μg m(-3)) and for PFOA up to 4.89 μg m(-3) (mean = 0.53 μg m(-3)) in ENV+ sorbent samples as compared to the general exposure levels from air reaching only low ng m(-3) (<30 ng m(-3)) levels. FTOHs were not detected in aerosols but PFOA showed an average level of 12 μg m(-3) (range = 1.2-47 μg m(-3)). The ski waxers' exposure to paraffin fumes and PFAS is not in compliance with the occupational exposure standards and by far exceed the general populations' exposure. Preventivemeasures must be taken to minimize the exposure in this occupational group.				1													1			B	-	大気、PFOAとPFOH	
183	ばく露	Noorlander, Cornelle W; van Leeuwen, Stefan P J; Te Biesebeek, Jan Dirk; Mengelers, Marcel J B; Zeilmaker, Marco J	Levels of perfluorinated compounds in food an	2011	J Agric Food Chem. 2011 Jul 13;59(13):7496-505. doi: 10.1021/jf104943p. Epub 2011 Jun 10.	This study presents concentrations of perfluorinated compounds in food and the dietary intake of perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in The Netherlands. The concentrations of perfluorinated compounds in food were analyzed in pooled samples of foodstuffs randomly purchased in several Dutch retail store chains with nation-wide coverage. The concentrations analyzed for PFOS and PFOA were used to assess the exposure to these compounds in The Netherlands. As concentrations in drinking water in The Netherlands were missing for these compounds, conservative default concentrations of 7 pg/g for PFOS and 9 pg/g for PFOA, as reported by European Food Safety Authority, were used in the exposure assessment. In food, 6 out of 14 analyzed perfluorinated compounds could be quantified in the majority of the food categories (perfluoroheptanoic acid (PFHpA), PFOA, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoro-1-hexanesulfonate (PFHxS), and PFOS). The highest concentration of the sum of these six compounds was found in crustaceans (825 pg/g product, PFOS: 582 pg/g product) and in lean fish (481 pg/g product, PFOS: 308 pg/g product). Lower concentrations were found in beef, fatty fish, flour, butter, eggs, and cheese (concentrations between 20 and 100 pg/g product; PFOS, 29-82 pg/g product) and milk, pork, bakery products, chicken, vegetable, and industrial oils (concentration lower than 10 pg/g product; PFOS not detected). The median long-term intake for PFOS was 0.3 ng/kg bw/day and for PFOA 0.2 ng/kg bw/day. The corresponding high level intakes (99th percentile) were 0.6 and 0.5 ng/kg bw/day,respectively. These intakes were well below the tolerable daily intake values of both compounds (PFOS, 150 ng/kg bw/day; PFOA, 1500 ng/kg bw/day). The intake calculations quantified the contribution of drinking water to the PFOS and PFOA intake in The Netherlands. Important contributors of PFOA intake were vegetables/fruit and flour. Milk, beef, and lean fish were important contributors of PFOS intake.				1													1			B	-		
184	ばく露	Susmann, Herbert P; Schaider, Laurel A; Rodgers, Kathryn M; Rudel, Ruthann A	Dietary Habits Related to Food Packaging and	2019	Environ Health Perspect. 2019 Oct;127(10):107003. doi: 10.1289/EHP4092. Epub 2019 Oct 9.	BACKGROUND: Per- and polyfluoroalkyl substances (PFASs) are common industrial and consumer product chemicals with widespread human exposures that have been linked to adverse health effects. PFASs are commonly detected in foods and food-contact materials (FCMs), including fast food packaging and microwave popcorn bags. OBJECTIVES: Our goal was to investigate associations between serum PFASs and consumption of restaurant food and popcorn in a representative sample of Americans. METHODS: We analyzed 2003-2014 serum PFAS and dietary recall data from the National Health and Nutrition Examination Survey (NHANES). We used multivariable linear regressions to investigate relationships between consumption of fast food, restaurant food, food eaten at home, and microwave popcorn and serum levels of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorohexanesulfonic acid (PFHxS), and perfluorooctanesulfonic acid (PFOS). RESULTS: Calories of food eaten at home in the past 24 h had significant inverse associations with serum levels of all five PFASs; these associations were stronger in women. Consumption of meals from fast food/pizza restaurants and other restaurants was generally associated with higher serum PFAS concentrations, based on 24-h and 7-d recall, with limited statistical significance. Consumption of popcorn was associated with significantly higher serum levels of PFOA, PFNA, PFDA, and PFOS, based on 24-h and 12-month recall, up to a 63% (95% CI: 34, 99) increase in PFDA among those who ate popcorn daily over the last 12 months. CONCLUSIONS: Associations between serum PFAS and popcornconsumption may be a consequence of PFAS migration from microwave popcorn bags. Inverse associations between serum PFAS and food eaten at home-primarily from grocery stores-is consistent with less contact between home-prepared food and FCMs, some of which contain PFASs. The potential for FCMs to contribute to PFAS exposure, coupled with concerns about toxicity and persistence, support the use of alternatives to PFASs in FCMs.				1													1			B	-		
185	ばく露	Swedish Chemical Agency	Occurrence and use of highly fluorinated subst	2015	Report from a government assignment. Report 7/15. Available online: https://www.kemi.se/en/global/rapporter/2015/ report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf	Highly fluorinated substances (per- and polyfluorinated alkyl substances, PFAS) are used in many different articles and chemical products due to their attractive properties. They are repellent to water, grease, and dirt, temperature resistant and film-forming. However, other less desirable properties are their extreme persistence in the environment, and that several of them accumulate in living organisms and can be toxic. The knowledge of the presence and use of highly fluorinated substances is limited and this report is a survey of how these substances are used. The report will be used in future work to prevent additional health and environmental problems with PFAS. The survey was conducted at the Swedish Chemicals Agency in (the spring) 2015. It is based on information from databases available to the agency (e.g. the Swedish products register and EU databases). Searches were also made in scientific publications and reports as well as lists of industrial chemicals from various countries (mainly from North America and Asia). In addition, information has been obtained from the industry and searches have been made in patent databases. Although all known uses of PFAS are considered in the report, the focus is on those assessed to be most relevant for Sweden. Alternatives to PFAS, alternative materials and methods are also included in the survey. The highly fluorinated substances have been compiled and grouped and, when possible, related to different uses. The results of this survey demonstrate that there are probably more than 3,000 commercial highly fluorinated substances in circulation on the global market. The largest group is polymers. Many of the substances have technical qualities with more or less unspecified formulations. We see that the industry has replaced longer carbon chain lengths with shorter ones, mainly six perfluorinated carbons. Information from various patents suggests a strong increase of proposed uses of existing substances in new technical areas. Further, it indicates that the development of new highly fluorinated substances is more moderate. The survey shows that these substances already today are widely used, from more well-known areas, such as fire-fighting foam, textiles and food packaging to less investigated areas, such as cosmetics, dental restorative materials and dirt-repellent coating for smartphones. Identified alternatives to PFAS are fluorine-free substances, different materials and alternative techniques. Alternatives could be identified primarily for textiles and fire-fighting foam. Generally, it has been difficult to find alternatives that will match the desired properties of the highly fluorinated substances. This lack of alternatives demonstrates that there is a need for technical development. Due to significant lack of available information this survey cannot give a complete picture. For example, information on quantities could only be obtained for a few substances. Furthermore, our sources could only give information on uses for about half of the identified substances. This is not surprising, since many of the highly fluorinated substances are entering the EU and Sweden through imports of articles, and for those there are virtually no control. Another reason for the lack of information is that many highly fluorinated substances are very effective and therefore used in low concentrations to achieve the desired effect. Within REACH there are register requirements for the manufacturers or importers of substances from 100 tonne/year. At low volumes, which can be the case for most PFAS, information requirements are very low. For quantities below 100 tonne/year (1 tonne/year from June 2018) manufacturers and importers are not required to submit any information at all. In Sweden manufacturers and importers are obliged to register chemical products in the Swedish products register. However, there are in many cases no requirements to notify substances that are added in concentrations below 5 percent, which often is the case for																	1			B	-		
186	ばく露	Sznajder-Katarzyńska, Katarzyna; Surma, Magdalena; Cieślik, Ewa; Wiczkowski, Wiesław	The perfluoroalkyl substances (PFASs) contan	2018	Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2018 Sep;35(9):1776-1786. doi: 10.1080/19440049.2018.1502477. Epub 2018 Aug 10.	Fruit and vegetables play a major role in human nutrition due to richness of nutrients, dietary fibre, and phytochemicals. As dietary intake is identified as one of the dominant exposure pathways to perfluoroalkyl substances (PFASs), a cross-sectional study involving determination of their levels in food of plant origin has been conducted. Locally-grown and imported fruit and vegetable samples, collected in 2016 were inspected for 10 perfluoroalkyl acids (PFAAs) using QuEChERS as sample pre-treatment procedure followed by micro-HPLC-MS/MS. Three of 10 target analytes, perfluorobutanoic acid (PFBA), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS) were quantitatively determined. The detection frequency for PFASs across the 55 samples analysed was less than 10%. The major contributor of the total PFASs concentration in the investigated group was PFBA for which the concentration, reported only for banana, apple and orange samples, was 50.740 ng g(-1) ww. The most often detected compound was PFOA. The origin and growing region are possible factors with the potential to influence PFASs distribution profile and their levels in food.							1										1			B	-	食品、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
187	ばく露	Taniyasu, Sachi; Senthilkumar, Kurunthachalam; Yamazaki, Eriko; Yeung, Leo W Y; Guruge, Keerthi S; Kannan, Kurunthachalam; Yamashita, Nobuyoshi	Perfluoroalkyl substances in the blood of wild r	2013	Arch Environ Contam Toxicol. 2013 Jul;65(1):149-70. doi: 10.1007/s00244-013-9878-4. Epub 2013 Mar 14.	Numerous studies have reported on the global distribution, persistence, fate, and toxicity of perfluoroalkyl and polyfluoroalkyl substances (PFASs). However, studies on PFASs in terrestrial mammals are scarce. Rats can be good sentinels of human exposure to toxicants because of their habitat, which is in close proximity to humans. Furthermore, exposure data measured for rats can be directly applied for risk assessment because many toxicological studies use rodent models. In this study, a nationwide survey of PFASs in the blood of wild rats as well as surface water samples collected from rats' habitats from 47 prefectures in Japan was conducted. In addition to known PFASs, combustion ion chromatography technique was used for analysis of total fluorine concentrations in the blood of rats. In total, 216 blood samples representing three species of wild rats (house rat, Norway rats, and field mice) were analyzed for 23 PFASs. Perfluorooctanesulfonate (PFOS; concentration range <0.05-148 ng/mL), perfluorooctane sulfonamide (PFOSA; <0.1-157), perfluorododecanoate (<0.05-5.8), perfluoroundecanoate (PFUnDA; <0.05-51), perfluorodecanoate (PFDA; <0.05-9.7), perfluorononanoate (PFNA; <0.05-249), and perfluorooctanoate (PFOA) (<0.05-60) were detected >80 % of the blood samples. Concentrations of several PFASs in rat blood were similar to those reported for humans. PFSAs (mainly PFOS) accounted for 45 % of total PFASs, whereas perfluoroalkyl carboxylates (PFCAs), especially PFUnDA and PFNA, accounted for 20 and 10 % of total PFASs, respectively. In water samples, PFCAs were the predominant compounds with PFOA and PFNA found in >90 % of the samples.There were strong correlations ($p < 0.001$ to $p < 0.05$) between human population density and levels of PFOS, PFNA, PFOA, and PFOSA in wild rat blood.	1		1														1		B	-	日本、ラットの血液、47都道府県216、23PFAS	
188	ばく露	Wang, Zhanyun; Cousins, Ian T; Scheringer, Martin; Buck, Robert C; Hungerbühler, Konrad	Global emission inventories for C4-C14 perfluo	2014	Environ Int. 2014 Aug;69:166-76. doi: 10.1016/j.envint.2014.04.006. Epub 2014 May 24.	We identify eleven emission sources of perfluoroalkyl carboxylic acids (PFCAs) that have not been discussed in the past. These sources can be divided into three groups: [i] PFCAs released as ingredients or impurities, e.g., historical and current use of perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA) and their derivatives; [ii] PFCAs formed as degradation products, e.g., atmospheric degradation of some hydrofluorocarbons (HFCs) and hydrofluoroethers (HFEs); and [iii] sources from which PFCAs are released as both impurities and degradation products, e.g., historical and current use of perfluorobutane sulfonyl fluoride (PBSF)- and perfluorohexane sulfonyl fluoride (PHxSF)-based products. Available information confirms that these sources were active in the past or are still active today, but due to a lack of information, it is not yet possible to quantify emissions from these sources. However, our review of the available information on these sources shows that some of the sources may have been significant in the past (e.g., the historical use of PFBA-, PFHxA-, PBSF- and PHxSF-based products), whereas others can be significant in the long-term (e.g., (bio)degradation of various side-chain fluorinated polymers where PFCA precursors are chemically bound to the backbone). In addition, we summarize critical knowledge and data gaps regarding these sources as a basis for future research.				1												1		B	-	総説、PFASの11の排出源	
189	ばく露	Zhang, Haiyan; Vestergren, Robin; Wang, Thanh; Yu, Junchao; Jiang, Guibin; Herzke, Dorte	Geographical Differences in Dietary Exposure t	2017	Environ Sci Technol. 2017 May 16;51(10):5747-5755. doi: 10.1021/acs.est.7b00246. Epub 2017 Apr 25.	Emissions of perfluoroalkyl acids (PFAAs) have increased in China over the past decade, but human exposure pathways are poorly understood. Here we analyzed 15 PFAAs in commonly consumed food items and calculated body weight normalized dietary intake rates (estimated dietary intake, EDIs) in an area with ongoing PFAA production (Hubei province; n = 121) and an urbanized coastal area (Zhejiang province; n = 106). Geographical differences in concentrations were primarily observed for perfluorooctanesulfonic acid (PFOS) and perfluorohexanesulfonic acid (PFHxS) in animal food items and short-chain PFAAs in vegetable food items. The average EDI of ∑PFAAs for adults in Hubei (998 ng kg(-1) day(-1)) was more than 2 orders of magnitude higher than that in Zhejiang (9.03 ng kg(-1) day(-1)). In Hubei province, the average EDI of PFOS for adults (87 ng kg(-1) day(-1)) was close to or exceeded advisory guidelines used in other countries indicating health risks for the population from long-term exposure. Yet, PFOS could only account for about 10% of the EDI of ∑PFAAs in the Hubei province, which was dominated by short-chain PFAAs through consumption of vegetables. The large contribution of short-chain PFAAs to the total EDIs in manufacturing areas emphasize the need for improved exposure and hazard assessment tools of these substances.	1														1		B	-	中国、食品、15PFAS	
190	環境中運命	Blaine, Andrea C; Rich, Courtney D; Hundal, Lakhwinder S; Lau, Christopher; Mills, Marc A; Harris, Kimberly M; Higgins, Christopher P	Uptake of perfluoroalkyl acids into edible crops	2013	Environ Sci Technol. 2013 Dec 17;47(24):14062-9. doi: 10.1021/es403094q. Epub 2013 Nov 21.	The presence of perfluoroalkyl acids (PFAAs) in biosolids destined for use in agriculture has raised concerns about their potential to enter the terrestrial food chain via bioaccumulation in edible plants. Uptake of PFAAs by greenhouse lettuce (Lactuca sativa) and tomato (Lycopersicon lycopersicum) grown in an industrially impacted biosolids-amended soil, a municipal biosolids-amended soil, and a control soil was measured. Bioaccumulation factors (BAFs) were calculated for the edible portions of both lettuce and tomato. Dry weight concentrations observed in lettuce grown in a soil amended (biosolids:soil dry weight ratio of 1:10) with PFAA industrially contaminated biosolids were up to 266 and 236 ng/g for perfluorobutanoic acid (PFBA) and perfluoropentanoic acid (PFPeA), respectively, and reached 56 and 211 ng/g for PFBA and PFPeA in tomato, respectively. BAFs for many PFAAs were well above unity, with PFBA having the highest BAF in lettuce (56.8) and PFPeA the highest in tomato (17.1). In addition, the BAFs for PFAAs in greenhouse lettuce decreased approximately 0.3 log units per CF2 group. A limited-scale field study was conducted to verify greenhouse findings. The greatest accumulation was seen for PFBA and PFPeA in both field-grown lettuce and tomato; BAFs for PFBA were highest in both crops. PFAA levels measured in lettuce and tomato grown in field soil amended with only a single application of biosolids (at an agronomic rate for nitrogen) were predominantly below the limit of quantitation (LOQ). In addition, corn (Zea mays) stover, corn grains, and soil were collected from several full-scale biosolids-amended farm fields. At these fields, all PFAAs were below the LOQ in the corn grains and only trace amounts of PFBA and PFPeA were detected in the corn stover. This study confirms that the bioaccumulation of PFAAs from biosolids-amended soils depends strongly on PFAA concentrations, soil properties, the type of crop, and analyte.	1	1	1			1	1		1		1	1	1		1			B	-	植物濃縮、レタスとトマト、	
191	環境中運命	Hurley, M. D.; Andersen, M. P. S.; Wallington, T. J.; Ellis, D. A.; Martin, J. W.; Mabury, S. A.	Atmospheric chemistry of perfluorinated carbo	2004	J Phys Chem A, 108: 615-620. doi: 10.1021/jp036343b.	Relative rate techniques were used to study the kinetics of the reactions of OH radicals with a homologous series of perfluorinated acids, F(CF2)(n)COOH (n = 1, 2, 3, 4), in 700 Torr of air at 296 +/- 2 K. For n > 1, the length of the F(CF2)(n) group had no discernible impact on the reactivity of the molecule. For n = 1, k(OH + F(CF2)(n)COOH) = (9.35 +/- 2.08) x 10(-14) cm(3) molecule(-1) s(-1). For n = 2-4, k(OH + F(CF2)(n)COOH) = (1.69 +/- 0.22) x 10(-13) cm(3) molecule(-1) s(-1). Dimerization constants for 2F(CF2)(n)COOH = (F(CF2)(n)COOH)(2) were determined to be 0.32 +/- 0.03 Torr(-1), 0.30 +/- 0.03 Torr(-1), 0.41 +/- 0.04 Torr(-1), and 0.46 +/- 0.05 Torr(-1) for n = 1, 2, 3. 4, respectively. Atmospheric lifetimes of F(CF2)(n)COOH with respect to reaction with OH radicals are estimated to be approximately 230 days for n = 1 and 130 days for n > 1. Reaction with OH radicals is a minor atmospheric fate of F(CF2)(n)COOH. The major atmospheric removal mechanism for F(CF2)(n)COOH is believed to be wet and dry deposition which probably occurs on a time scale of the order of 10 days.	1					1							1					B	-	大気、ラジカルとの反応	
192	環境中運命	Venkatesan, Arjun K; Halden, Rolf U	Loss and in situ production of perfluoroalkyl ch	2014	Environ Res. 2014 Jul;132:321-7. doi: 10.1016/j.envres.2014.04.024. Epub 2014 May 14.	An outdoor mesocosm study was conducted in Baltimore, Maryland, to explore the fate of thirteen perfluoroalkyl substances (PFASs) over the course of three years in biosolids/soil mixtures (1:2) exposed to ambient outdoor conditions. Analysis by liquid chromatography tandem mass spectrometry showed perfluorooctanoate (PFOA) to be the most abundant analyte found early in the soil weathering experiment at 24.1 ng/g dry weight (dw), followed by perfluoroundecanoate (PFUnDA) and perfluorodecanoate (PFDA) at 18.4 and 17.4 ng/g dw, respectively. Short-chain perfluorinated carboxylates (PFCAs; C4-C8) showed observable loss from biosolids/soil mixtures, with experimentally determined first-order half-lives in soil ranging from 385 to 866 days. Perfluorooctane sulfonate (PFOS), perfluorononaoate (PFNA) and PFUnDA levels in biosolids/soil mixtures remained stable, while other long-chain PFCAs [PFDA, perfluorododecanoate (PFDoDA)] and perfluorooctane sulfonamide (PFOSA) levels increased over time, presumably due to the breakdown of unidentified precursors in a process analogous to that reported previously for wastewater treatment plants. This study informs risk assessment initiatives by furnishing data on the environmental persistence of PFASs while also constituting the first report on in situ production of long-chained PFASs in terrestrial environments.	1					1	1		1									B	-	メソコムス実験、13PFAS	
193	環境中運命	Zhao, Hongxia; Qu, Baocheng; Guan, Yue; Jiang, Jingqiu; Chen, Xiuying	Influence of salinity and temperature on uptak	2016	Springerplus. 2016 Apr 27;5:541. doi: 10.1186/s40064-016-2016-9. eCollection 2016.	Perfluoroalkyl substances (PFASs) have recently attracted increasing concerns due to their ubiquitous existence, adverse effects and persistence in environment. This study employed four perfluorinated carboxylic acids (PFCAs) to examine effects of salinity and temperature on the PFAS uptake in wheat, one of the major crops in the North China Plain. Wheat plants were grown in the spiked-PFCA hydroponic culture system at different salinities and temperatures. As expected, salinity and temperature significantly impacted the root uptake and translocation of wheat to four PFCAs, and the concentrations for each of PFCAs in wheat root and shoot increased with increasing salinity and temperature, respectively. PFCA concentrations at high salinity or high temperature were up to thrice those found at low salinity or low temperature. Except for perfluorobutanoic acid, the amount of PFCAs in root was always higher than that in shoot at the ranges of salinity and temperature tested. Additionally salinity and temperature were also capable of influencing the transfer factors (TFs) of four PFCAs, and significant increase was observed in the TFs in response to the increases in salinity and temperature.	1					1							1					B	-	小麦への移行、塩や温度の影響、4PFAS	
194	蓄積性	Sanchez Garcia, D.; Sjödin, M.; Hellstrandh, M.; Norinder, U.; Nikiforova, V.; Lindberg, J.; Wincent, E.; Bergman, Å.; Cotgreave, I.; Munic Kos, V.	Cellular accumulation and lipid binding of perfl	2018	Chem Biol Interact 281: 1-10. doi: 10.1016/j.cbi.2017.12.021	Many chemicals accumulate in organisms through a variety of different mechanisms. Cationic amphiphilic drugs (CADs) accumulate in lysosomes and bind to membranes causing phospholipidosis, whereas many lipophilic chemicals target adipose tissue. Perfluoroalkyl substances (PFASs) are widely used as surfactants, but many of them are highly bioaccumulating and persistent in the environment, making them notorious environmental toxicants. Understanding the mechanisms of their bioaccumulation is, therefore, important for their regulation and substitution with new, less harmful chemicals. We compared the highly bioaccumulative perfluorooctanesulfonic acid PFOS to its three less bioaccumulative alternatives perfluorooctanoic acid (PFOA), perfluorohexanoic acid (PFHxA) and perfluorobutane sulfonic acid (PFBS), in their ability to accumulate and remain in lung epithelial cells (NCI-H292) and adipocytes (3T3-L1K) in vitro. As a reference point we tested a set of cationic amphiphilic drugs (CADs), known to highly accumulate in cells and strongly bind to phospholipids, together with their respective non-CAD controls. Finally, all compounds were examined for their ability to bind to neutral lipids and phospholipids in cell-free systems. Cellular accumulation and retention of the test compounds were highly correlated between the lung epithelial cells and adipocytes. Interestingly, although an anion itself, intensities of PFOS accumulation and retention in cells were comparable to thoseof CAD compounds, but PFOS failed to induce phospholipidosis or alter lysosomal volume. Compared to other lipophilicity measures, phospholipophilicity shows the highest correlation ($R^2 = 0.75$) to cellular accumulation data in both cell types and best distinguishes between high and low accumulating compounds. This indicates that binding to phospholipids may be the most important component in driving high cellular accumulation in lung epithelial cells, as well as in adipocytes, and for both CADs and bioaccumulating PFASs. Obtained continuous PLS models based on compound's affinity for phospholipids and neutral lipids can be used as good prediction models of cellular accumulation and retention of PFASs and CADs.		1		1				1									B	-	肺上皮細胞、脂肪細胞への蓄積、4PFAS	
195	蓄積性	Yoo, Hoon; Washington, John W; Jenkins, Thomas M; Ellington, J Jackson	Quantitative determination of perfluorochemica	2011	Environ Sci Technol. 2011 Oct 1;45(19):7985-90. doi: 10.1021/es102972m. Epub 2011 Jan 19.	Analytical methods for determining perfluorochemicals (PFCs) and fluorotelomer alcohols (FTOHs) in plants using liquid chromatography/tandem mass spectrometry (LC/MS/MS) and gas chromatography/mass spectrometry (GC/MS) were developed, and applied to quantify a suite of analytes in plants from biosolid-amended fields. Dichloromethane-methanol and ethylacetate were chosen as extracting solutions for PFCs and FTOHs, respectively. Nine perfluorocarboxylic acids (PFCAs), three perfluorosulfonic acids (PFSAs), and ten FTOHs were monitored. Most PFCAs and perfluorooctanesulfonate (PFOS) were quantifiable in plants grown in contaminated soils, whereas PFCs went undetected in plants from two background fields. Perfluorooctanoic acid (PFOA) was a major homologue (~10-200 ng/g dry wt), followed by perfluorodecanoic acid (~3-170 ng/g). [PFOS] in plants (1-20 ng/g) generally was less than or equal to most [PFCAs]. The site-specific grass/soil accumulation factor (GSAF = [PFC](Grass)/[PFC](Soil)) was calculated to assess transfer potentials from soils. Perfluorohexanoic acid had the highest GSAF (= 3.8), but the GSAF decreased considerably with increasing PFCA chain length. Log-transformed GSAF was significantly correlated with the PFCA carbon-length ($p < 0.05$). Of the measured alcohols, 8:2nFTOH was the dominant species (≤1.5 ng/g), but generally was present at ≥10× lower concentrations than PFOA.	1					1		1		1	1			1				B	-	植物中濃度、PFCA、PFOH	
196	蓄積性	Lasier, Peter J; Washington, John W; Hassan, Sayed M; Jenkins, Thomas M	Perfluorinated chemicals in surface waters and	2011	Environ Toxicol Chem. 2011 Oct;30(10):2194-201. doi: 10.1002/etc.622. Epub 2011 Aug 4.	Concentrations of perfluorinated chemicals (PFCs) were measured in surface waters and sediments from the Coosa River watershed in northwest Georgia, USA, to examine their distribution downstream of a suspected source. Samples from eight sites were analyzed using liquid chromatography-tandem mass spectrometry. Sediments were also used in 28-d exposures with the aquatic oligochaete, Lumbriculus variegatus, to assess PFC bioaccumulation. Concentrations of PFCs in surface waters and sediments increased significantly below a land-application site (LAS) of municipal/industrial wastewater and were further elevated by unknown sources downstream. Perfluorinated carboxylic acids (PFCAs) with eight or fewer carbons were the most prominent in surface waters. Those with 10 or more carbons predominated sediment and tissue samples. Perfluorooctane sulfonate (PFOS) was the major homolog in contaminated sediments and tissues. This pattern among sediment PFC concentrations was consistent among sites and reflected homolog concentrations emanating from the LAS. Concentrations of PFCs in oligochaete tissues revealed patterns similar to those observed in the respective sediments. The tendency to bioaccumulate increased with PFCA chain length and the presence of the sulfonate moiety. Biota-sediment accumulation factors indicated that short-chain PFCAs with fewer than seven carbons may be environmentally benign alternatives in aquatic ecosystems; however, sulfonates with four to seven carbons may be as likely to bioaccumulate as PFOS.				1				1		1							B	-	米国北西ジョージア、表流水と底泥、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
197	蓄積性	Sepulvado, Jennifer G; Blaine, Andrea C; Hundal, Lakhwinder S; Higgins, Christopher P	Occurrence and fate of perfluorochemicals in s	2011	Environ Sci Technol. 2011 Oct 1;45(19):8106-12. doi: 10.1021/es103903d. Epub 2011 Mar 29.	The recent implementation of soil and drinking water screening guidance values for two perfluorochemicals (PFCs), perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) by the U.S. Environmental Protection Agency (EPA), reflects the growing concerns regarding the presence of these persistent and bioaccumulative chemicals in the natural environment. Previous work has established the potential risk to the environment from the land application of industrially contaminated biosolids, but studies focusing on environmental risk from land application of typical municipal biosolids are lacking. Thus, the present study investigated the occurrence and fate of PFCs from land-applied municipal biosolids by evaluating the levels, mass balance, desorption, and transport of PFCs in soils receiving application of municipal biosolids at various loading rates. This study is the first to report levels of PFCs in agricultural soils amended with typical municipal biosolids. PFOS was the dominant PFC in both biosolids (80-219 ng/g) and biosolids-amended soil (2-483 ng/g). Concentrations of all PFCs in soil increased linearly with increasing biosolids loading rate. These data were used to develop a model for predicting PFC soil concentrations in soils amended with typical municipal biosolids using cumulative biosolids loading rates. Mass balance calculations comparing PFCs applied vs those recovered in the surface soil interval indicated the potential transformation of PFC precursors. Laboratory desorption experiments indicated that the leaching potential of PFCs decreases with increasing chain length and that previously derived organic-carbonnormalized partition coefficients may not be accurate predictors of the desorption of long-chain PFCs from biosolids-amended soils. Trace levels of PFCs were also detected in soil cores from biosolids-amended soils to depths of 120 cm, suggesting potential movement of these compounds within the soil profile over time and confirming the higher transport potential for short-chain PFCs in soils amended with municipal biosolids.				1				1				1				1						B	-	バイオソリッド、PFAS	
198	環境中運命	D'Ambro, Emma L; Pye, Havala O T; Bash, Jesse O; Bowyer, James; Allen, Chris; Efstathiou, Christos; Gilliam, Robert C; Reynolds, Lara; Talgo, Kevin; Murphy, Benjamin N	Characterizing the Air Emissions, Transport, ar	2021	Environ Sci Technol. 2021 Jan 19;55(2):862-870. doi: 10.1021/acs.est.0c06580. Epub 2021 Jan 4.	Per- and polyfluoroalkyl substances (PFASs) have been released into the environment for decades, yet contributions of air emissions to total human exposure, from inhalation and drinking water contamination via deposition, are poorly constrained. The atmospheric transport and fate of a PFAS mixture from a fluoropolymer manufacturing facility in North Carolina were investigated with the Community Multiscale Air Quality (CMAQ) model applied at high resolution (1 km) and extending ~150 km from the facility. Twenty-six explicit PFAS compounds, including GenX, were added to CMAQ using current best estimates of air emissions and relevant physicochemical properties. The new model, CMAQ-PFAS, predicts that 5% by mass of total emitted PFAS and 2.5% of total GenX are deposited within ~150 km of the facility, with the remainder transported out. Modeled air concentrations of total GenX and total PFAS around the facility can reach 24.6 and 8500 ng m(-3) but decrease to ~0.1 and ~10 ng m(-3) at 35 km downwind, respectively. We find that compounds with acid functionality have higher deposition due to enhanced water solubility and pH-driven partitioning to aqueous media. To our knowledge, this is the first modeling study of the fate of a comprehensive, chemically resolved suite of PFAS air emissions from a major manufacturing source.					1				1												B	-	大気輸送、モデル、26PFAS	
199	蓄積性	Hoke, Robert A; Ferrell, Barbra D; Sloman, Terry L; Buck, Robert C; Buxton, L William	Aquatic hazard, bioaccumulation and screenin	2016	Chemosphere. 2016 Apr;149:336-42. doi: 10.1016/j.chemosphere.2016.01.009. Epub 2016 Feb 11.	The fluoropolymer manufacturing industry is moving to alternative polymerization processing aid technologies with more favorable toxicological and environmental profiles as part of a commitment to curtail the use of long-chain perfluoroalkyl acids (PFAAs). To facilitate the environmental product stewardship assessment and premanufacture notification (PMN) process for a candidate replacement chemical, we conducted acute and chronic aquatic toxicity tests to evaluate the toxicity of ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate (C6HF11O3.H3N) or the acid form of the substance to the cladoceran, Daphnia magna, the green alga, Pseudokirchneriella subcapitata, and a number of freshwater fish species including the rainbow trout, Oncorhynchus mykiss, In addition, testing with the common carp, Cyprinus carpio, was conducted to determine the bioconcentration potential of the acid form of the compound. Based on the relevant criteria in current regulatory frameworks, the results of the aquatic toxicity and bioconcentration studies indicate the substance is of low concern for aquatic hazard and bioconcentration in aquatic organisms. Evaluation of environmental monitoring data in conjunction with the predicted no effect concentration (PNEC) based on the available data suggest low risk to aquatic organisms.					1				1												B	-	毒性評価	
200	蓄積性	Pan, Yitao; Zhang, Hongxia; Cui, Qianqian; Sheng, Nan; Yeung, Leo W Y; Guo, Yong; Sun, Yan; Dai, Jiayin	First Report on the Occurrence and Bioaccumu	2017	Environ Sci Technol. 2017 Sep 5;51(17):9553-9560. doi: 10.1021/acs.est.7b02259. Epub 2017 Aug 22.	Here, we report on the occurrence of a novel perfluoroalkyl ether carboxylic acid, ammonium perfluoro-2-[(propoxy)propoxy]-1-propanoate (HFPO-TA), in surface water and common carp (Cyprinus carpio) collected from the Xiaoqing River and in residents residing near a fluoropolymer production plant in Huantai County, China. Compared with the levels upstream of the Xiaoqing River, HFPO-TA concentrations (5200-68500 ng/L) were approximately 120-1600-times higher downstream after receiving fluoropolymer plant effluent from a tributary. The riverine discharge of HFPO-TA was estimated to be 4.6 t/yr, accounting for 22% of total PFAS discharge. In the wild common carp collected downstream from the point source, HFPO-TA was detected in the blood (median: 1510 ng/mL), liver (587 ng/g ww), and muscle (118 ng/g ww). The log BCF(blood) of HFPO-TA (2.18) was significantly higher than that of PFOA (1.93). Detectable levels of HFPO-TA were also found in the sera of residents (median: 2.93 ng/mL). This is the first report on the environmental occurrence and bioaccumulation of this novel chemical. Our results indicate an emerging usage of HFPO-TA in the fluoropolymer manufacturing industry and raise concerns about the toxicity and potential health risks of HFPO-TA to aquatic organisms and humans.					1				1												B	-	地表水と鯉のGenX	
201	蓄積性	Blaine, Andrea C; Rich, Courtney D; Sedlacko, Erin M; Hundal, Lakhwinder S; Kumar, Kuldip; Lau, Christopher; Mills, Marc A; Harris, Kimberly M; Higgins, Christopher P	Perfluoroalkyl acid distribution in various plant	2014	Environ Sci Technol. 2014 Jul 15;48(14):7858-65. doi: 10.1021/es500016s. Epub 2014 Jun 20.	Crop uptake of perfluoroalkyl acids (PFAAs) from biosolids-amended soil has been identified as a potential pathway for PFAA entry into the terrestrial food chain. This study compared the uptake of PFAAs in greenhouse-grown radish (Raphanus sativus), celery (Apium graveolens var. dulce), tomato (Lycopersicon lycopersicum), and sugar snap pea (Pisum sativum var. macrocarpon) from an industrially impacted biosolids-amended soil, a municipal biosolids-amended soil, and a control soil. Individual concentrations of PFAAs, on a dry weight basis, in mature, edible portions of crops grown in soil amended with PFAA industrially impacted biosolids were highest for perfluorooctanoate (PFOA; 67 ng/g) in radish root, perfluorobutanoate (PFBA; 232 ng/g) in celery shoot, and PFBA (150 ng/g) in pea fruit. Comparatively, PFAA concentrations in edible compartments of crops grown in the municipal biosolids-amended soil and in the control soil were less than 25 ng/g. Bioaccumulation factors (BAFs) were calculated for the root, shoot, and fruit compartments (as applicable) of all crops grown in the industrially impacted soil. BAFs were highest for PFBA in the shoots of all crops, as well as in the fruit compartment of pea. Root-soil concentration factors (RCFs) for tomato and pea were independent of PFAA chain length, while radish and celery RCFs showed a slight decrease with increasing chain length. Shoot-soil concentration factors (SCFs) for all crops showed a decrease with increasing chain length (0.11 to 0.36 log decrease per CF2 group). The biggest decrease (0.54-0.58 log decrease per CF2 group) was seen in fruit-soil concentrationfactors (FCFs). Crop anatomy and PFAA properties were utilized to explain data trends. In general, fruit crops were found to accumulate fewer long-chain PFAAs than shoot or root crops presumably due to an increasing number of biological barriers as the contaminant is transported throughout the plant (roots to shoots to fruits). These data were incorporated into a preliminary conceptual framework for PFAA accumulation in edible crops. In addition, these data suggest that edible crops grown in soils conventionally amended for nutrients with biosolids (that are not impacted by PFAA industries) are unlikely a significant source of long-chain PFAA exposure to humans.				1						1	1		1			1		1				B	-	ラディッシュ、セロリ、トマト、スナップエンドウ豆中のPFAS、土壌の影響	
202	蓄積性	Chiesa, Luca Maria; Nobile, Maria; Ceriani, Federica; Malandra, Renato; Arioli, Francesco; Panseri, Sara	Risk characterisation from the presence of env	2019	Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2019 Jan;36(1):152-162. doi: 10.1080/19440049.2018.1563723. Epub 2019 Jan 11.	Salmon consumption is increasing year by year. Salmon aquaculture is the fastest growing food production system in the world, and often uses feed mixed with antibiotics or other drugs. Feed can be also contaminated by environmental contaminants like persistent organic pollutants and organophosphorus pesticides that usually accumulate in fatty tissue, or emerging contaminants such as perfluoroalkyl substances (PFASs), that instead bioaccumulate in protein tissues. Therefore, there is the need to investigate the presence of antibiotics and environmental contaminants, with multi-class and multi-residue liquid chromatography-high resolution mass spectrometry and gas chromatography tandem mass spectrometry methods to monitor a broad spectrum of residues comparing between wild and farmed salmons. The presence of residues was encountered at a concentration range of 0.35-51.52 ng g(-1) for antibiotics only in farmed salmon, 0.19-34.51 ng g(-1) for PFASs and 0.26-9.01 ng g(-1) for (polybrominated diphenyl ethers) PBDEs, and 0.19-5.91 ng g(-1) for organochlorine pesticides with higher frequencies and concentrations in farmed fish. Finally, the risk deriving from salmon intake is low, being of minor concern only for PBDE 99 and perfluorooctanoic acid.				1						1											B	-	サーモン中の濃度、PFAS	
203	環境中運命	Dreyer, Annekatrin; Weinberg, Ingo; Temme, Christian; Ebinghaus, Ralf	Polyfluorinated compounds in the atmosphere	2009	Environ Sci Technol. 2009 Sep 1;43(17):6507-14. doi: 10.1021/es9010465.	High volume air samples taken onboard several research vessels in the Atlantic Ocean, the Southern Ocean, and the Baltic Sea as well as at one land-based site close to Hamburg, Germany, in 2007 and 2008 were analyzed for per- and polyfluorinated organic compounds (PFCs). A set of neutral, volatile PFCs such as fluorotelomer alcohols (FTOH) or perfluoroalkyl sulfonamides and ionic nonvolatile PFCs like perfluorinated carboxylates (PFCA) and sulfonates (PFSA) were collected on PUF/XAD-2/PUF cartridges and glass fiber filters and determined using GC-MS and HPLC-MS/MS. PFCs were detected in all air samples, even in Antarctic regions, and occurred predominantly in the gas phase. Total gas-phase concentrations of ship-based samples ranged from 4.5 pg m(-3) in the Southern Ocean to 335 pg m(-3) in European source regions. Concentrations of 8:2 FTOH, the analyte that was usually observed in highest concentrations, were between 1.8 and 130 pg m(-3). PFC concentrations decreased from continental regions toward marine regions and from Central Europe toward the Arctic and Antarctica. Southern hemispheric concentrations of individual PFCs were significantly lower than those of the northern hemisphere. On the basis of this data set, marine background PFC concentrations and atmospheric residence times were calculated. This study gives further evidence that volatile PFCs undergo atmospheric long-range transportto remote regions and may contribute to their contamination with persistent PFCA and PFSA.					1				1				1								B	-	ドイツ、大気、PFAS	
204	蓄積性	Kelly, Barry C; Ikonomou, Michael G; Blair, Joel D; Surridge, Blair; Hoover, Dale; Grace, Richard; Gobas, Frank A P C	Perfluoroalkyl contaminants in an Arctic marin	2009	Environ Sci Technol. 2009 Jun 1;43(11):4037-43. doi: 10.1021/es9003894.	To better understand the bioaccumulation behavior of perfluoroalkyl contaminants (PFCs), we conducted a comparative analysis of PFCs and lipophilic organohalogens in a Canadian Arctic marine food web. Concentrations of perfluorooctane sulfonic acid (PFOS), perfluorooctansulfoamide (PFOSA), and C7-C14 perfluorocarboxylic acids (PFCAs) ranged between 0.01 and 0.1 ng x g(-1) dry wt in sediments and 0.1 and 40 ng x g(-1) wet wt in biota, which was equivalent to or higher than levels of PCBs, PBDEs, and organochlorine pesticides. In beluga whales, PFOS and PFCA concentrations were higher ($P < 0.05$) in protein-rich compartments (liver and blood), compared to other tissues/fluids (milk, blubber, muscle, and fetus). In the marine mammalian food web, concentrations of PFOSA and lipophilic organochlorines (ng x g(-1) lipid equivalent) and proteinophilic substances (i.e., PFOS and C8-C14 PFCAs, ng x g(-1) protein) increased significantly ($P < 0.05$) with trophic level. Trophic magnification factors (TMFs) of organochlorines ranged between 5 and 14 and exhibited significant curvilinear relationships ($P < 0.05$) with octanol-water and octanol-air partition coefficients (KOW, KOA). TMFs of perfluorinated acids (PFAs) ranged between 2 and 11 and exhibited similar correlation ($P < 0.05$) with protein-water and protein-air partition coefficients (KPW, KPA). PFAs did not biomagnify in the aquatic piscivorous food web (TMF range: 0.3-2). This food web specific biomagnification behavior was attributed to the high aqueous solubility and low volatility of PFAs. Specifically, the anticipated phase-partitioning of these proteinophilic substances, represented bytheir protein-water (KPW) and protein-air (KPA) partition coefficients, likely results in efficient respiratory elimination in water-respiring organisms but very slow elimination and biomagnification in air-breathing animals. Lastly, the results indicate that PFOS exposure in nursing Hudson Bay beluga whale calves (CI95 range = 2.7 x 10(-5) to 1.8 x 10(-4) mg x kg bw(-1) x d(-1)), exceedsthe oral reference dose for PFOS (7.5 x 10(-5) mg x kg bw(-1) x d(-1)), which raises concern for potential biological effects in these and other sensitive Arctic marine wildlife species.				1				1		1								1			B	-	カナダ、食物連鎖、PFOS、PFOSA、PFCA	
205	環境中運命	Krippner, Johanna; Brunn, Hubertus; Falk, Sandy; Georgii, Sebastian; Schubert, Sven; Stahl, Thorsten	Effects of chain length and pH on the uptake a	2014	Chemosphere. 2014 Jan;94:85-90. doi: 10.1016/j.chemosphere.2013.09.018. Epub 2013 Oct 3.	Maize is the most important grain crop grown for human nutrition, animal fodder and biogas production worldwide. Nonetheless, no systematic studies have been undertaken on these plants to examine the uptake mechanisms for perfluoroalkyl substances (PFASs) dependent upon chain length and pH value. The aim of the present study was therefore to determine the influence of chain length (C4 to C10) and pH value (pH 5, pH 6, pH 7) on the uptake and distribution of seven perfluoroalkyl carboxylic acids (PFCAs) and three perfluoroalkane sulfonic acids (PFSAs) by maize in nutrient solution experiments under controlled conditions in a climate chamber. A pH-dependent uptake was observed for perfluorodecanoic acid (PFDA) with an uptake rate of 2.51 μg g(-1) at pH 5 compared to 1.52 μg g(-1) root dry weight (DW) per day (d) at pH 7. Perfluorobutanoic acid (PFBA) had the highest uptake rate within the group of PFCAs with an average of 2.46 μg g(-1) root DWd(-1) and perfluorooctane sulfonic acid (PFOS) had the highest uptake rate (3.63 μg g(-1) root DWd(-1)) within the group of PFSAs. The shoot:root ratio for shorter-chain PFCAs (≤ C7) and PFBS (C4) was >2.0, which indicates that shorter-chain PFASs are transferred predominantly and at higher concentrations to the shoot. In contrast, long-chain PFCAs such as perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) as well as the PFASs perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS) accumulated at higher concentrations in the roots of maize plants with a shoot:root ratio of <1.0.					1				1	1	1		1								B	-	トウモロコシ、吸収への炭素数やpHの影響、10PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
206	環境中運命	Scher, Deanna P; Kelly, James E; Huset, Carin A; Barry, Kitrina M; Yingling, Virginia L	Does soil track-in contribute to house dust cor	2019	J Expo Sci Environ Epidemiol. 2019 Mar;29(2):218-226. doi: 10.1038/s41370-018-0101-6. Epub 2018 Dec 5.	The Minnesota Department of Health measured levels of perfluoroalkyl acids (PFAAs) in house dust at homes in communities impacted by PFAA-contaminated soil and drinking water to determine whether PFAAs in soil outside the home are associated with concentrations in dust. House dust samples from both interior living spaces and entryways to the yard were collected and analyzed separately based on the presumption that PFAAs in entryway dust may better reflect “track-in” of PFAAs into the home from contaminated soil or lawns irrigated with contaminated water. PFAA detections and concentrations in living rooms were significantly higher compared to entryways; and concentrations in both sampling locations were higher than corresponding soil concentrations, suggesting that interior sources were the main contributors to PFAAs in house dust. PFAA dust concentrations in entryways were significantly associated with living room dust levels for all analytes except PFBA. Relationships between entryway dust and soil were only seen for one PFAA (PFOA). However, median concentrations of PFOA in entryway and living room dust were 35 and 70 times higher (respectively) than in soil, which highlights the lack of importance of PFAA soil track-in as a contributor to dust concentration in this setting. Due to the small sample size, larger scale studies are needed to further assess the potential for migration of PFAA contaminated soil to indoor dust.			1								1												B	-	米国ミネソタ、ハウスダスト、PFAS濃度	
207	蓄積性	Tipton, Jessica J; Guillette, Louis J Jr; Lovelace, Susan; Parrott, Benjamin B; Rainwater, Thomas R; Reiner, Jessica L	Analysis of PFAAs in American alligators part 1	2017	J Environ Sci (China). 2017 Nov;61:24-30. doi: 10.1016/j.jes.2017.05.045. Epub 2017 Jun 20.	Environmental contamination resulting from the production or release of harmful chemicals can lead to negative consequences for wildlife and human health. Perfluorinated alkyl acids (PFAAs) were historically produced as protective coatings for many household items and currently persist in the environment, wildlife, and humans. PFAAs have been linked to immune suppression, endocrine disruption, and developmental toxicity in wildlife and laboratory studies. This study examines the American alligator, Alligator mississippiensis, as an important indicator of ecosystem contamination and a potential pathway for PFAA exposure in humans. Alligator meat harvested in the 2015 South Carolina (SC) public hunt season and prepared for human consumption was collected and analyzed for PFAAs to determine meat concentrations and relationships with animal body size (total length), sex, and location of harvest. Of the 15 PFAAs analyzed, perfluorooctane sulfonate (PFOS) was found in all alligator meat samples and at the highest concentrations (median 6.73ng/g). No relationship was found between PFAA concentrations and total length or sex. Concentrations of one or all compounds varied significantly across sampling locations, with alligators harvested in the Middle Coastal hunt unit having the highest PFOS concentrations (median 16.0ng/g; p=0.0001). Alligators harvested specifically from Berkley County, SC (located in the Middle Coastal hunt unit) had the highest PFOS concentrations and the greatest number of PFAAs detected (p<0.0001). The site-specific nature of PFAA concentrations in alligator meat observed in thisstudy suggests a source of PFAA contamination in Berkley County, SC.			1								1												B	-	アメリカワニ、15PFAS濃度	
208	蓄積性	Young, Wendy M; South, Paul; Begley, Timothy H; Noonan, Gregory O	Determination of perfluorochemicals in fish an	2013	J Agric Food Chem. 2013 Nov 20;61(46):11166-72. doi: 10.1021/jf403935g. Epub 2013 Nov 8.	This paper reports the validation and application of a method for determination of 10 perfluorochemicals (PFCs) in retail fish and shellfish. The analytes of interest were 7 perfluorinated carboxylates and 3 perfluorinated sulfonates. Fish and shellfish samples were digested with a basic solution of 10 mM sodium hydroxide in methanol before sonication and solid phase extraction through weak anion exchange. Analysis was performed using liquid chromatography-tandem mass spectrometry. Recoveries from spiking five different types of fish and shellfish indicate that the method performs similarly with different fish types, and recoveries were over 90% for all analytes. Forty-six retail samples, collected between 2010 and 2012, including 13 different types of fish and shellfish were analyzed for PFCs. The 13 different types included the top 10 most-consumed fish and shellfish in the United States according to data collected by the National Fisheries Institute. Two Standard Reference Materials were also analyzed. Most fish and shellfish had no detected PFCs; only 11 samples of the 46 tested had detectable concentrations of PFCs.			1								1												B	-	魚と貝、10PFAS、分析法	
209	蓄積性	Young, Wendy; Wiggins, Stacey; Limm, William; Fisher, Christine M; DeJager, Lowri; Genualdi, Susan	Analysis of Per- and Poly(fluoroalkyl) Substanc	2022	J Agric Food Chem. 2022 Oct 26;70(42):13545-13553. doi: 10.1021/acs.jafc.2c04673. Epub 2022 Oct 17.	Seafood consumption has been identified as one of the major contributors of per- and poly(fluoroalkyl) substances (PFASs) to the human diet. To assess dietary exposure, highly consumed seafood products in the United States were selected for analysis. The analytical method previously used for processed food was extended to include four additional long-chain perfluorocarboxylic acids (PFCAs), which have been reported in seafood samples. This method was single-lab-validated, and method detection limits were reported at 345 ng kg(-1) for perfluorobutanoic acid (PFBA) and 207 ng kg(-1) for perfluoropentanoic acid (PFPeA) and below 100 ng kg(-1) for the rest of the PFAS analytes. The 81 seafood samples (clams, crab, tuna, shrimp, tilapia, cod, salmon, pollock) were analyzed for 20 PFASs using the updated analytical method. Most of the seafood packaging was also analyzed by Fourier transform infrared-attenuated total reflectance (FTIR-ATR) to identify packaging potentially coated with PFASs. None of the packaging samples in this study were identified as having PFASs. A wide range of concentrations was observed among the seafood samples, ranging from below the method detection limit to the highest concentration of 23 μg kg(-1) for the sum of PFASs in one of the canned clam samples. Such a wide range is consistent with those reported in previous studies. The highest concentrations were reported in clams and crabs, followed by cod, tuna, pollock, tilapia, salmon, and shrimp. Technical perfluorooctanoic acid (PFOA) dominated the profile of the clam samples, which has been consistently found in other clam samples, especially in Asia. Long-chainPFCAs, specifically perfluoroundecanoic (PFUdA) and perfluorododecanoic (PFDoA), were the most frequently detected analytes across all seafood samples. The trends observed are comparable with those in the literature where benthic organisms tend to have the highest PFAS concentrations, followed by lean fish, fatty fish, and aquaculture. The results from this study will be used to prioritize future studies and to inform steps to reduce consumer exposure to PFASs.			1								1												B	-	81海産物、20PFAS	
210	環境中運命	Zhu, Hongkai; Kannan, Kurunthachalam	Distribution and partitioning of perfluoroalkyl c	2019	Sci Total Environ. 2019 Jan 10;647:954-961. doi: 10.1016/j.scitotenv.2018.08.051. Epub 2018 Aug 5.	A field study was conducted to elucidate distribution and partitioning of perfluoroalkyl carboxylic acids (PFCAs; C7-12) in a terrestrial ecosystem that was contaminated with industrial sources of release. Surface soil (0-6 cm), plants, and earthworms were collected from a field located within a 1-mile radius of a fluoropolymer industry that had been manufacturing fluorochemicals for over five decades. The mean concentrations of ΣPFCAs were 150, 420, 61, 68, and 430 ng/g dry weight (dw) in surface soil, earthworms, grass roots, grass leaves, and tree leaves, respectively. The measured concentrations were higher than those reported for corresponding matrices in other locations worldwide, suggesting that fluorochemical manufacturing operations have contributed to the contamination of this nearby land. Soil and plant tissues consisted mainly of perfluorooctanoic acid (PFOA; C8) (77.3-97.1% of the total PFCAs), whereas longer-chain PFCAs, such as perfluoroundecanoic acid (PFUnDA; C11: 17.6%) and perfluorododecanoic acid (PFDoDA; C12: 31.9%), accounted for relatively higher proportions in earthworms. Spatial distribution of PFCAs at this site suggested that both atmospheric deposition and groundwater recharge have contributed to the sources of contamination. Both earthworm- and grass-accumulated PFCAs from soil with biota-soil accumulation factors and root concentration factors increased with perfluorocarbon chain length. The translocation factors of PFCAs in grass decreased as the number of carbons in the fluorocarbon moiety increased. This field study is appropriate to improve our understanding of partitioning of PFCAsamong soil, plants, and earthworms.			1								1												B	-	土壌、植物、ミミズ、PFCA	
211	蓄積性	Axelson, S.	Perfluoroalkyl substances in Arctic birds - A co	2014	Swedish University of Agricultural Sciences. Sciences. Bachelor of Science. https://stud.epsilon.slu.se/6902/11/axelson_s_140625.pdf	Perfluoroalkyl substances (PFASs) are ubiquitous in the environment today and they have been detected even in remote areas such as the Arctic. PFASs can be transported by the atmosphere and ocean currents but the transport mechanism is not fully understood. PFASs may be harmful to organisms due to their persistence in the environment, bio-accumulation potential and toxicity. Studies have shown that PFASs can cause adverse effects on the metabolism as well as the endocrine- and reproduction systems in organisms. In this study, PFASs were investigated in glaucous gull (Larus hyperboreus) (n=5) and black guillemot (Cepphus grylle) (n=4) from Svalbard. In glaucous gull, the mean ΣPFAS concentrations were 147 ng g -1 in liver and 15 ng g -1 in muscle. In black guillemot, the mean ΣPFAS concentrations were 36 ng g -1 in liver and 2.5 ng g -1 in muscle. Perfluorooctane sulfonate (PFOS) was the most abundant compound, constituting in average 72 % of the ΣPFASs. The mean PFOS concentration was more than four times higher in glaucous gull than in black guillemot. This can be explained by the glaucous gull’s high trophic level, migration patterns to more industrialized areas, and omnivorous feeding patterns. The concentration levels were higher in liver than in muscle tissue for both species, which complies with other similar studies. This might be due to the fact that PFAS typically accumulate in protein-rich tissues with high blood content, and that the liver has a detoxifying function and takes care of the contaminants in the body. As PFASs are produced in industrial areas far away from Svalbard, the detected concentration levels in the studied species give reason to further investigate the fate and transport of PFASs, as well as their effects on wildlife in the Arctic region.											1												B	-	スバールバル諸島、鳥中のPFAS	
212	環境中運命	Blaine, Andrea C; Rich, Courtney D; Sedlacko, Erin M; Hyland, Katherine C; Stushnoff, Cecil; Dickenson, Eric R V; Higgins, Christopher P	Perfluoroalkyl acid uptake in lettuce (Lactuca s	2014	Environ Sci Technol. 2014 Dec 16;48(24):14361-8. doi: 10.1021/es504150h. Epub 2014 Nov 25.	Using reclaimed water to irrigate food crops presents an exposure pathway for persistent organic contaminants such as perfluoroalkyl acids (PFAAs) to enter the human food chain. This greenhouse study used reclaimed water augmented with varying concentrations (0.2-40 μg/L) of PFAAs, including perfluorocarboxylates (C3F7COO(-) to C8F17COO(-)) and perfluorosulfonates (C4F9SO2O(-), C6F13SO2O(-), C8F17SO2O(-)), to investigate potential uptake and concentration-response trends in lettuce (Lactuca sativa) and strawberry (Fragaria ananassa). In addition, studies were conducted to evaluate the role of soil organic carbon concentrations on plant uptake of PFAAs. PFAA concentrations in lettuce leaves and strawberry fruit were measured for each aqueous PFAA concentration applied. PFAA plant concentrations increased linearly with the aqueous concentration for all PFAAs, with PFCAs bioaccumulating to a greater degree than PFSAs in the edible portions of the tested plants. Chain-length-dependency trends were evident in both lettuce shoot and strawberry fruit, with decreasing concentrations associated with increasing chain length. Perfluorobutanoate (PFBA) and perfluoropentanoate (PFPeA), both short-chain PFAAs (<8 carbon chain length), accumulated the most compared with other PFAAs tested in the edible parts of both lettuce and strawberry. PFAA concentrations in strawberry root and shoot were also measured at selected PFAA aqueous concentrations (0.4, 4, and 40 μg/L). Short-chain perfluorocarboxylates were the dominant fraction in the strawberry fruit and shoot compartments, whereas a more even distribution of all PFAAs appeared in theroot compartment. Lettuce grown in soils with varying organic carbon contents (0.4%, 2%, 6%) was used to assess the impact of organic carbon sorption on PFAA bioaccumulation. The lettuce grown in soil with the 6% organic carbon content had the lowest bioaccumulation of PFAAs. Bioaccumulation factors for lettuce were correlated to carbon chain length of PFAAs, showing approximately a 0.4 to 0.6 log decrease per CF2 group. This study confirms that PFAAs can enter and bioaccumulate in food crops irrigated with reclaimed water. Bioaccumulation potential depends on analyte functional group and chain length, concentration in the reclaimed water, and organic carbon content of the soil.			1			1	1				1												B	-	レタスやイチゴへの吸収、PFAS	
213	環境中運命	Boiteux, Virginie; Dauchy, Xavier; Rosin, Christophe; Munoz, Jean-François	National screening study on 10 perfluorinated	2012	Arch Environ Contam Toxicol. 2012 Jul;63(1):1-12. doi: 10.1007/s00244-012-9754-7. Epub 2012 Mar 9.	The occurrence of seven perfluoroalkyl carboxylates (PFCAs) and three perfluoroalkyl sulfonates (PFASs) was studied in raw- and treated-water samples from public water systems. Two sampling campaigns were performed during the summer of 2009 and in June 2010. Sampling was equally distributed across the 100 French departments. In total, 331 raw-water samples and 110 treated-water samples were analyzed during this study, representing approximately 20% of the national water supply flow. Concentrations of perfluorinated compounds (PFCs) were determined using automated solid-phase extraction and liquid chromatography-tandem mass spectrometry. In raw-water samples, the highest individual PFC concentration was 139 ng/L for perfluorohexanoic acid (PFHxA). The sum of all of the determined components was >100 ng/L at three sampling points (199, 117, and 115 ng/L). Of the investigated PFCs, perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid (PFOA), and PFHxA predominated (detected in 27%, 13%, 11%, and 7% of samples, respectively). Geographical variability was observed, with departments crossed by major rivers or with high population densities being more affected by PFC contamination. Compared with raw water, short-chain PFCAs, but not PFASs, were found in higher abundance in treated water. This difference suggests a relative effectiveness of certain water treatments for the elimination of PFASs but also a possible degradation of PFCA precursors by water-treatment processes. Our investigations did not show any heavily contaminated sites. In treated-water samples, thehighest individual PFC concentration was 125 ng/L for PFHxA. The sum of all of the determined components was >100 ng/L at one sampling point (156 ng/L). The values observed for PFOS and PFOA in drinking water were not greater than the health-based drinking-water concentration protectives for lifetime exposure that have been defined for other countries.			1		1						1												B	-	フランス、原水と水道水、10PFAS	
214	蓄積性	Braune, Birgit M; Letcher, Robert J	Perfluorinated sulfonate and carboxylate comp	2013	Environ Sci Technol. 2013 Jan 2;47(1):616-24. doi: 10.1021/es303733d. Epub 2012 Dec 18.	Perfluorinated sulfonates (PFSAs) and perfluorinated carboxylates (PFCAs), as well as selected precursor compounds, were measured in eggs of thick-billed murres (Uria lomvia) and northern fulmars (Fulmarus glacialis) from Prince Leopold Island in the Canadian Arctic between 1975 and 2011 as well as in eggs of three additional species (black guillemot Cepphus grylle, black-legged kittiwake Rissa tridactyla, glaucous gull Larus hyperboreus) sampled in 2008. ΣPFCA concentrations increased significantly from 1975 to 2011 in the murre and fulmar eggs at an average annual rate of 0.56 and 0.91 ng g(-1) ww, respectively, whereas perfluorooctane sulfonate (PFOS) concentrations did not change significantly. The interspecies comparison of eggs sampled in 2008 found that black guillemots had the highest PFOS and lowest ΣPFCA levels, and northern fulmars had the highest ΣPFCA levels. PFUnA (C(11)) and PFTrA (C(13)) were the predominant PFCAs measured in eggs of all five species except for the black guillemot where PFDA (C(10)) contributed almost equally with PFTrA (C(13)) to the PFCA profile. Based on published toxicity thresholds, levels of neither perfluorooctanoate (PFOA) nor PFOS in seabird eggs from the Canadian Arctic are of toxicological concern. These are the first interspecies comparisons for PFASs in seabirds from the Canadian Arctic.			1								1												B	-	北極、卵と鳥、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
215	蓄積性	Bräunig, Jennifer; Baduel, Christine; Barnes, Craig M; Mueller, Jochen F	Leaching and bioavailability of selected perfluc	2019	Sci Total Environ. 2019 Jan 1;646:471-479. doi: 10.1016/j.scitotenv.2018.07.231. Epub 2018 Jul 26.	Historical usage of aqueous film-forming foam (AFFF) at firefighting training grounds (FTGs) is a potential source of perfluoroalkyl acids (PFAAs) to the surrounding environment. In this study the leaching of PFAAs from field contaminated soil and their uptake into biota was investigated. Soil was sampled from FTGs at two airports and the total as well as the leachable concentration of 12 PFAAs was determined. A greenhouse study was carried out to investigate the uptake of PFAAs from soils into earthworms (Eisenia fetida) and wheat grass (Elymus scaber). Perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonate (PFHxS) were the most dominant PFAAs in all soils samples, with concentrations of PFOS reaching 13,400 ng/g. Leachable concentrations of PFOS and PFHxS reached up to 550 μg/L and 22 μg/L, respectively. In earthworms concentrations of PFOS reached 65,100 ng/g after a 28-day exposure period, while in wheat grass the highest concentration was measured for uptake of PFHxS (2,800 ng/g) after a 10-week growth-period. Bioaccumulation factors (BAFs) for earthworms ranged from 0.1 for perfluorohexanoic acid (PFHxA) to 23 for perfluorododecanoic acid (PFDoA) and initially showed a decreasing trend with increasing perfluoroalkyl chain length, followed by an increase with increasing perfluoroalkyl chain length for perfluoroalkyl carboxylic acids (PFCAs). In wheat grass the highest BAF was found for perfluorobutanoic acid (BAF = 70), while the lowest was observed for perfluorononanoic acid (BAF = 0.06). BAFs in wheat grass decreased with increasing perfluoroalkyl chain length for both PFCAs and perfluoroalkyl sulfonicacids (PFSAs). The results show that PFAAs readily leach from impacted soils and are bioaccumulated into earthworms and plants in an analyte dependent way. This shows considerable potential for PFAAs to move away from the original source either by leaching or uptake into ecological receptors, which may be a potential entry route into the terrestrial foodweb.			1		1						1													B	-			
216	蓄積性	Brendel, Stephan; Fetter, Éva; Staude, Claudia; Vierke, Lena; Biegel-Engler, Annegret	Short-chain perfluoroalkyl acids: environmenta	2018	Environ Sci Eur. 2018;30(1):9. doi: 10.1186/s12302-018-0134-4. Epub 2018 Feb 27.	BACKGROUND: Short-chain PFASs (per- and polyfluoroalkyl substances) are widely used as alternatives to long-chain PFASs. Long-chain PFASs become gradually regulated under REACH (EC No. 1907/2006) and other international regulations, due to having persistent, bioaccumulative and toxic properties and/or being toxic for reproduction. The increasingly used short-chain PFASs are assumed to have a lower bioaccumulation potential. Nonetheless, they have other properties of concern and are already widely distributed in the environment, also in remote regions. The REACH Regulation does not directly address these emerging properties of concern, complicating the implementation of regulatory measures. Therefore, this study illustrates these environmental concerns and provides a strategy for a regulation of short-chain PFASs within REACH. RESULTS: Short-chain PFASs have a high mobility in soil and water, and final degradation products are extremely persistent. This results in a fast distribution to water resources, and consequently, also to a contamination of drinking water resources. Once emitted, short-chain PFASs remain in the environment. A lack of appropriate water treatment technologies results in everlasting background concentrations in the environment, and thus, organisms are permanently and poorly reversibly exposed. Considering such permanent exposure, it is very difficult to estimate long-term adverse effects in organisms. Short-chain PFASs enrich in edible parts of plants and the accumulation in food chains is unknown. Regarding these concerns and uncertainties, especially with respect to the precautionary principle,short-chain PFASs are of equivalent concern to PBT substances. Therefore, they should be identified as substances of very high concern (SVHC) under REACH. The SVHC identification should be followed by a restriction under REACH, which is the most efficient way to minimize the environmental and human exposure of short-chain PFASs in the European Union. CONCLUSION: Due to an increasing use of short-chain PFASs, an effective regulation is urgently needed. The concerns of short-chain PFASs do not match the "classical" concerns as defined under REACH, but are not of minor concern. Therefore, it is of advantage to clearly define the concerns of short-chain PFASs. This might facilitate the following restriction process under REACH.			1		1						1	1												B	-	短鎖PFAS		
217	蓄積性	Chen, Fangfang; Gong, Zhiyuan; Kelly, Barry C	Bioavailability and bioconcentration potential o	2016	Sci Total Environ. 2016 Oct 15;568:33-41. doi: 10.1016/j.scitotenv.2016.05.215. Epub 2016 Jun 8.	Currently, information regarding bioavailability and bioconcentration potential of perfluoroalkyl phosphinic acids (PFPiAs) in aquatic organisms does not exist. The main objective of the present study was to assess uptake and elimination kinetics of PFPiAs in zebrafish (Danio rerio) following aqueous exposure. The results showed that PFPiA exposure can result in very high steady-state bioconentration factors (BCFss), compared to perfluorocarboxylates and perfluorosulfonates.C6/C10 PFPiA exhibited the highest BCFss, ranging between 10(7) and 10(10), orders of magnitude higher than those for long-chain perfluorocarboxylates. Strong positive relationships were observed between BCFss versus the membrane-water distribution coefficient (Dmw) and the protein-water partition coefficient (Kpw) of the studied perfluoroalkyl substances. However, BCFss exhibited a substantial drop for the very hydrophobic PFPiAs (C8/C10 and C6/C12 PFPiAs). The reduced BCFss of these long-chain PFPiAs (perfluoroalkyl chain length=18; Dmw=10(9)) is likely the result of reduced bioavailability due to interaction with solute molecules/organic matter present in the water phase and/or reduced gill membrane permeability. While PFPiAs can be metabolized to perfluoroalkyl phosphonic acids, the metabolic transformation rate seems insufficient to counteract the high degree of uptake across gill membranes. These findings help to better understand exposure pathways and bioaccumulation behavior of these important perfluorinated acids in aquatic systems.					1						1													C	-	ペルフルオロアルキルリン酸		
218	環境中運命	Chu, Shaogang; Letcher, Robert J	In vitro metabolic formation of perfluoroalkyl su	2014	Environ Sci Technol. 2014 Jun 3;48(11):6184-91. doi: 10.1021/es500169x. Epub 2014 May 13.	Currently there is a scientific debate on whether fluorinated polymers (or copolymers) are a source, as a result of their degradation and subsequent formation, of perfluorinated carboxylic acids (PFCAs) and perfluorinated alkanesulfonates (PFSAs). The present study investigated whether commercially available fluorinated surfactants, such as Scotchgard fabric protector (3M Company), can be metabolically degraded, using a model microsomal in vitro assay (Wistar-Han rats liver microsomes), and with concomitant formation of PFCAs, PFASs, and/or their precursors. The results showed that the main in vitro metabolite from the pre-2002 product was perfluorooctane sulfonamide (FOSA), and coincident with the detection of the major fabric protector components, which contains the N-ethyl-perfluorooctanesulfonyl chemical moiety (C8F17SO2N(C2H5)-); the main in vitro metabolite of the post-2002 product was perfluorobutane sulfonamide (FBSA), which was coincident with the detection of the major fabric protector components, and contains the N-methyl-perfluorobutanesulfonyl chemical moiety (C4F9SO2N(CH3)-). FOSA or FBSA metabolite concentrations increased over the 0-60 min microsomal incubation period. However, concentrations of their small molecule precursors such as alkylated FOSAs or FBSAs were not detectable (<LODs) in these fabric protector original standard solutions. Thus, the FOSA or FBSA metabolites were derived from the copolymer product itself rather than nonreacted reagents in the Scotchgard products. This result is consistent with reports of high concentrations of PFASs detected in the plasma of persons in householdswhere Scotchgard products are heavily used.					1						1													C	-	ペルフルオロアルキルリン酸スルホンアミド		
219	環境中運命	Codling, Garry; Halsall, Crispin; Ahrens, Lutz; Del Vento, Sabino; Wiberg, Karin; Bergknut, Magnus; Laudon, Hjalmar; Ebinghaus, Ralf	The fate of per- and polyfluoroalkyl substances	2014	Environ Pollut. 2014 Aug;191:190-8. doi: 10.1016/j.envpol.2014.04.032. Epub 2014 May 21.	Per- and polyfluoroalkyl substances (PFAS) were measured systematically in a snowpack in northern Sweden to determine chemical behaviour during seasonal melt. Average PFAS concentrations were generally low, but displayed a wide range with median (range) concentrations of PFOA and PFOS of 66.5 pg L(-1) (ND-122) and 20.5 pg L(-1) (2.60-253) respectively. Average concentrations of the shorter chain, C4 and C5 perfluoroalkyl carboxylates (PFCAs) and perfluoroalkyl sulfonates (PFSAs), were ~10-fold higher. Differences in the PFAS concentrations and profile were observed between surface snow and deeper layers, with evidence of PFAS migration to deeper snow layers as melt progressed. Chemical loads (ng m(-2)) for C4-9 PFCAs decreased gradually as melt progressed, but increased for C4, C6-8 PFSAs and the longer chain C10-12 PFCAs. This enrichment in the diminishing snowpack is an unusual phenomenon that will affect PFAS elution with meltwater and subsequent entry to catchment surface waters.					1						1													B	-			
220	蓄積性	Dassuncao, Clifton; Hu, Xindi C; Zhang, Xianming; Bossi, Rossana; Dam, Maria; Mikkelsen, Bjarni; Sunderland, Elsie M	Temporal Shifts in Poly- and Perfluoroalkyl Sul	2017	Environ Sci Technol. 2017 Apr 18;51(8):4512-4521. doi: 10.1021/acs.est.7b00293. Epub 2017 Mar 28.	Poly- and perfluoroalkyl substances (PFASs) are persistent, bioaccumulative anthropogenic compounds associated with adverse health impacts on humans and wildlife. PFAS production changed in North America and Europe around the year 2000, but impacts on wildlife appear to vary across species and location. Unlike other mammal species, cetaceans lack the enzyme for transforming an important intermediate precursor (perfluorooctane sulfonamide: FOSA), into a prevalent compound in most wildlife (perfluorooctanesulfonate: PFOS). Thus, their tissue burden differentiates these two compounds while other mammals contain PFOS from both direct exposure and precursor degradation. Here we report temporal trends in 15 PFASs measured in muscle from juvenile male North Atlantic pilot whales (Globicephala melas) harvested between 1986 and 2013. FOSA accounted for a peak of 84% of the 15 PFASs around 2000 but declined to 34% in recent years. PFOS and long-chained PFCAs (C9-C13) increased significantly over the whole period (2.8% yr(-1) to 8.3% yr(-1)), but FOSA declined by 13% yr(-1) after 2006. Results from FOSA partitioning and bioaccumulation modeling forced by changes in atmospheric inputs reasonably capture magnitudes and temporal patterns in FOSA concentrations measured in pilot whales. Rapid changes in atmospheric FOSA in polar and subpolar regions around 2000 helps to explain large declines in PFOS exposure for species that metabolize FOSA, including seafood consuming human populations. This work reinforces the importance of accounting for biological exposures to PFAS precursors.					1						1													B	-			
221	蓄積性	Delinsky, Amy D; Strynar, Mark J; McCann, Patricia J; Varns, Jerry L; McMillan, Larry; Nakayama, Shoji F; Lindstrom, Andrew B	Geographical distribution of perfluorinated con	2010	Environ Sci Technol. 2010 Apr 1;44(7):2549-54. doi: 10.1021/es903777s.	In response to growing interest in human exposure to perfluorinated compounds (PFCs), the state of Minnesota measured and reported PFC concentrations in fish collected from the Minneapolis-St. Paul area. To better determine the geographical distribution of PFC contamination throughout Minnesota, fish were collected from 59 lakes throughout the state and several areas along the Mississippi River. Composite fish samples were analyzed for 10 PFC analytes by solid-phase extraction (SPE) and liquid chromatography-tandem mass spectrometry (LC/MS/MS). PFOS (perfluorooctanesulfonate) was the most commonly detected PFC, occurring in 73% of fish from the Mississippi River but only 22% of fish from lakes. Fish from Mississippi River Pool 2 near the Minneapolis-St. Paul area had the highest levels of PFOS, whereas locations upstream had PFOS concentrations below 40 ng/g, the concentration at which Minnesota issues "one meal per week" fish consumption advice. Fish from most Minnesota lakes tested (88%) had PFOS concentrations below 3 ng/g. Two lakes, McCarrons and Zumbro, contained fish with PFOS levels above 40 ng/g. The results reported here will help researchers to better understand the extent of PFC contamination in Minnesota fish and evaluate potential sources of contamination and will provide a basis for comprehensive fish consumption advice.					1						1					1								B	-			
222	蓄積性	Falk, Sandy; Failing, Klaus; Georgii, Sebastian; Brunn, Hubertus; Stahl, Thorsten	Tissue specific uptake and elimination of perfl	2015	Chemosphere. 2015 Jun;129:150-6. doi: 10.1016/j.chemosphere.2014.06.061. Epub 2014 Jul 11.	Tissue specific uptake and elimination of perfluoroalkyl acids (PFAAs) were studied in rainbow trout (Oncorhynchus mykiss). Adult trout were exposed to perfluorobutane sulfonic acid (PFBS), perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) via food over a time period of 28d. In the following 28-d depuration period the fish were fed PFAA-free food. At defined sampling times four animals were removed from the experimental tank, euthanized and dissected. Muscle, liver, kidneys, gills, blood, skin and carcass were examined individually. At the end of the accumulation phase between 0.63% (PFOA) and 15.5% (PFOS) of the absolute, applied quantity of PFAAs was recovered in the whole fish. The main target organ was the liver with recovery rates between 0.11% (PFBS) and 4.01% (PFOS) of the total amount of ingested PFAAs. Perfluoroalkyl sulfonic acids were taken up more readily and had longer estimated elimination half-lives than perfluoroalkyl carboxylic acids of the same chain length. The longest estimated elimination half-lives were found to be for PFOS between 8.4d in muscle tissue and 20.4d in the liver and for PFNA between 8.2d in the blood and 11.6d in the liver.					1						1													B	-			
223	蓄積性	Fang, S.; Chen, X.; Zhao, S.; Zhang, Y.; Jiang, W.; Yang, L.; Zhu, L.	Trophic magnification and isomer fractionation	2014	Environ Sci Technol. 2014 Feb 18;48(4):2173-82. doi: 10.1021/es405018b. Epub 2014 Feb 6.	Biomagnification of perfluoroalkyl substances (PFASs) are well studied in marine food webs, but related information in fresh water ecosystem and knowledge on fractionation of their isomers along the food web are limited. The distribution, bioaccumulation, magnification, and isomer fractionation of PFASs were investigated in a food web of Taihu Lake, China. Perfluorooctanesulfonate (PFOS) and perfluorocarboxylates (PFCAs) with longer carbon chain lengths, such as perfluorodecanoate (PFDA) and perfluoroundecanoate (PFUnA), were predominant in organisms, while perfluorohexanoate (PFHxA) and perfluorooctanoate (ΣPFOA) contributed more in the water phase. The consistent profile signature of PFOA isomers in water phase with 3M electrochemical fluorination (ECF) products suggests that ECF production of PFOA still exists in China. Linear proportions of PFOA, PFOS and perfluorooctane sulfonamide (PFOSA) in the biota were in the range of 91.9-100%, 78.6-95.5%, and 72.2-95.5%, respectively, indicating preferential bioaccumulation of linear isomers in biota. Trophic magnification factors (TMFs) were estimated for PFDA (2.43), perfluorododecanoate (PFDoA) -2.68 and PFOS -3.46 when all biota were included, suggesting that PFOS and long-chained PFCAs are biomagnified in the fresh water food web. The TMF of PFOS isomers descended in the order: n-PFOS - 3.86 > 3+5m-PFOS -3.35 > 4m-PFOS -3.32 > 1m-PFOS -2.92 > m2-PFOS -2.67 > iso-PFOS (2.59),which is roughly identical to their elution order on a FluoroSep-RP Octyl column, suggesting that hydrophobicity may be an important contributor for isomer discrimination in biota.		1		1						1	1												B	-			

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
224	環境中運命	García-Valcárcel, A I; Molero, E; Escorial, M C; Chueca, M C; Tadeo, J L	Uptake of perfluorinated compounds by plants	2014	Sci Total Environ. 2014 Feb 15;472:20-6. doi: 10.1016/j.scitotenv.2013.10.054. Epub 2013 Nov 28.	The uptake rates of three perfluorinated carboxylates and three perfluorinated sufonates by a grass (B diandrus) grown in nutrient solution at two different perfluorinated compounds (PFCs) concentrations were assessed. Grass can be ingested by grazing animals causing the PFCs to enter the food chain, which is a pathway of human exposure to these compounds. A rapid and miniaturized method was developed to determine PFCs in plants, based on a matrix solid-phase dispersion (MSPD) extraction procedure followed by quantitation by HPLC-MS/MS with an MQL in the range from 1 to 9 ng/g. An increase of PFCs levels in plant was observed along the exposure time. Differences in uptake for studied perfluorinated carboxylates were found, showing a decrease with carbon chain length (from 3027 to 1,167 ng/g at the end of assay), whereas no significant differences in absorption were obtained between perfluorinated sulfonates (about 1,700 ng/g). Initially, higher PFC transfer factors (ratio between concentration in plant and concentration in initial nutrient solution) were obtained for plants growing in the nutrient solution at the highest PFC concentration, but these factors became similar with time to plants exposed to the lowest concentration.				1						1							1				B	-		
225	蓄積性	Gebbink, Wouter A; Bossi, Rossana; Rigét, Frank F; Rosing-Asvid, Aqqalu; Sonne, Christian; Dietz, Rune	Observation of emerging per- and polyfluoroalk	2016	Chemosphere. 2016 Feb;144:2384-91. doi: 10.1016/j.chemosphere.2015.10.116. Epub 2015 Nov 22.	The present pilot study examined emerging per- and polyfluoroalkyl substances (PFASs), i.e., a suite of short chain perfluoroalkyl acids (PFAAs), PFAA precursors and replacement chemicals, and legacy PFASs (long chain length PFAAs) in livers from ringed seals, polar bears and, for the first time, killer whales from East Greenland collected in 2012-2013. Among the emerging PFASs, perfluorobutanesulfonic acid (PFBS) and F-53B (a chlorinated polyfluorinated ether sulfonic acid) were detected in Arctic wildlife, albeit at concentrations approximately four orders of magnitude lower compared to perfluorooctanesulfonic acid (PFOS). PFOS was positively correlated with F-53B, but not PFBS in all three species. A total of 17 PFASs were detected in killer whales, including in a mother-fetus pair, demonstrating maternal transfer. ΣPFAS concentrations in killer whales (269 ± 90 ng/g) were comparable to concentrations found in ringed seals (138 ± 7 ng/g), however, an order of magnitude lower compared to concentrations found in polar bear livers (2336 ± 263 ng/g). Patterns of long chain PFAAs in killer whales differed from the pattern in ringed seals and polar bears. Of the monitored PFAA precursors, only perfluorooctanesulfonamide (FOSA) was detected in all three species, and FOSA/PFOS ratios and isomer patterns indicated that killer whales have a potential lower metabolic capacity to degrade FOSA compared to polar bears and ringed seals.				1						1											B	-		
226	蓄積性	Gebbink, Wouter A; Bignert, Anders; Berger, Urs	Perfluoroalkyl Acids (PFAAs) and Selected Pre	2016	Environ Sci Technol. 2016 Jun 21;50(12):6354-62. doi: 10.1021/acs.est.6b01197. Epub 2016 Jun 1.	The present study examined the presence of perfluoroalkyl acids (PFAAs) and selected precursors in the Baltic Sea abiotic environment and guillemot food web, and investigated the relative importance of precursors in food web accumulation of PFAAs. Sediment, water, zooplankton, herring, sprat, and guillemot eggs were analyzed for perfluoroalkane sulfonic acids (PFSAs; C4,6,8,10) and perfluoroalkyl carboxylic acids (PFCAs; C6-15) along with six perfluoro-octane sulfonic acid (PFOS) precursors and 11 polyfluoroalkyl phosphoric acid diesters (diPAPs). FOSA, FOSAA and its methyl and ethyl derivatives (Me- and EtFOSAA), and 6:2/6:2 diPAP were detected in sediment and water. While FOSA and the three FOSAAs were detected in all biota, a total of nine diPAPs were only detected in zooplankton. Concentrations of PFOS precursors and diPAPs exceeded PFOS and PFCA concentrations, respectively, in zooplankton, but not in fish and guillemot eggs. Although PFOS precursors were present at all trophic levels, they appear to play a minor role in food web accumulation of PFOS based on PFOS precursor/PFOS ratios and PFOS and FOSA isomer patterns. The PFCA pattern in fish could not be explained by the intake pattern based on PFCAs and analyzed precursors, that is, diPAPs. Exposure to additional precursors might therefore be a dominant exposure pathway compared to direct PFCA exposure for fish.				1						1	1						1				B	-		
227	蓄積性	Goeritz, Ina; Falk, Sandy; Stahl, Thorsten; Schäfers, Christoph; Schlechtriem, Christian	Biomagnification and tissue distribution of perf	2013	Environ Toxicol Chem. 2013 Sep;32(9):2078-88. doi: 10.1002/etc.2279. Epub 2013 Jul 12.	The present study investigated the biomagnification potential as well as the substance and tissue-specific distribution of perfluoroalkyl substances (PFASs) in market-size rainbow trout (Oncorhynchus mykiss). Rainbow trout with an average body weight of 314 ± 21 g were exposed to perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) in the diet for 28 d. The accumulation phase was followed by a 28-d depuration phase, in which the test animals were fed with nonspiked trout feed. On days 0, 7, 14, 28, 31, 35, 42, and 56 of the present study, fish were sampled from the test basin for PFAS analysis. Biomagnification factors (BMFs) for all test compounds were determined based on a kinetic approach. Distribution factors were calculated for each test compound to illustrate the disposition of PFASs in rainbow trout after 28 d of exposure. Dietary exposure of market-size rainbow trout to PFASs did not result in biomagnification; BMF values were calculated as 0.42 for PFOS, >0.23 for PFNA, >0.18 for PFHxS, >0.04 for PFOA, and >0.02 for PFBS, which are below the biomagnification threshold of 1. Liver, blood, kidney, and skin were identified as the main target tissues for PFASs in market-size rainbow trout. Evidence was shown that despite relative low PFAS contamination, the edible parts of the fish (the fillet and skin) can significantly contribute to the whole-body burden.		1	1	1						1							1				B	-		
228	環境中運命	Guelfo, Jennifer L; Higgins, Christopher P	Subsurface transport potential of perfluoroalky	2013	Environ Sci Technol. 2013 May 7;47(9):4164-71. doi: 10.1021/es3048043. Epub 2013 Apr 25.	Subsurface transport potential of a suite of perfluoroalkyl acids (PFAAs) was studied in batch sorption experiments with various soils and in the presence of co-contaminants relevant to aqueous film-forming foam (AFFF)-impacted sites. Specifically, PFAA sorption to multiple soils in the presence of nonaqueous phase liquid (NAPL) and nonfluorinated AFFF surfactants was examined. This study is the first to report on sorption of perfluorobutanoate (PFBA) and perfluoropentanoate (PFPeA) (log Koc = 1.88 and 1.37, respectively) and found that sorption of these compounds does not follow the chain-length dependent trend observed for longer chain-length PFAAs. Sorption of PFBA was similar to that of perfluorooctanoate (PFOA, log Koc = 1.89). NAPL and nonfluorinated AFFF surfactants all had varying impacts on sorption of longer chain (>6 CF2 groups) PFAAs. The primary impact of NAPL was observed in low foc soil (soil A) where Freundlich n-values increased when NAPL was present. Impacts of nonfluorinated AFFF surfactants varied with surfactant and soil. The anionic surfactant sodium decyl sulfate (SDS) illicited PFAA chain-length dependent impacts in two negatively charged soils with varying foc. In soil A, Kd values for perfluoroheptanoate (PFHpA) increased 91% with SDS, whereas values for perfluorodecanoate (PFDA) increased only 28%. An amphoteric surfactant, n,n-dimethyldodecylamine n-oxide (AO), had the most notable impact on PFAA sorption to a positively charged soil (soil C). In this soil, AO oxide significantly increased sorption for the longer chain PFAAs (i.e., 528% increase in Kd for PFDA). Changes in sorption caused by SDS and AO may be due to mixedhemimicelle formation, competitive sorption, or changes to PFAA solubility. Short-chain PFAA behavior in the presence of NAPL, SDS, and AO was again notable. Co-contaminants generally increased the sorption of these compounds to all soils. Log Kd values of PFBA in soil A increased 85%, 372%, and 32% in the presence of NAPL, SDS, and AO, respectively. Use of Kd values to calculate retardation factors (Rf) of PFAAs demonstrates the variability of co-contaminant impacts on PFAA transport. Whereas NAPL and nonfluorinated surfactants decreased the sorption of perfluorooctanesulfonate (PFOS) at lower PFOS concentrations (1 μg/L), they led to increases in sorption at higher PFOS concentrations (500 μg/L). These results demonstrate that PFAA groundwater transport will depend on the solid phase characteristics as well as PFAA concentration and chain length. Detailed site-specific information will likely be needed to accurately predict PFAA transport at AFFF-impacted sites.				1						1	1										B	-		
229	環境中運命	Higgins, Christopher P; Luthy, Richard G	Sorption of perfluorinated surfactants on sedin	2006	Environ Sci Technol. 2006 Dec 1;40(23):7251-6. doi: 10.1021/es061000n.	The sorption of anionic perfluorochemical (PFC) surfactants of varying chain lengths to sediments was investigated using natural sediments of varying iron oxide and organic carbon content. Three classes of PFC surfactants were evaluated for sorptive potential: perfluorocarboxylates, perfluorosulfonates, and perfluorooctyl sulfonamide acetic acids. PFC surfactant sorption was influenced by both sediment-specific and solution-specific parameters. Sediment organic carbon, rather than sediment iron oxide content, was the dominant sediment-parameter affecting sorption, indicating the importance of hydrophobic interactions. However, sorption also increased with increasing solution [Ca2+] and decreasing pH, suggesting that electrostatic interactions play a role. Perfluorocarbon chain length was the dominant structural feature influencing sorption, with each CF2 moiety contributing 0.50-0.60 log units to the measured distribution coefficients. The sulfonate moiety contributed an additional 0.23 log units to the measured distribution coefficient, when compared to carboxylate analogs. In addition, the perfluorooctyl sulfonamide acetic acids demonstrated substantially stronger sorption than perfluorooctane sulfonate (PFOS). These data should prove useful for modeling the environmental fate of this class of contaminants.				1						1	1				1		1				B	-		
230	環境中運命	Hurtado, Carlos; Domínguez, Carmen; Pérez-Babace, Lorea; Cañameras, Núria; Comas, Jordi; Bayona, Josep M	Estimate of uptake and translocation of emerg	2016	J Hazard Mater. 2016 Mar 15;305:139-148. doi: 10.1016/j.jhazmat.2015.11.039. Epub 2015 Nov 30.	The widespread distribution of emerging organic contaminants (EOCs) in the water cycle can lead to their incorporation in irrigated crops, posing a potential risk for human consumption. To gain further insight into the processes controlling the uptake of organic microcontaminants, Batavia lettuce (Lactuca sativa) grown under controlled conditions was watered with EOCs (e.g., non-steroidal anti-inflammatories, sulfonamides, β-blockers, phenolic estrogens, anticonvulsants, stimulants, polycyclic musks, biocides) at different concentrations (0-40 μgL(-1)). Linear correlations were obtained between the EOC concentrations in the roots and leaves and the watering concentrations for most of the contaminants investigated. However, large differences were found in the root concentration factors ([Formula: see text] =0.27-733) and leaf translocation concentration factors ([Formula: see text] =0-3) depending on the persistence of the target contaminants in the rhizosphere and the specific physicochemical properties of each one. With the obtained dataset, a simple predictive model based on a linear regression and the root bioconcentration and translocation factors can be used to estimate the concentration of the target EOCs in leaves based on the dose supplied in the irrigation water or the soil concentration. Finally, enantiomeric fractionation of racemic ibuprofen from the initial spiking mixture suggests that biodegradation mainly occurs in the rhizosphere.				1						1		1									B	-		
231	環境中運命	Johansson, J H; Salter, M E; Acosta Navarro, J C; Leck, C; Nilsson, E D; Cousins, I T	Global transport of perfluoroalkyl acids via sea	2019	Environ Sci Process Impacts. 2019 Apr 17;21(4):635-649. doi: 10.1039/c8em00525g.	Perfluoroalkyl acids (PFAAs) are persistent organic pollutants found throughout the world's oceans. Previous research suggests that long-range atmospheric transport of these substances may be substantial. However, it remains unclear what the main sources of PFAAs to the atmosphere are. We have used a laboratory sea spray chamber to study water-to-air transfer of 11 PFAAs via sea spray aerosol (SSA). We observed significant enrichment of all PFAAs relative to sodium in the SSA generated. The highest enrichment was observed in aerosols with aerodynamic diameter < 1.6 μm, which had aerosol PFAA concentrations up to ~62 000 times higher than the PFAA water concentrations in the chamber. In surface microlayer samples collected from the sea spray chamber, the enrichment of the substances investigated was orders of magnitude smaller than the enrichment observed in the aerosols. In experiments with mixtures of structural isomers, a lower contribution of branched PFAA isomers was observed in the surface microlayer compared to the bulk water. However, no clear trend was observed in the comparison of structural isomers in SSA and bulk water. Using the measured enrichment factors of perfluorooctanoic acid and perfluorooctane sulfonic acid versus sodium we have estimated global annual emissions of these substances to the atmosphere via SSA as well as their global annual deposition to land areas. Our experiments suggest that SSA may currently be an important source of these substances to the atmosphere and, over certain areas, to terrestrial environments.				1						1											B	-		
232	蓄積性	Keller, Jennifer M; Ngai, Lily; Braun McNeill, Joanne; Wood, Lawrence D; Stewart, Kelly R; O'Connell, Steven G; Kucklick, John R	Perfluoroalkyl contaminants in plasma of five s	2012	Environ Toxicol Chem. 2012 Jun;31(6):1223-30. doi: 10.1002/etc.1818. Epub 2012 Apr 27.	The authors compared blood plasma concentrations of 13 perfluoroalkyl contaminants (PFCs) in five sea turtle species with differing trophic levels. Wild sea turtles were blood sampled from the southeastern region of the United States, and plasma was analyzed using liquid chromatography tandem mass spectrometry. Mean concentrations of perfluorooctane sulfonate (PFOS), the predominant PFC, increased with trophic level from herbivorous greens (2.41 ng/g), jellyfish-eating leatherbacks (3.95 ng/g), omnivorous loggerheads (6.47 ng/g), to crab-eating Kemp's ridleys (15.7 ng/g). However, spongivorous hawksbills had surprisingly high concentrations of PFOS (11.9 ng/g) and other PFCs based on their trophic level. These baseline concentrations of biomagnifying PFCs demonstrate interesting species and geographical differences. The measured PFOS concentrations were compared with concentrations known to cause toxic effects in laboratory animals, and estimated margins of safety (EMOS) were calculated. Small EMOS (<100), suggestive of potential risk of adverse health effects, were observed for all five sea turtle species for immunosuppression. Estimated margins of safety less than 100 were also observed for liver, thyroid, and neurobehavorial effects for the more highly exposed species. These baseline concentrations and the preliminary EMOS exercise provide a better understanding of the potential health risks of PFCs for conservation managers to protect these threatened and endangered species.				1						1											B	-		
233	環境中運命	Krippner, Johanna; Falk, Sandy; Brunn, Hubertus; Georgii, Sebastian; Schubert, Sven; Stahl, Thorsten	Accumulation potentials of perfluoroalkyl carbo	2015	J Agric Food Chem. 2015 Apr 15;63(14):3646-53. doi: 10.1021/acs.jafc.5b00012. Epub 2015 Apr 7.	Uptake of perfluoroalkyl acids (PFAAs) by maize represents a potential source of exposure for humans, either directly or indirectly via feed for animals raised for human consumption. The aim of the following study was, therefore, to determine the accumulation potential of perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs) in maize (Zea mays). Two different concentrations of PFAAs were applied as aqueous solution to the soil to attain target concentrations of 0.25 mg or 1.00 mg of PFAA per kg of soil. Maize was grown in pots, and after harvesting, PFAA concentrations were measured in the straw and kernels of maize. PFCA and PFSA concentrations of straw decreased significantly with increasing chain length. In maize kernels, only PFCAs with a chain length ≤ C8 as well as perfluorobutanesulfonic acid (PFBS) were detected. The highest soil-to-plant transfer for both straw and kernels was determined for short-chained PFCAs and PFSAs.				1						1	1				1						B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
234	環境中運命	Kwadijk, C J A F; Korytár, P; Koelmans, A A	Distribution of perfluorinated compounds in aq	2010	Environ Sci Technol. 2010 May 15;44(10):3746-51. doi: 10.1021/es100485e.	The distribution of 15 perfluorinated compounds (PFCs) among eel (Anguilla anguilla), sediment, and water was investigated for 21 locations in The Netherlands. Furthermore, for perfluorooctanesulfonate (PFOS), a 30 year time series was measured for three locations using historical eel samples. These historical samples revealed concentrations increasing by a factor of 2-4 until the mid-1990s, followed by a return to the initial levels. In the samples described here, PFOS dominated aqueous concentrations, ranging from 4.7 to 32 ng/L in water, from 0.5 to 8.7 ng/g in sediment, and from 7 to 58 ng/g in eel filet. Field-based sediment water distribution coefficients (K(D)) were calculated and corrected for organic carbon content (K(OC)), which reduced variability among samples. Log K(OC) ranges were 2.6-3.7 for the C7-C9 carboxylic acids and 2.2-3.2 for the C4-C8 sulfonates. Bioaccumulation factors (log BAFs) for eel ranged from 1.09-3.26 for the C7-C9 carboxylic acids to 1.4-3.3 for the C4-C8 sulfonates. Perfluoroalkyl chain length correlated well with both sorption and bioaccumulation factors. Magnitudes and trends in K(D) or BAF appeared to agree well with previously published laboratory data. Results imply that PFCs are mainly present in water, which is important for PFC fate modeling and risk assessment.				1						1												B	-			
235	環境中運命	Lai, Senchao; Song, Junwei; Song, Tianli; Huang, Zhijiong; Zhang, Yingyi; Zhao, Yan; Liu, Guicheng; Zheng, Junyu; Mi, Wenying; Tang, Jianhui; Zou, Shichun; Ebinghaus, Ralf; Xie, Zhiyong	Neutral polyfluoroalkyl substances in the atmo	2016	Environ Pollut. 2016 Jul;214:449-455. doi: 10.1016/j.envpol.2016.04.047. Epub 2016 Apr 23.	Neutral Polyfluoroalkyl substances (PFASs) in the atmosphere were measured during a cruise campaign over the northern South China Sea (SCS) from September to October 2013. Four groups of PFASs, i.e., fluorotelomer alcohols (FTOHs), fluorotelomer acrylates (FTAs), fluorooctane sulfonamides (FOSAs) and fluorooctane sulfonamidoethanols (FASEs), were detected in gas samples. FTOHs was the predominant PFAS group, accounting for 95.2-99.3% of total PFASs (ΣPFASs), while the other PFASs accounted for a small fraction of ΣPFASs. The concentrations of ΣPFASs ranged from 18.0 to 109.9 pg m(-3) with an average of 54.5 pg m(-3). The concentrations are comparable to those reported in other marine atmosphere. Higher concentrations of ΣPFASs were observed in the continental-influenced samples than those in other samples, pointing to the substantial contribution of anthropogenic sources. Long-range transport is suggested to be a major pathway for introducing gaseous PFASs into the atmosphere over the northern SCS. In order to further understand the fate of gaseous PFASs during transport, the atmospheric decay of neutral PFASs under the influence of reaction with OH radicals and atmospheric physical processes were estimated. Concentrations of 8:2 FTOH, 6:2 FTOH and MeFBSE from selected source region to the atmosphere over the SCS after long-range transport were predicted and compared with the observed concentrations. It suggests that the reaction with OH radicals may play an important role in the atmospheric decay of PFAS during long-range transport, especially for shorted-lived species. Moreover, theinfluence of atmospheric physical processes on the decay of PFAS should be further considered.				1						1												C	-		中性のPFAS	
236	蓄積性	Lam, James C W; Lyu, Jinling; Kwok, Karen Y; Lam, Paul K S	Perfluoroalkyl Substances (PFASs) in Marine M	2016	Environ Sci Technol. 2016 Jul 5;50(13):6728-36. doi: 10.1021/acs.est.5b06076. Epub 2016 Feb 29.	Perfluorinated sulfonic acids (PFSAs) and perfluorinated carboxylic acids (PFCAs), as well as the replacement for the phase-out C8 PFSAs were determined in the liver samples of Indo-Pacific humpback dolphins (Sousa chinensis) and finless porpoises (Neophocaena phocaenoides) from the South China Sea between 2002 and 2014. Levels of total perfluoroalkyl substances (PFASs) in samples ranged from 136-15,300 and 30.5-2,720 ng/g dw for dolphin and porpoise, respectively. Significant increasing trends of several individual PFCAs and perfluorobutane sulfonate (PFBS) were found in cetacean samples from 2002 to 2014, whereas no significant temporal trends of ΣPFASs appeared over the sampling period. This pattern may be attributed to the increasing usage of PFCAs and C4-based PFSAs following the restriction/voluntary withdrawal of the production and use of perfluorooctane sulfonate (PFOS) related products. In addition, significantly increasing temporal shifting trends of PFOS to PFBS were observed in the dolphin liver samples. This pattern may be attributed to the substitution of PFOS by its alternative, PFBS. The highest levels of PFOS were observed in the liver samples of dolphin as compared with other marine mammal studies published since 2006, indicating high contamination of PFAS in the South China region. An assessment of relatively high concentrations of C8-based PFASs in the liver samples of cetaceans predicted that concentrations of PFOS would be expected to affect some proportion of the cetacean populations studied, based on the toxicity thresholds derived.				1						1	1	1									B	-			
237	蓄積性	Lam, Nguyen Hoang; Cho, Chon-Rae; Kannan, Kurunthachalam; Cho, Hyeon-Seo	A nationwide survey of perfluorinated alkyl sub	2017	J Hazard Mater. 2017 Feb 5;323(Pt A):116-127. doi: 10.1016/j.jhazmat.2016.04.010. Epub 2016 Apr 7.	Water, sediment, various tissues of fish, crustacean, gastropod and bivalve were collected from major river basins in Vietnam and analyzed for the presence of perfluorinated alkyl substances (PFASs). Furthermore, the occurrence of PFASs in coastal, tap and well waters collected from eight different regions in Vietnam was investigated. PFOA and PFOS were consistently detected as the dominant PFASs in surface waters. The greatest concentrations of PFOA (53.5ngL(-1)) and PFOS (40.2ngL(-1)) were found in a surface water sample collected from a channel that receives wastewater treatment plant discharges. PFOS and PFHxS were found as the predominant PFASs in sediments. The greatest PFAS concentration in biota was 16.9ng PFUnDA g(-1) wet weight found in a fish liver. Some long-chain PFCAs including PFNA, PFUnDA and PFTrDA as well as PFHxS were more abundant than short-chain PFASs in biota tissues. The measured concentrations of PFOS and PFOA in surface and tap waters were below the provisional health advisory. The rank order of mean bioconcentration factor of PFOS in biota was; crustacean (115L/kg), gastropod (1117L/kg), fish (1120L/kg) and bivalve (2110L/kg). This study provides baseline information for a better understanding of PFASs contamination in Vietnam.			1	1						1											B	-			
238	蓄積性	Lan, Zhonghui; Zhou, Meng; Yao, Yiming; Sun, Hongwen	Plant uptake and translocation of perfluoroalky	2018	Environ Sci Pollut Res Int. 2018 Nov;25(31):30907-30916. doi: 10.1007/s11356-018-3070-3. Epub 2018 Sep 4.	Application of per- and polyfluoroalkyl substances (PFASs) is shifting to short-chain analogs (C ≤ 6) that raises concerns for their potential ecotoxicological risks. In the present study, pot experiments were carried out to study the effects of perfluoroalkyl acids (PFAAs), including perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs), with different carbon chain lengths (C4, C6, and C8) on the growth of wheat seedlings and their plant uptake and transfer at two spiking levels (200 and 2000 μg/kg soil). Exposure to C4 PFAAs slightly inhibited chlorophyll activity, whereas exposure to C8 PFAAs showed enhancement. The bioaccumulation factors (BAFs) for C4 PFAAs in wheat were over 10, while BAFs for C8 PFAAs were all below 1. Rhizospheric and root to shoot transfer factors for PFAAs were both negatively correlated with their log K(ow) ($p < 0.05$). PFCAs exhibited both higher rhizospheric mobility and accumulation potentials than PFSAs of the same chain lengths. Hence, perfluoroalkyl chain governs the mobility of PFAAs in a soil-plant system besides interactions of their head groups, and the substitution with shorter chain PFASs raises concerns for their higher plant accumulation potential that brings higher ecotoxicological and human exposure risks via food chains.				1						1											B	-			
239	蓄積性	Lescord, Gretchen L; Kidd, Karen A; De Silva, Amila O; Williamson, Mary; Spencer, Christine; Wang, Xiaowa; Muir, Derek C G	Perfluorinated and polyfluorinated compounds	2015	Environ Sci Technol. 2015 Mar 3;49(5):2694-702. doi: 10.1021/es5048649. Epub 2015 Feb 17.	Per- and polyfluorinated alkyl substances (PFASs) enter Arctic lakes through long-range atmospheric transport and local contamination, but their behavior in aquatic food webs at high latitudes is poorly understood. This study compared the concentrations of perfluorocarboxylates, perfluorosulfonates, and fluorotelomer sulfonates (FTS) in biotic and abiotic samples from six high Arctic lakes near Resolute Bay, Nunavut, Canada. Two of these lakes are known to be locally contaminated by a small airport and Arctic char (Salvelinus alpinus) from these lakes had over 100 times higher total [PFAS] when compared to fish from neighboring lakes. Perfluorononanoate (PFOA) and perfluorooctanesulfonate (PFOS) dominated in char, benthic chironomids (their main prey), and sediments, while pelagic zooplankton and water were dominated by lower chain acids and perfluorodecanesulfonate (PFDS). This study also provides the first measures of perfluoroethylcyclohexanesulfonate (PFECHS) and FTS compounds in water, sediment, juvenile char, and benthic invertebrates from lakes in the high Arctic. Negative relationships between [PFAS] and δ (15)N values (indicative of trophic position) within these food webs indicated no biomagnification. Overall, these results suggest that habitat use and local sources of contamination, but not trophic level, are important determinants of [PFAS] in biota from freshwater food webs in the Canadian Arctic.				1						1											B	-			
240	環境中運命	Li, Yasong; Oliver, Danielle P; Kookana, Rai S	A critical analysis of published data to discern	2018	Sci Total Environ. 2018 Jul 1;628-629:110-120. doi: 10.1016/j.scitotenv.2018.01.167. Epub 2018 Feb 9.	Widespread usage of per- and polyfluoroalkyl substances (PFASs) has caused major environmental contamination globally. The hydrophilic and hydrophobic properties of PFASs affect the sorption behaviour and suggest organic carbon may not be the only factor affecting sorption. We reviewed the quality of all data published in peer-reviewed literature on sorption of PFASs to critically evaluate the role organic carbon (OC) and other properties have in sorption of PFASs in soils or sediments. The largest data sets available were for perfluorooctanoic acid (PFOA, n = 147) and perfluorooctane sulfonic acid (PFOS, n = 178), and these analyses showed very weak correlations between sorption coefficient (K(d)) and OC alone ($R(2) = 0.05$-0.07). When only laboratory-derived K(d) values of PFASs and OC were analysed, the R(2) values increased for PFOA ($R(2) = 0.24$, n = 42), PFOS ($R(2) = 0.38$, n = 69), perfluorononanoic acid (PFNA, $R(2) = 0.77$ n = 12), and perfluorodecanoic acid (PFDA, $R(2) = 0.78$, n = 13). However, the relationships were heavily skewed by one or two high OC values. Similarly there was no significant relationship between K(d) values and pH for PFOS ($R(2) = 0.06$) and PFOA ($R(2) = 0.07$), across a range of environmental pH values. Our analyses showed sorption behaviour of a range of PFASs could not be explained by a single soil or sediment property. Multiple regression models better explained the sorption behaviour of a number of PFASs. Regressions of OC and pH together explained a significant proportion of the variation in K(d) values for 9 out of 14 PFASs and 8 of these regressions had ≥10 data points. This review highlightedthat at least OC, pH and clay content are properties having significant effect on sorption. There is a clear need for more data and studies with thorough characterisation of soils or sediments to better understand their role in PFASs sorption. Current assessments based on OC alone are likely to be erroneous.				1	1					1											B	-			
241	環境中運命	Li, Fei; Fang, Xinliang; Zhou, Zhenming; Liao, Xiaobin; Zou, Jing; Yuan, Baoling; Sun, Wenjie	Adsorption of perfluorinated acids onto soils: K	2019	Sci Total Environ. 2019 Feb 1;649:504-514. doi: 10.1016/j.scitotenv.2018.08.209. Epub 2018 Aug 17.	The adsorption of perfluorinated acids (PFAs) onto soils with different physicochemical properties was investigated in this study. The adsorption kinetics for all PFAs onto the soil with the highest contents of total organic carbon (TOC) and iron oxide were well described by a biexponential adsorption model, indicating that two types of binding sites characterized by a fast and a slow sorption rates were involved in the adsorption, and the time required for achieving adsorption equilibrium was <48 h for all PFAs. The adsorption isotherms were well represented by both of Freundlich equation ($R(2) = 0.9547$-0.9977) and/or Virial equation ($R(2) = 0.8720$-0.9995). The interfacial capacitances derived from the Virial isotherm were substantially low (in the range of 33.7 to 851 μF/m(2)) for all soils, but were not analyte-independent for all PFAs onto the same soil. The linear regression between distribution coefficient (K(d)) and individual soil property as well as principle component analysis were conducted for determining the dominant soil physicochemical properties affecting the adsorption of PFAs onto soil in the present study. The results indicated that the content of protein rather than of total organic carbon (TOC) was the dominant property, and then followed by anion exchange capacity (AEC) and the content of iron oxides. For the other properties, the influences of fulvic acid (FA) and aluminum oxides were PFA-dependent, while there were no effects of saccharide, humic acid (HA), specific surface area (SSA) and cation exchange capacities (CEC) on the adsorption.				1						1											B	-			
242	蓄積性	Martin, Jonathan W; Mabury, Scott A; Solomon, Keith R; Muir, Derek C G	Dietary accumulation of perfluorinated acids ir	2003	Environ Toxicol Chem. 2003 Jan;22(1):189-95. doi: 10.1002/etc.5620220125	Perfluorinated acids (PFAs) recently have emerged as persistent global contaminants after their detection in wildlife and humans from various geographic locations. The highest concentrations of perfluorooctane sulfonate are characteristically observed in high trophic level organisms, indicating that PFAs may have a significant bioaccumulation potential. To examine this phenomenon quantitatively, we exposed juvenile rainbow trout (Oncorhynchus mykiss) simultaneously to a homologous series of perfluoroalkyl carboxylates and sulfonates for 34 d in the diet, followed by a 41-d depuration period. Carcass and liver concentrations were determined by using liquid chromatography-tandem mass spectrometry, and kinetic rates were calculated to determine compound-specific bioaccumulation parameters. Depuration rate constants ranged from 0.02 to 0.23/d, and decreased as the length of the fluorinated chain increased. Assimilation efficiency was greater than 50% for all test compounds, indicating efficient absorption from food. Bioaccumulation factors (BAFs) ranged from 0.038 to 1.0 and increased with length of the perfluorinated chain; however, BAFs were not statistically greater than 1 for any PFA. Sulfonates bioaccumulated to a greater extent than carboxylates of equivalent perfluoroalkyl chain length, indicating that hydrophobicity is not the sole determinant of PFA accumulation potential and that the acid function must be considered. Dietary exposure will not result in biomagnification of PFAs in juvenile trout, but extrapolation of these bioaccumulation parameters to larger fish and homeothermic organisms shouldnot be performed.				1						1	1							1			B	-			

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
243	環境中運命	Meyer, T. & Wania, F.	What environmental fate processes have the s	2007	Atmospheric Environment, 41(13), 2757–2767. doi: 10.1016/j.atmosenv.2006.11.053	Fate and transport models can be used to identify and classify chemicals that have the potential to undergo long-range transport and to accumulate in remote environments. For example, the Arctic contamination potential (ACP), calculated with the help of the zonally averaged global transport model Globo-POP, is a numerical indicator of an organic chemical's potential to be transported to polar latitudes and to accumulate in the Arctic ecosystem. It is important to evaluate how robust such model predictions are and in particular to appreciate to what extent they may depend on a specific choice of environmental model input parameters. Here, we employ a recently developed graphical method based on partitioning maps to comprehensively explore the sensitivity of ACP estimates to variations in environmental parameters. Specifically, the changes in the ACP of persistent organic contaminants to changes in each environmental input parameter are plotted as a function of the two-dimensional hypothetical "chemical space" defined by two of the three equilibrium partition coefficients between air, water and octanol. Based on the patterns obtained, this chemical space is then segmented into areas of similar parameter sensitivities and superimposed with areas of high default ACP and elevated environmental bioaccumulation potential within the Arctic. Sea ice cover, latitudinal temperature gradient, and macro-diffusive atmospheric transport coefficients, and to a lesser extent precipitation rate, display the largest influence on ACP-values for persistent organic contaminants, including those that may bioaccumulate within the polar marine ecosystems. These environmental characteristics are expected to be significantly impacted by global climate change processes, highlighting the need to explore more explicitly how climate change may affect the long-range transport and accumulation behavior of persistent organic pollutants.									1												C	-		
244	環境中運命	Milinovic, Jelena; Lacorte, Silvia; Vidal, Miquel; Rigol, Anna	Sorption behaviour of perfluoroalkyl substance	2015	Sci Total Environ. 2015 Apr 1;511:63-71. doi: 10.1016/j.scitotenv.2014.12.017. Epub 2014 Dec 19.	The sorption behaviour of three perfluoroalkyl substances (PFASs), perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and perfluorobutane sulfonic acid (PFBS), was studied in six soils with contrasting characteristics, especially in the organic carbon content. Sorption isotherms were obtained by equilibrating the soil samples with 0.01 mol L(-1) CaCl2 solutions spiked with increasing concentrations of the target PFAS. The sorption reversibility of PFASs was also tested for some of the samples. Liquid chromatography coupled to tandem mass spectrometry was used to quantify the target PFASs in the solutions. Both the Freundlich and linear models were appropriate to describe the sorption behaviour of PFASs in soils, and enabled us to derive solid-liquid distribution coefficients (Kd) for each compound in each soil. Kd values increased from 19 to 295 mL g(-1) for PFOS, from 2.2 to 38 mL g(-1) for PFOA and from 0.4 to 6.8 mL g(-1) for PFBS, and were positively correlated with the organic carbon content of the soil. KOC values obtained from the correlations were 710, 96 and 17 mL g(-1) for PFOS, PFOA and PFBS, respectively. Whereas Kd values decreased in the sequence PFOS>PFOA>PFBS, desorption yields were lower than 13% for PFOS, from 24 to 58% for PFOA, and from 32 to 60% for PFBS. This shows that the physicochemical characteristics of PFASs, basically their hydrophobicity, controlled their sorption behaviour in soils, with PFOS being the most irreversibly sorbed PFAS.				1						1												B	-		
245	環境中運命	Moody, C. A. & Field, J. A.	Perfluorinated Surfactants and the Environmer	2000	Environmental Science & Technology, 34, 3864-3870. doi: 10.1021/ES991359U	The recent identification of one class of fluorinated surfactants in groundwater impacted by fire-fighting activity has created an awareness of the potential environmental issues resulting from the use of aqueous film forming foam (AFFF) agents. Aqueous film forming foams are used to extinguish hydrocarbon-fuel fires and their repeated usage, particularly at military sites, has led to AFFF-contaminated groundwater. Formulations of AFFF agents include fluorinated surfactants, which are an important class of specialty chemicals that have physio-chemical properties that differentiate them from hydrocarbon surfactants. Little is known about the occurrence, transport, biodegradation, and toxicity of fluorinated surfactants in the environment. The fact that fluorinated surfactants, as well as other AFFF components, co-occur with priority pollutants (e.g., jet fuel components and chlorinated solvents) complicates studies on their fate and effect in the environment. Research is needed to sufficiently identify those fluorinated surfactants present in commercial AFFF products and environmental samples and to characterize their environmental properties. Additionally, the environmental behavior of the AFFF mixtures and complex AFFF-wastewaters needs to be investigated.									1												B	-		
246	環境中運命	Munoz, Gabriel; Giraudel, Jean-Luc; Botta, Fabrizio; Lestremau, François; Dévier, Marie-Hélène; Budzinski, Hélène; Labadie, Pierre	Spatial distribution and partitioning behavior o	2015	Sci Total Environ. 2015 Jun 1;517:48-56. doi: 10.1016/j.scitotenv.2015.02.043. Epub 2015 Feb 23.	The spatial distribution and partitioning of 22 poly- and perfluoroalkyl substances (PFASs) in 133 selected rivers and lakes were investigated at a nationwide scale in mainland France. ΣPFASs was in the range<LOD-725 ng L(-1) in the dissolved phase (median: 7.9 ng L(-1)) and <LOD-25 ng g(-1) dry weight (dw) in the sediment (median: 0.48 ng g(-1) dw); dissolved PFAS levels were significantly lower at "reference" sites than at urban, rural or industrial sites. Although perfluorooctane sulfonate (PFOS) was found to be the prevalent compound on average, a multivariate analysis based on neural networks revealed noteworthy trends for other compounds at specific locations and, in some cases, at watershed scale. For instance, several sites along the Rhône River displayed a peculiar PFAS signature, perfluoroalkyl carboxylates (PFCAs) often dominating the PFAS profile (e.g., PFCAs>99% of ΣPFASs in the sediment, likely as a consequence of industrial point source discharge). Several treatments for data below detection limits (non-detects) were used to compute descriptive statistics, differences among groups, and correlations between congeners, as well as log Kd and log Koc partition coefficients; in that respect, the Regression on Order Statistics (robust ROS) method was preferred for descriptive statistics computation while the Akritas-Theil-Sen estimator was used for regression and correlation analyses. Multiple regression results suggest that PFAS levels in the dissolved phase and sediment characteristics (organic carbon fraction and grain size) may be significant controlling factors of PFAS levels in the sediment.				1						1										1		B	-		
247	環境中運命	Navarro, Irene; de la Torre, Adrián; Sanz, Paloma; Porcel, Miguel Ángel; Pro, Javier; Carbonell, Gregoria; Martínez, María de Los Ángeles	Uptake of perfluoroalkyl substances and halog	2017	Environ Res. 2017 Jan;152:199-206. doi: 10.1016/j.envres.2016.10.018. Epub 2016 Oct 26.	The bioaccumulation behavior of perfluoroalkyl substances (PFASs) and halogenated flame retardants (HFRs) was examined in three horticultural crops and earthworms. Two species, spinach (Spinacia oleracea) and tomato (Solanum lycopersicum L.), were grown in field soil amended with a single application of biosolids (at agronomic rate for nitrogen), to represent the scenario using commercial biosolids as fertilizer, and the third crop, corn (Zea mays) was grown in spiked soil (~50mg PFOS/kg soil, ~5mg Deca-BDE/kg soil and a mixture of both, ~50mg PFOS and ~5mg Deca-BDE/kg soil) to represent a worst-case scenario. To examine the bioaccumulation in soil invertebrates, earthworms (Eisenia andrei) were exposed to the spiked soil where corn had been grown. PFASs and HFRs were detected in the three crops and earthworms. To evaluate the distribution of the compounds in the different plant tissues, transfer factors (TFs) were calculated, with TF values higher for PFASs than PBDEs in all crop plants: from 2 to 9-fold in spinach, 2 to 34-fold in tomato and 11 to 309-fold in corn. Bioaccumulation factor (BAF) values in earthworms were also higher for PFASs (4.06 ± 2.23) than PBDEs (0.02 ± 0.02).				1						1												B	-		
248	蓄積性	Navarro, Irene; de la Torre, Adrián; Sanz, Paloma; Pro, Javier; Carbonell, Gregoria; Martínez, María de Los Ángeles	Bioaccumulation of emerging organic compour	2016	Environ Res. 2016 Aug;149:32-39. doi: 10.1016/j.envres.2016.05.004. Epub 2016 May 9.	In the present work, the bioaccumulation behavior of 49 target emerging organic compounds (20 perfluoroalkyl substances, PFASs, and 29 halogenated flame retardants, HFRs) was studied in soil invertebrates (Eisenia andrei). Multi species soil systems (MS-3) were used to assess the fate and the effects associated with the application of four biosolids in agricultural soil on terrestrial soil organisms. Biosolid amendment increased concentrations 1.5-14-fold for PFASs, 1.1-2.4-fold for polybrominated diphenyl ethers, PBDEs, and 1.1-3.6-fold for chlorinated flame retardants, CFRs. Perfluorooctanesulfonate, PFOS, (25%) and BDE-209 (60%) were the predominant PFAS and HFR compounds, respectively, in biosolids-amended soils. Total concentrations (ng/g dry weight) in earthworms from biosolid-amended soils ranged from 9.9 to 101 for PFASs, from 45 to 76 for PBDEs and 0.3-32 for CFRs. Bioaccumulation factors (BAFs) were calculated to evaluate the degree of exposure of pollutants in earthworms. The mean BAF ranged from 2.2 to 198 for PFASs, 0.6-17 for PBDEs and 0.5-20 for CFRs. The relationship of PFAS and PBDE BAFs in earthworms and their log Kow were compared: PFAS BAFs increased while PBDE BAFs declined with increasing log Kow values. The effect of the aging (21 days) on the bioavailability of the pollutants in amended soils was also assessed: the residence time affected differently to the compounds studied.				1						1												B	-		
249	蓄積性	Numata, Jorge; Kowalczyk, Janine; Adolphs, Julian; Ehlers, Susan; Schafft, Helmut; Fuerst, Peter; Müller-Graf, Christine; Lahrssen-Wiederholt, Monika; Greiner, Matthias	Toxicokinetics of seven perfluoroalkyl sulfonic	2014	J Agric Food Chem. 2014 Jul 16;62(28):6861-70. doi: 10.1021/jf405827u. Epub 2014 Jun 30.	The transfer of a mixture of perfluoroalkyl acids (PFAAs) from contaminated feed into the edible tissues of 24 fattening pigs was investigated. Four perfluoroalkyl sulfonic (PFSAs) and three perfluoroalkyl carboxylic acids (PFCAs) were quantifiable in feed, plasma, edible tissues, and urine. As percentages of unexcreted PFAA, the substances accumulated in plasma (up to 51%), fat, and muscle tissues (collectively, meat 40-49%), liver (under 7%), and kidney (under 2%) for most substances. An exception was perfluorooctanesulfonic acid (PFOS), with lower affinity for plasma (23%) and higher for liver (35%). A toxicokinetic model is developed to quantify the absorption, distribution, and excretion of PFAAs and to calculate elimination half-lives. Perfluorohexanoic acid (PFHxA), a PFCA, had the shortest half-life at 4.1 days. PFSAs are eliminated more slowly (e.g., half-life of 634 days for PFOS). PFAAs in pigs exhibit longer elimination half-lives than in most organisms reported in the literature, but still shorter than in humans.				1						1	1							1			B	-		
250	環境中運命	Ochoa-Herrera, Valeria; Field, Jim A; Luna-Velasco, Antonia; Sierra-Alvarez, Reyes	Microbial toxicity and biodegradability of perfl	2016	Environ Sci Process Impacts. 2016 Sep 14;18(9):1236-1246. doi: 10.1039/c6em00366d.	Perfluorooctane sulfonate (PFOS) and related perfluoroalkyl and polyfluoroalkyl substances (PFASs) are emerging contaminants that have been widely applied in consumer and industrial applications for decades. However, PFOS has raised public concern due to its high bioaccumulative character, environmental persistence, and toxicity. Shorter PFASs such as perfluorobutane sulfonate (PFBS) and polyfluoroalkyl compounds have been proposed as alternatives to PFOS but it is unclear whether these fluorinated substances pose a risk for public health and the environment. The objective of this research was to investigate the microbial toxicity and the susceptibility to microbial degradation of PFOS and several related fluorinated compounds, i.e., short-chain perfluoroalkyl and polyfluoroalkyl sulfonic and carboxylic acids. None of the compounds tested were toxic to the methanogenic activity of anaerobic wastewater sludge even at very high concentrations (up to 500 mg L-1). All PFASs evaluated were highly resistant to microbial degradation. PFOS was not reductively dehalogenated by the anaerobic microbial consortium even after very long periods of incubation (3.4 years). Similarly, the tested short chain perfluoroalkyl substances (i.e., PFBS and trifluoroacetic acid) and a polyfluoroalkyl PFOS analogue, 6 : 2 fluorotelomer sulfonic acid (FTSA) were also resistant to anaerobic biodegradation. Likewise, no conclusive evidence of microbial degradation was observed under aerobic conditions for any of the short-chain perfluoroalkyl and polyfluoroalkyl carboxylic acids tested after 32 weeks of incubation. Collectively, these results indicate that PFOS and its alternatives such as short chain perfluoroalkyl sulfonates and carboxylates and their polyfluorinated homologues are highly resistant to microbial degradation.				1						1												B	-	毒性評価、微生物分解性、PFOS、短鎖PFAS	
251	蓄積性	O'Connell, Steven G; Arendt, Michael; Segars, Al; Kimmel, Tricia; Braun-McNeill, Joanne; Avens, Larisa; Schroeder, Barbara; Ngai, Lily; Kucklick, John R; Keller, Jennifer M	Temporal and spatial trends of perfluorinated c	2010	Environ Sci Technol. 2010 Jul 1;44(13):5202-9. doi: 10.1021/es9036447.	Perfluorinated compounds (PFCs) are globally distributed persistent environmental contaminants. This study provides temporal trends as well as large-scale spatial trends of PFC concentrations in threatened juvenile loggerhead sea turtles near or from Florida Bay (FL Bay), Cape Canaveral (FL), Charleston (SC), Core Sound (NC), and Chesapeake Bay (MD). PFCs were extracted from 163 plasma and serum samples using solid-phase extraction and quantified with LC-MS/MS. Concentrations of six compounds significantly varied by site, with MD or FL Bay turtles having the highest concentrations. Perfluorooctane sulfonate (PFOS) was the predominant PFC at all sites (range: 0.31 ng/g to 39.0 ng/g). FL Bay turtles, compared to other sites, accumulated a unique PFC pattern with a higher proportion of perfluorocarboxylates compared to PFOS. Furthermore, this study was the first to statistically correlate wildlife PFC concentrations with human population, used as a proxy for urbanization and sources of PFCs to the environment. Positive relationships were found in which human population accounted for 75 and 81% of the variance in turtle PFOS and perfluoroundecanoate (PFUnA) concentrations (p = 0.06 and 0.04), respectively. PFOS and perfluorononanoate (PFNA) significantly decreased from 2000-2008 in SC turtles annually by 20 and 11%, respectively (p </= 0.02). Future investigations should continue temporal assessments as PFC regulations change, attempt to pinpoint specific sources and transport pathways in areas with unique PFC patterns, and assess turtle health at sites with higher PFC concentrations.				1						1												B	-	米国、血漿、血清、PFC	
252	環境中運命	Campos Pereira, Hugo; Ullberg, Malin; Kleja, Dan Berggren; Gustafsson, Jon Petter; Ahrens, Lutz	Sorption of perfluoroalkyl substances (PFASs)	2018	Chemosphere. 2018 Sep;207:183-191. doi: 10.1016/j.chemosphere.2018.05.012. Epub 2018 May 4.	Accurate prediction of the sorption of perfluoroalkyl substances (PFASs) in soils is essential for environmental risk assessment. We investigated the effect of solution pH and calculated soil organic matter (SOM) net charge on the sorption of 14 PFASs onto an organic soil as a function of pH and added concentrations of Al(3+), Ca(2+) and Na(+). Often, the organic C-normalized partitioning coefficients (K(OC)) showed a negative relationship to both pH (Δlog K(OC)/ΔpH = -0.32 ± 0.11 log units) and the SOM bulk net negative charge (Δlog K(OC) = -1.41 ± 0.40 per log unit mol(c) g(-1)). Moreover, perfluorosulfonic acids (PFSAs) sorbed more strongly than perfluorocarboxylic acids (PFCAs) and the PFAS sorption increased with increasing perfluorocarbon chain length with 0.60 and 0.83 log K(OC) units per CF(2) moiety for C(3)-C(10) PFCAs and C(4), C(6), and C(8) PFSAs, respectively. The effects of cation treatment and SOM bulk net charge were evident for many PFASs with low to moderate sorption (C(5)-C(8) PFCAs and C(6) PFSA). However for the most strongly sorbing and most long-chained PFASs (C(9)-C(11) and C(13) PFCAs, C(8) PFSA and perfluorooctane sulfonamide (FOSA)), smaller effects of cations were seen, and instead sorption was more strongly related to the pH value. This suggests that the most long-chained PFASs, similar to other hydrophobic organic compounds, are preferentially sorbed to the highly condensed domains of the humin fraction, while shorter-chained PFASs are bound to a larger extent to humic and fulvic acid, where cation effects are significant.				1						1												B	-	土壌吸着、14PFAS、pH、DOM等の影響評価	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
253	蓄積性	Pi, N; Ng, J Z; Kelly, B C	Uptake and elimination kinetics of perfluoroalk	2017	Water Res. 2017 Jun 15;117:167-174. doi: 10.1016/j.watres.2017.04.003. Epub 2017 Apr 4.	Studies investigating the bioaccumulation behavior of perfluoroalkyl substances (PFASs) in aquatic macrophytes are limited. The present study involved controlled mesocosm experiments to assess uptake and elimination rate constants (k(u),k(e)), bioconcentration factors (BCFs) and translocation factors (TFs) of several perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkane sulfonic acids (PFSAs) in two aquatic plant species, including one submerged species (Echinodorus horemanii) and one free-floating species (Eichhornia crassipes). The results indicated all PFASs were readily accumulated in these aquatic macrophytes. k(u) and BCFs increased with increasing perfluoroalkyl chain length. For PFCAs and PFSAs with identical perfluoroalkyl chain length, the corresponding PFSA exhibited higher bioaccumulation potential. On a whole-plant basis, the bioaccumulation potential of PFASs in submerged and free-floating macrophytes were comparable, indicating sorption to plant biomass is similar in the different species. Conversely, when considering accumulation in foliage, BCFs in the free-floating macrophyte were substantially lower compared to submerged species, especially for longer-chain PFASs. Compounds with shorter perfluoroalkyl chain length (PFBS, PFPeA and PFHxA) exhibited preferential translocation to leaf tissue (TFs >1). BCFs exhibited a sigmoidal relationship with pefluoroalkyl chain length, membrane-water distribution coefficients (D(mw)), protein-water distribution coefficients (D(pw)) and organic-water partition coefficients (K(oc)). For these trends, maximum BCF values were exhibited by long-chain PFCAs,with a log D(mw), log D(pw) and log K(oc) of 6.47, 5.72 and 5.04, respectively. These findings are useful for future design and implementation of phytoremediation systems, as well for future develop of mechanistic models for predicting the environmental fate and distribution of these contaminants of concern.				1						1	1											B	-	水生植物、生物濃縮、PFAS	
254	環境中運命	Pico, Yolanda; Blasco, Cristina; Farré, Marinella; Barceló, Damia	Occurrence of perfluorinated compounds in wa	2012	Environ Sci Pollut Res Int. 2012 May;19(4):946-57. doi: 10.1007/s11356-011-0560-y. Epub 2011 Jul 7.	PURPOSE: Perfluorinated compounds (PFCs) are widely distributed from industrialized to remote locations throughout the world. This study demonstrates the spatial distributions of PFCs in water and sediments from the L'Albufera Natural Park (Valencia, Spain). METHODS: Grab water and sediment samples were collected. PFCs were extracted from sediments with acidified acetonitrile by ultrasonication and cleaned up by solid-phase extraction (SPE) and from water by SPE. Determination was carried out by liquid chromatography-tandem mass spectrometry. RESULTS: In 100% of the samples (both water and sediments), perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were the predominant PFCs. Among the 12 sampling sites, PFOS concentrations in sediments ranged from 0.10 to 4.80 ng/g dry weight and in water from 0.94 to 58.1 ng/L. PFOA concentrations in sediment were from 0.004 to 1.24 ng/g and in water from 0.99 to 120 ng/L. Other perfluorocarboxylic acids (C5, C6, C7, C9, and C10) and perfluorosulfonates (C4 and C10) were also identified in several locations. The sum of all 10 compounds (ΣPFCs) concentration range from 0.99 to 120 ng/L in water and from 0.25 to 17.4 ng/g in sediments. Sediment-water distribution coefficients (log K (D)) were in the range 2.31-4.51 and positively correlated with perfluoroalkyl chain length. CONCLUSIONS: PFC concentrations in water and sediment were both less than those able to cause acute toxicity; low but detectable PFCs pollution in the L'Albufera Natural Park in Valencia was demonstrated. These compounds are bioaccumulative; thus, the risk associated withthese exposures requires a deeper evaluation of long-term chronic toxicity.				1						1												B	-	スペイン、水と底質、PFAS	
255	生分解性	Quinete, Natalia; Orata, Francis; Maes, Anke; Gehron, Markus; Bauer, Karl-Heinz; Moreira, Isabel; Wilken, Rolf-Dieter	Degradation studies of new substitutes for per	2010	Arch Environ Contam Toxicol. 2010 Jul;59(1):20-30. doi: 10.1007/s00244-009-9451-3. Epub 2010 Jan 7.	Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are manmade, stable perfluorosurfactants. The properties of perfluoroalkylated compounds that cause them to persist in the environment are also the properties that made them attractive compounds for industrial usage for over 50 years. Due to the unique properties of the carbon-fluorine bond and the polarity of perfluoroalkyl groups, potential substitutes to replace perfluorinated surfactants in most cases continue to be perfluoroalkyl based. Thus, issues of persistence in the environment remain. There is a need to test emerging new substitute surfactants for biodegradability. This study involved degradability measurements of emerging perfluorinated surfactant substitutes. The stability of the substitutes of perfluorinated surfactants was tested by employing advanced oxidation processes, which were based on degradation by ultraviolet lamp, hydrogen peroxide, or both, followed by conventional tests, among them an automated method based on the manometric respirometry test (OECD 301 F; OxiTop), closed-bottle test (OECD 301 D), and standardized fixed-bed bioreactor on perfluorobutane sulfonate, fluorosurfactant Zonyl, two fluoraliphatic esters (NOVEC FC-4430 and NOVEC FC-4432), and 10-(trifluoromethoxy) decane 1 sulfonate. Most of these new surfactants are well established in the marketplace and have been used in several applications as alternatives to PFOS- and PFOA-based surfactants. Ready biodegradation tests for fluoroaliphatic esters, the fluorosurfactant Zonyl, perfluorobutane sulfonate, and 10-(trifluoromethoxy) decane-1-sulfonate using themanometric respirometry test (OxiTop) did not meet the ready biodegradability test criteria. However, 10-(trifluoromethoxy) decane-1-sulfonate was observed to be degradable when a standardized fixed-bed bioreactor test was applied.				1						1												B	-	促進酸化＋生分解、PFAS	
256	蓄積性	Routti, Heli; Aars, Jon; Fuglei, Eva; Hanssen, Linda; Lone, Karen; Polder, Anuschka; Pedersen, Åshild Ø; Tartu, Sabrina; Welker, Jeffrey M; Yoccoz, Nigel G	Emission Changes Dwarf the Influence of Feed	2017	Environ Sci Technol. 2017 Oct 17;51(20):11996-12006. doi: 10.1021/acs.est.7b03585. Epub 2017 Sep 29.	We monitored concentrations of per- and polyfluoroalkyl substances (PFASs) in relation to climate-associated changes in feeding habits and food availability in polar bears (Ursus maritimus) and arctic foxes (Vulpes lagopus) (192 plasma and 113 liver samples, respectively) sampled from Svalbard, Norway, during 1997-2014. PFASs concentrations became greater with increasing dietary trophic level, as bears and foxes consumed more marine as opposed to terrestrial food, and as the availability of sea ice habitat increased. Long-chained perfluoroalkyl carboxylates (PFCAs) in arctic foxes decreased with availability of reindeer carcasses. The ~9-14% yearly decline of C(6-8) perfluoroalkyl sulfonates (PFSAs) following the cease in C(6-8) PFSA precursor production in 2001 indicates that the peak exposure was mainly a result of atmospheric transport of the volatile precursors. However, the stable PFSA concentrations since 2009-2010 suggest that Svalbard biota is still exposed to ocean-transported PFSAs. Long-chain ocean-transported PFCAs increased 2-4% per year and the increase in C(12-14) PFCAs in polar bears tended to level off since ~2009. Emerging short-chain PFASs showed no temporal changes. Climate-related changes in feeding habits and food availability moderately affected PFAS trends. Our results indicate that PFAS concentrations in polar bears and arctic foxes are mainly affected by emissions.				1						1												B	-	ノルウェー、血漿と肝臓、ホッキョクグマとホッキョクギツネ	
257	蓄積性	Routti, Heli; Gabrielsen, Geir Wing; Herzke, Dorte; Kovacs, Kit M; Lydersen, Christian	Spatial and temporal trends in perfluoroalkyl su	2016	Environ Pollut. 2016 Jul;214:230-238. doi: 10.1016/j.envpol.2016.04.016. Epub 2016 Apr 17.	This study investigates concentrations of perfluoroalkyl carboxylates (PFCAs), perfluoroalkyl sulfonates (PFSAs) and perfluoroalkane sulfonamides (FASA) in plasma from ringed seals sampled in the period 1990-2010 (n = 71) in Svalbard, Norway. Perfluorooctane sulfonate was dominant among the perfluoroalkyl substances. PFCAs were dominated by perfluoroundecanoate followed by perfluorononanoate. C4C8 PFCAs and perfluorooctane sulfonamide (FOSA) were detected in ≤42% of the samples. PFSA and PFCA concentrations were higher in seals sampled from Kongsfjorden, a fjord influenced by strong inflows of Atlantic Water compared to seals from fjords dominated by Arctic Water (e.g. Billefjorden). Sex, age and body condition of the seals did not influence PFAS concentrations. Due to the confounding effect of year and sampling area, temporal trends were assessed only in seals sampled from Kongsfjorden (5 years, n = 51). PFHxS and PFOS concentrations did not show significant linear trends during the whole study period, but a decrease was observed since 2004. Concentrations of all of the detected PFCAs (C9C13 PFCAs) increased until 2004 after which they have declined or stabilized.				1						1												B	-	アザラシ、血漿、PFCA、PFSA、FASA	
258	環境中運命	Sáez, Monica; de Voogt, Pim; Parsons, John R	Persistence of perfluoroalkylated substances in	2008	Environ Sci Pollut Res Int. 2008 Sep;15(6):472-7. doi: 10.1007/s11356-008-0020-5. Epub 2008 Jul 2.	BACKGROUND, AIM, AND SCOPE: Perfluoroalkylated substances (PFAS) are chemicals with completely fluorinated alkyl chains. The specific properties of the F-C bond give PFAS a high stability and make them very useful in a wide range of applications. PFAS also pose a potential risk to the environment and humans because they have been recently characterized as persistent, bioaccumulative, and toxic. The objective of this work is to study the bacterial degradation of PFAS under aerobic and anaerobic conditions in municipal sewage sludge as a contribution toward understanding their environmental fate and behavior. MATERIALS AND METHODS: Bacterial communities from sewage sludge were exposed to a mixture of PFAS under aerobic or anaerobic conditions. Individual PFAS concentrations were determined in the experiment media at different exposure times using liquid chromatography-mass spectrometry analysis after extraction with solid-phase extraction. RESULTS: The PFAS analyses of samples of sludge showed repeatable replicate results, allowing a reliable quantification of the different groups of PFAS analyzed. No conclusive evidence for PFAS degradation was observed under the experimental conditions tested in this work. Reduction in concentrations, however, was observed for some PFAS in sludge under aerobic conditions. DISCUSSION: The largest concentration decrease occurred for the fluorotelomer alcohols (FTOHs), especially for the 8:2 FTOH, which have been described as biodegradable in the literature. However, this concentration decrease could be due to different causes: sorption to glass, septa, or matrixcomponents, as well as bacterial activity. Therefore, it is not certain that biodegradation occurred. CONCLUSIONS: PFAS are very recalcitrant chemicals, especially when fully fluorinated. Although some decreases in concentration have been observed for some PFAS, such as the FTOHs, there is no conclusive evidence for biodegradation. It can be concluded that the PFAS tested in these experiments are non-biodegradable under these experimental conditions. RECOMMENDATIONS AND PERSPECTIVES: Since the presence of PFAS is ubiquitous in the environment and they can be toxic, more research is needed in this field to elucidate which PFAS are susceptible to biodegradation, the conditions required for biodegradation, and the possible routes followed. A possible inhibitory effect of PFAS on bacteria, the threshold concentrations, and conditions of inhibition should also be investigated.				1						1												B	-	下水汚泥による微生物分解	
259	環境中運命	Scher, Deanna P; Kelly, James E; Huset, Carin A; Barry, Kitrina M; Hoffbeck, Richard W; Yingling, Virginia L; Messing, Rita B	Occurrence of perfluoroalkyl substances (PFAS	2018	Chemosphere. 2018 Apr;196:548-555. doi: 10.1016/j.chemosphere.2017.12.179. Epub 2017 Dec 29.	The decades-long disposal of manufacturing waste containing perfluoroalkyl substances (PFAS) in landfills resulted in contamination of groundwater serving as the drinking water supply for the eastern Twin Cities metropolitan region. While measures were taken to reduce the levels of PFAS in the drinking water, questions remained about possible non-drinking water pathways of exposure in these communities. The Minnesota Department of Health (MDH) investigated whether PFAS in water used for yard and garden irrigation results in elevated concentrations of PFAS in soil and home-grown produce. In 2010, samples of outdoor tap water, garden soil, and garden produce were collected at homes impacted by the contamination and analyzed for several PFAS. Perfluorobutanoic acid (PFBA) was the primary PFAS present in water, followed by perfluoropentanoic acid (PFPeA). Although PFBA, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were present in 100% of soil samples at higher concentrations compared to other PFAS, only PFBA was readily translocated to plants. Significant determinants of PFBA concentration in produce were the amount of PFBA applied to the garden via watering and the type of produce tested. Results from this real-world study are consistent with experimental findings that short-chain PFAS have the highest potential to translocate to and bioaccumulate in edible plants. These findings are globally relevant, as short-chain PFAS serve as commercial substitutes for longer-chain compounds and are increasingly detected in water due to their relatively high solubility and mobility.	1					1							1						B	-	水、土壌、植物への移行、PFAS	
260	環境中運命	Shan, Guoqiang; Wei, Mingcui; Zhu, Lingyan; Liu, Zhengtao; Zhang, Yahui	Concentration profiles and spatial distribution	2014	Sci Total Environ. 2014 Aug 15;490:351-9. doi: 10.1016/j.scitotenv.2014.05.005. Epub 2014 May 24.	Jiangsu Hi-tech Fluorochemical Industry Park, China, is one of the largest fluorochemical industry centers in Asia and could be a point source of polyfluoroalkyl substances (PFASs) to the surrounding environment. Besides water, sediment and soil samples, tree leaves and bark were also collected to monitor airborne PFASs around the facilities. Perfluorooctanoic acid and short-chain perfluorocarboxylates including perfluorohexanoic acid and perfluoropentanoic acid were found predominantly in all the samples. The target ∑PFASs were distributed in the dissolved phase with a proportion of 96.5±2.9%. High concentrations of ∑PFASs (up to 12,700 ng/L in surface water) were found at sites near and within the wastewater treatment plant and the facilities. The ∑PFASs in the sediment/sludge were in the range of 3.33-324 ng/g dw. For the first time, tree samples were used for bio-monitoring airborne PFASs in the environment. The ∑PFASs in the tree leaf and bark samples were in the range of 10.0-276 and 6.76-120 ng/g dw, respectively. The spatial distribution of ∑PFASs in the tree leaves suggested that airborne PFASs could be transported from the center to the surrounding environment by prevailing wind.				1						1												B	-	水、土壌、底質、木の葉、樹皮	
261	環境中運命	Skaar, Jøran Solnes; Ræder, Erik Magnus; Lyche, Jan Ludvig; Ahrens, Lutz; Kallenborn, Roland	Elucidation of contamination sources for poly-	2019	Environ Sci Pollut Res Int. 2019 Mar;26(8):7356-7363. doi: 10.1007/s11356-018-2162-4. Epub 2018 May 12.	A combination of local (i.e. firefighting training facilities) and remote sources (i.e. long-range transport) is assumed to be responsible for the occurrence of per- and polyfluoroalkyl substances (PFASs) in Svalbard (Norwegian Arctic). However, no systematic elucidation of local PFASs sources has been conducted yet. Therefore, a survey was performed aiming at identifying local PFAS pollution sources on the island of Spitsbergen (Svalbard, Norway). Soil, freshwater (lake, draining rivers), seawater, meltwater run-off, surface snow and coastal sediment samples were collected from Longyearbyen (Norwegian mining town), Ny-Ålesund (research facility) and the Lake Linnévatnet area (background site) during several campaigns (2014-2016) and analysed for 14 individual target PFASs. For background site (Linnévatnet area, sampling during April to June 2015), ΣPFAS levels ranged from 0.4 to 4 ng/L in surface lake water (n = 20). PFAS in meltwater from the contributing glaciers showed similar concentrations (~ 4 ng/L, n = 2). The short-chain perfluorobutanoate (PFBA) was predominant in lake water (60-80% of the ΣPFASs), meltwater (20-30%) and run-off water (40%). Long-range transport is assumed to be the major PFAS source. In Longyearbyen, five water samples (i.e. 2 seawater, 3 run-off) were collected near the local firefighting training site (FFTS) in November 2014 and June 2015, respectively. The highest PFAS levels were found in FFTS meltwater run-off (118 ng/L). Perfluorooctane sulfonic acid (PFOS) was the most abundant compound in the FFTS meltwater run-off (53-58% PFASs). At the research station Ny-Ålesund, seawater (n = 6), soil(n = 9) and freshwater (n = 10) were collected in June 2016. Low ΣPFAS concentrations were determined for seawater (5-6 ng/L), whereas high ΣPFAS concentrations were found in run-off water (113-119 ng/L) and soil (211-800 ng/g dry weight (dw)) collected close to the local FFTS. In addition, high ΣPFAS levels (127 ng/L) were also found in freshwater from lake Solvatnet close to former sewage treatment facility. Overall, at both FFTS-affected sites (soil, water), PFOS was the most abundant compound (60-69% of ΣPFASs). FFTS and landfill locations were identified as major PFAS sources for Svalbard settlements.				1						1												B	-	土壌、淡水、海水、雪解け水の流出水、表層雪、海岸の底質、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
262	環境中運命	Taniyasu, Sachi; Yamashita, Nobuyoshi; Yamazaki, Eriko; Petrick, Gert; Kannan, Kurunthachalam	The environmental photolysis of perfluorooctar	2013	Chemosphere. 2013 Feb;90(5):1686-92. doi: 10.1016/j.chemosphere.2012.09.065. Epub 2012 Oct 18.	A field study on the photolysis of perfluoroalkyl substances (PFASs) was conducted at high altitudes in Mt. Mauna Kea (Hawaii, USA; 4200 m) and Mt. Tateyama (Toyama, Japan; 2500 m). Results of photolysis of PFASs in the field were further confirmed in laboratory studies. Perfluorooctanesulfonate (PFOS), which is perceived as a non-degradable chemical in the environment, can undergo photolysis. Long chain PFASs can be successively dealkylated to short chain compounds such as perfluorobutyric acid (PFBA) and perfluorobutane sulfonate (PFBS), but the short chain compounds were relatively more resistant to photodegradation. These results suggest that environmental levels of short chain PFASs would increase both due to their formation from photolysis of long chain PFASs and from direct releases. Earlier studies on photolysis of PFASs were focused on the formation of perfluorocarboxylic acids (PFCAs) and perfluorosulfonic acids (PFSAs) from precursor compounds (such as fluorotelomer alcohols) under laboratory conditions. Our study suggests that PFSAs and PFCAs themselves can undergo photodegradation in the environment.				1						1												B	-	光分解、フィールド調査、PFAS	
263	蓄積性	Van de Vijver, Kristin Inneke; Hoff, Philippe; Das, Krishna; Brasseur, Sophie; Van Dongen, Walter; Esmans, Eddy; Reijnders, Peter; Blust, Ronny; De Coen, Wim	Tissue distribution of perfluorinated chemicals	2005	Environ Sci Technol. 2005 Sep 15;39(18):6978-84. doi: 10.1021/es050942+.	Perfluorinated acids (PFAs) are today widely distributed in the environment, even in remote arctic areas. Recently, perfluorooctane sulfonate (PFOS) has been identified in marine mammals all over the world, but information on the compound-specific tissue distribution remains scarce. Furthermore, although longer perfluorinated carboxylic acids (PFCAs) are used in industry and were shown to cause severe toxic effects, still little is known on potential sources or their widespread distribution. In this study, we report for the first time on levels of longer chain PFCAs, together with some short chain PFAs, perfluorobutane sulfonate (PFBS) and perfluorobutanoate (PFBA), in liver, kidney, blubber, muscle, and spleen tissues of harbor seals (Phoca vitulina) from the Dutch Wadden Sea. PFOS was the predominant compound in all seal samples measured (ranging from 89 to 2724 ng/g wet weight); however, large variations between tissues were monitored. Although these are preliminary results, it is, to our knowledge, the first time that PFBS could be found at detectable concentrations (2.3 +/- 0.7 ng/g w wt) in environmental samples. PFBS was only detected in spleen tissue. PFCA levels were much lower than PFOS concentrations. The dominant PFCA in all tissues was PFNA (perfluorononanoic acid), and concentrations generally decreased in tissues for all other PFCA homologues with increasing chain length. No clear relationship between PFOS levels in liver and kidney was observed. Furthermore, hepatic PFDA (perfluorodecanoic acid) levels increased with increasing body length, but in kidney tissue, PFDA levels showed an inverserelationship with increasing body length. These data suggest large differences in tissue distribution and accumulation patterns of perfluorinated compounds in marine organisms.				1						1												B	-	ゴマフアザラシの肝臓、腎臓、脂肪、筋肉、脾臓細胞、PFAS	
264	蓄積性	Van de Vijver, Kristin Inneke; Holsbeek, Ludo; Das, Krishna; Blust, Ronny; Joiris, Claude; De Coen, Wim	Occurrence of perfluorooctane sulfonate and o	2007	Environ Sci Technol. 2007 Jan 1;41(1):315-20. doi: 10.1021/es060827e.	Perfluorooctane sulfonate (PFOS) and other perfluorinated alkylated substances (PFAS) were determined in liver, kidney, muscle, brain, and blubber samples of 31 harbor porpoises (Phocoena phocoena relicta) of different age and sex stranded along the Ukrainian coast of the Black Sea. In all individuals and in all tissues, PFOS was the predominant PFAS, accounting for on average 90% of the measured PFAS load. PFOS concentrations were the highest in liver (327+/-351 ng/g wet wt) and kidney (147 +/-262 ng/g wet wt) tissue, and lower in blubber (18+/-8 ng/g wet wt), muscle (41+/-50 ng/g wet wt), and brain (24 +/-23 ng/g wetwt). No significant differences could be determined between males and females, nor between juvenile and adult animals ($p > 0.05$). Perfluorononanoic acid, perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanoic acid could be detected in liver tissue of approximately 25% of the individuals. Perfluorobutane sulfonate, perfluorobutanoic acid, and perfluorooctanoic acid were not detected in any of the porpoise livers. Although we investigated a potential intraspecies segregation according to the source of prey, using stable isotopes, no statistically significant correlation between PFOS concentrations and stable isotopes could be determined. It is, however, noteworthy that the contamination by PFOS in the Black Sea harbor porpoises is comparable to levels found in porpoises from the German Baltic Sea and from coastal areas near Denmark and, therefore, might pose a threat to this population.				1						1												B	-	ネズミイルカ、肝臓、腎臓、筋肉、脳、脂肪中のPFAS	
265	蓄積性	Verreault, Jonathan; Berger, Urs; Gabrielsen, Geir W	Trends of perfluorinated alkyl substances in he	2007	Environ Sci Technol. 2007 Oct 1;41(19):6671-7. doi: 10.1021/es070723j.	The present study reports on concentrations, patterns, and temporal trends (1983, 1993, and 2003) of 16 perfluorinated alkyl substances (PFAS) in whole eggs of herring gulls (Larus argentatus) from two geographically isolated colonies in northern Norway. Perfluorooctane sulfonate (PFOS) was the predominant PFAS in all eggs with mean concentrations up to 42 ng/g wet weight (ww) in samples from 2003. Perfluorohexane sulfonate (PFHxS) and perfluorodecane sulfonate (PFDcS) were found at concentrations several orders of magnitude lower than PFOS. The general accumulation profile of perfluorocarboxylates (PFCAs) in herring gull eggs was characterized by high proportions of odd and long carbon (C) chain length compounds in which perfluoroundecanoate (C11) and perfluorotridecanoate (C13) dominated with mean concentrations up to 4.2 and 2.8 ng/g ww, respectively. In both colonies PFOS concentrations in eggs showed a nearly 2-fold significant increase from 1983 to 1993, followed by a leveling off up to 2003. A comparable trend was found for PFHxS, whereas PFDcS was found to increase also between 1993 and 2003. PFCA concentrations showed marked significant increases during 1983-1993 associated with either a weak rise post-1993 (C8- to C11-PFCAs), although nonsignificant, or leveling off (C12- and C13-PFCAs). However, the composition of individual PFCAs (C8 to C15) to the summed concentrations of those eight PFCAs highly differed between the colonies and sampling years investigated. Present results suggest that direct and indirect local- and/or remote-sourced inputs (atmospheric and waterborne) of PFCAs have changed over the last twodecades in these two coastal areas of Northern Norway.				1						1								1				B	-	北ノルウェー、全卵、16PFAS	
266	環境中運命	Vierke, Lena; Möller, Axel; Klitzke, Sondra	Transport of perfluoroalkyl acids in a water-sat	2014	Environ Pollut. 2014 Mar;186:7-13. doi: 10.1016/j.envpol.2013.11.011. Epub 2013 Dec 14.	The aim of this study was to gain an understanding of the transport of C4-10 perfluoroalkyl carboxylic acids (PFCAs) and C4,6,8 perfluoroalkyl sulfonic acids (PFSAs) in a water-saturated sediment column representing a riverbank filtration scenario under near-natural conditions. Short-chain PFCAs and PFSAs with up to six C-atoms showed complete tracer-like breakthrough. Longer chain ones were retarded due to sorption to the sediment or due to other processes in the aqueous phase. The study reports the first column derived sediment-water partition coefficients ranging from 0.01 cm(3) g(-1) to 0.41 cm(3) g(-1) for C4,6 PFSAs and from 0.0 cm(3) g(-1) to 6.5 cm(3) g(-1) for C4,5,6,8,9 PFCAs. The results clearly indicate that short-chain PFCAs and PFSAs may pose a problem if contaminated surface waters are used for drinking water production via riverbank filtration.				1						1												B	-	カラム試験、水から底質への移行、C4-10のPFAS	
267	環境中運命	Wang, Fei; Shih, Kaimin	Adsorption of perfluorooctanesulfonate (PFOS	2011	Water Res. 2011 Apr;45(9):2925-30. doi: 10.1016/j.watres.2011.03.007. Epub 2011 Mar 15.	The persistent nature of perfluorochemicals (PFCs) has attracted global concern in recent years. Perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) are the most commonly found PFC compounds, and thus their fate and transport play key roles in PFC distribution in the natural environment. As most solid phases in natural water contain alumina, an investigation of PFOS and PFOA adsorption behavior on alumina should prove useful in evaluating the environmental impact of this type of persistent pollutant. Systematic experiments were carried out in this study to investigate the adsorption behavior of PFOS and PFOA onto alumina. The results of adsorption kinetics on alumina show that it takes 48 h to reach equilibrium. The adsorption isotherms reveal maximum adsorption capacities of 0.252 μg/m(2) for PFOS and 0.157 μg/m(2) for PFOA at pH = 4.3, with the difference primarily due to their different functional groups. An increase in pH leads to a decrease in PFOS and PFOA adsorption on alumina, which may be attributed to the reduction in electrostatic interaction. The adsorption of both PFOS and PFOA decreases with an increase in ionic strength for all four types of cations (Na(+), K(+), Mg(2+), and Ca(2+)), due to the compression of the electrical double layer. Furthermore, the results also indicate that both Ca(2+) and Mg(2+) can form bridges with PFOA anions in solution, whereas only PFOS can be bridged by Ca(2+) due to the higher covalent nature of magnesium.				1						1												B	-	PFOS、PFOAのアルミナへの吸着特性実験	
268	環境中運命	Wang, Fei; Shih, Kaimin; Leckie, James O	Effect of humic acid on the sorption of perfluor	2015	Chemosphere. 2015 Jan;118:213-8. doi: 10.1016/j.chemosphere.2014.08.080. Epub 2014 Sep 29.	The sorption of PFOS and PFBS on boehmite was significantly retarded by the competitive sorption of humic acid (HA), implying that PFOS and PFBS are likely more mobile in water and groundwater systems enriched with HA. The sorption behavior of PFOS and PFBS on the HA-modified boehmite surface were also found to differ due to their different chain lengths. For a partially HA-modified boehmite surface, the isotherm study showed that PFOS had a much higher maximum sorption capacity than PFBS and that PFOS might possess additional surface interactions besides electrostatic interaction. For a HA-saturated boehmite, a linear sorption isotherm was found for PFOS while nearly no PFBS sorption was observed. This indicates that sorption behavior between PFOS and the sorbed HA on boehmite was dominated by hydrophobic interactions, instead of electrostatic interaction. In addition, a conceptual model combining hydrophobic and electrostatic interaction was established to explain the sorption behavior of PFOS and PFBS on HA-modified boehmite. Finally, the results revealed that the sorption of PFOS and PFBS on HA-modified boehmite is pH-dependent. The neutralization of negative sites on HA-modified boehmite reduced the electrostatic repulsion and enhanced the partitioning of PFBS on the sorbed HA.				1						1												B	-	PFOS、PFOAのベーマイトへのフミン酸との競合吸着	
269	環境中運命	Wen, Bei; Li, Longfei; Zhang, Hongna; Ma, Yibing; Shan, Xiao-Quan; Zhang, Shuzhen	Field study on the uptake and translocation of	2014	Environ Pollut. 2014 Jan;184:547-54. doi: 10.1016/j.envpol.2013.09.040. Epub 2013 Oct 31.	Field experiments were performed to evaluate the uptake and translocation of perfluoroalkyl acids (PFAAs) in wheat (Triticum aestivum L.) grown in soils amended with biosolids at different rates. Nine perfluorocarboxylic acids (PFCAs) and three perfluorosulfonic acids (PFSAs) were detected in the soils and wheat tissues. Total concentrations of PFAAs in the soils and wheat root, straw, husk and grain increased with increasing application of biosolids. PFCA concentrations in grain increased logarithmically with increasing PFCA concentrations in soils ($P < 0.01$) while PFSAs in grain were correlated linearly with PFSA concentrations in soils ($P < 0.01$), indicating that PFCAs and PFSAs may have different transport pathways from soil to grain. While no significant correlation was found between the root concentration factors (Croot/Csoil) and PFAA carbon chain length, the transfer factors from roots to straws (Cstraw/Croot) and from straws to grains (Cgrain/Cstraw) correlated negatively with PFAA carbon chain length ($P < 0.01$).				1						1	1											B	-	現場試験、土壌からの小麦のPFASの吸収	
270	蓄積性	Zafeiraki, Effrosyni; Gebbink, Wouter A; Hoogenboom, Ron L A P; Kotterman, Michiel; Kwadijk, Christiaan; Dassenakis, Emmanouil; van Leeuwen, Stefan P J	Occurrence of perfluoroalkyl substances (PFAS	2019	Chemosphere. 2019 Oct;232:415-423. doi: 10.1016/j.chemosphere.2019.05.200. Epub 2019 May 24.	A range of perfluoroalkyl substances (PFASs) was analysed in marine fish, farmed fish, crustaceans, bivalves and European eel caught in (mostly) Dutch waters, or purchased at Dutch markets (approximately 250 samples, collected between 2012 and 2018). Σ PFAS levels were highest in eels collected from rivers and lakes (average 43.6 ng/g and max 172 ng/g), followed by shrimps collected near the Dutch coast (average 6.7 and max. 33 ng/g ww), and seabass (average 4.5 and max. 9.4 ng/g ww). Most of the farmed fish (e.g. trout, catfish, turbot, salmon, tilapia, pangasius) were among the lowest contaminated samples in this study (averages ranged from 0.06 to 1.5 ng/g ww). Geographically, levels in marine fish from the northern North Sea (e.g. haddock, whiting, herring) were lower than in the central and southern North Sea (e.g. cod and flatfish). Concerning eel, no substantial geographical differences were found (apart from two distinct locations). The contamination pattern was similar in all species, where PFOS mostly dominated the profile, and other long-chain PFASs being frequently detected. Short-chain PFASs were rarely found. PFOS concentrations in eel varied from 3.3 ng/g (close to the North Sea) to 67 ng/g ww in eel caught from Ghent-Terneuzen canal. The majority of detected PFOS levels in eels (93%) and 1 shrimp sample from Eems-Dollard exceeded the EU Environmental Quality Standard (EQS) for surface water of 9.1 μg/kg ww. Other samples (e.g. shrimps, bivalves, flounder), subject to the EQS, did not exceed this level.				1						1												B	-	オランダの水中、あるいはオランダマーケットの海洋魚、養殖魚、甲殻類、二枚貝、ヨーロッパウナギ中のPFAS	
271	環境中運命	Zhang, Huanhuan; Liu, Wei; He, Xin; Wang, Yu; Zhang, Qian	Uptake of perfluoroalkyl acids in the leaves of	2015	Environ Toxicol Chem. 2015 Jul;34(7):1499-504. doi: 10.1002/etc.2968. Epub 2015 May 5.	Analytical methods for determining perfluoroalkyl acids (PFAAs) in leaves were developed to quantify a suite of analytes in both coniferous and deciduous broad-leaved trees. Sodium hydroxide-methanol and solid-phase extraction was selected as the extracting and cleanup strategy for PFAA analysis. Ten perfluorocarboxylic acids (PFCAs) and 4 perfluorosulfonic acids (PFSAs) were monitored in 7 kinds of leaves grown in the urban areas of Dalian, China. The results show that coniferous tree leaves take up more PFAAs than broad-leaved tree leaves, with the highest amount of 150 ng/g in pine needles. Leaf PFCA levels were much higher than PFSAs level. Short carbon-chain PFCAs with 3 to 6 perfluorinated carbons account for approximately 40% to 80% of the total leaf PFAAs, where uptake decreased with increasing carbon chain length. Temporal observation of leaf PFAAs revealed no significant variation of concentrations in the leaves over a weekly interval and the absence of significant seasonal change in pine needles and sophora. The present study provides some evidence for the accumulation of PFAAs in leaves, which is valuable for understanding their environmental behavior and the development of alternative bioindicator.				1						1												B	-	葉、PFAS	
272	環境中運命	Zhao, Lixia; Bian, Jingna; Zhang, Yahui; Zhu, Lingyan; Liu, Zhengtao	Comparison of the sorption behaviors and mec	2014	Chemosphere. 2014 Nov;114:51-8. doi: 10.1016/j.chemosphere.2014.03.098. Epub 2014 May 8.	The sorption of four perfluoroalkyl acids (PFAAs) [perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid (PFOA) and perfluorohexanoic acid (PFHxA)] on three typical minerals [montmorillonite (MM), kaolinite (KL) and hematite (HM)] was studied. The sorption of PFOS and PFHxS was much stronger than PFOA and PFHxA. The sorption of each PFAA on the minerals followed an order of HM>KL>MM, even though MM was positively while KL and HM were negatively charged, implying that the sorption is driven by some other interactions besides electrostatic attraction. The sorption decreased with an increase in pH and a decrease in ionic strength of the solution, and their impacts on PFOS were much stronger than other three PFAAs. Surface complexing and hydrogen-bonding could make great contributions to the sorption of PFOS on the minerals. The results are important for understanding the transport and fate of PFAAs in sediment and ground water.			1	1						1												B	-	鉱物への吸着、4PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
273	環境中運命	Zhou, Yunqiao; Wang, Tieyu; Jiang, Zhaoze; Kong, Xiaoxiao; Li, Qifeng; Sun, Yajun; Wang, Pei; Liu, Zhaoyang	Ecological effect and risk towards aquatic plan	2017	Chemosphere. 2017 Jan;167:98-106. doi: 10.1016/j.chemosphere.2016.09.146. Epub 2016 Oct 3.	In the present study, the concentrations and proportions of perfluoroalkyl substances (PFASs) in water and sediments (in different seasons) from the Qing River were investigated. The highest concentration of PFASs in water (207.59 ng L(-1)) was found in summer. The composition of PFASs in water changed with time, perfluorobutane sulfonate (PFBS) was the predominant compound in spring and summer, while long-chain PFASs, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), started to increase in autumn and winter. The PFASs concentration in sediments ranged from 0.96 to 4.05 ng g(-1) dw. The proportion of long-chain PFASs was higher than that of short-chain PFASs in sediments, the dominant component in sediments was PFOA with a contribution of 24.6-75.4% to total PFASs in sediments, followed by PFOS. The concentrations of PFASs in roots of emergent plants were relatively higher than those in submerged plants. However, the translocation effect of PFASs was not remarkable. Bioaccumulation factors (BAFs) of the aquatic plants indicated the absorption of PFASs were effective. BAFs in submerged plants basically increased with increasing chain length accordingly. In general, aquatic plants had the absorption preference for long-chain PFASs, especially PFOS, which was the predominant compounds in both submerged and emergent plants. Based on the results above, hornworts were selected to be cultivated indoor in the nutrient solution spiked gradient concentrations of PFOS to assess the general ecological risk. The results revealed that hornworts were resistant to PFOS and might be used asremediation flora to eliminate PFOS contamination.				1						1													B	-	中国、水と土壌、PFAS	
274	蓄積性	Zhou, Zhen; Liang, Yong; Shi, Yali; Xu, Lin; Cai, Yaqi	Occurrence and transport of perfluoroalkyl acid	2013	Environ Sci Technol. 2013 Aug 20;47(16):9249-57. doi: 10.1021/es402120y. Epub 2013 Aug 8.	Short-chain perfluoroalkyl acids (PFAAs), which have less than seven fluorinated carbons, have been introduced as substitutes for eight-carbon homologue products. In this study, water, sediment, and biological samples (fish and plant) were collected from Tangxun Lake, which is located near a production base of the fluorochemical industry in Wuhan, China. Perfluorobutane sulfonate (PFBS) and perfluorobutanoic acid (PFBA) were the predominant PFAAs in surface water, with average concentrations of 3660 ng/L and 4770 ng/L, respectively. However, perfluorooctane sulfonate (PFOS) was the most abundant PFAA in sediments, with an average concentration of 74.4 ng/g dw. The organic carbon normalized distribution coefficients (KOC) indicated that short-chain PFAAs (CF2 < 7) tended to have lower adsorption potentials than PFOS, perfluorooctanoic acid (PFOA), and longer perfluoroalkyl chain compounds. PFBS and PFBA could transport to a farther distance in the horizontal direction along the water flow and infiltrate into deeper depths in the vertical direction. However, levels of PFOS and PFOA in water dropped exponentially along the current, and their proportions were decreased gradually with the increasing depth in sediment cores. Furthermore, values of log bioconcentration factor (BCF) of the short-chain PFAAs were all relatively low (<1), indicating no bioaccumulation potentials for short-chain PFAAs in aquatic species.	1			1						1													B	-	中国、水と底泥と生物試料、短鎖PFAS	
275	環境中運命	Armitage, James; Cousins, Ian T; Buck, Robert C; Prevedouros, Konstantinos; Russell, Mark H; MacLeod, Matthew; Korzeniowski, Stephen H	Modeling global-scale fate and transport of pe	2006	Environ Sci Technol. 2006 Nov 15;40(22):6969-75. doi: 10.1021/es0614870.	The long-term (1950-2050) global fate of perfluorooctanoate (PFO) is investigated using the global distribution model, GloboPOP. The model is used to test the hypotheses that direct PFO emissions can account for levels observed in the global oceans and that ocean water transport to the Arctic is an important global distribution pathway. The model emission scenarios are derived from historical and projected PFO emissions solely from direct sources. Modeled ocean water concentrations compare favorably to observed PFO concentrations in the world's oceans and thus ocean inventories can be accounted for by direct sources. The model results support the hypothesis that long-range ocean transport of PFO to the Arctic is important and estimate a net PFO influx of approximately 8-23 tons per year flowing into the model's Northern Polar zone in 2005, an amount at least 1 order of magnitude greater than estimated PFO flux to the Arctic from potential indirect sources such as atmospheric transport and degradation of fluorotelomer alcohols. Modeled doubling times of ocean water concentrations in the Arctic between 1975 and 2005 of approximately 7.5-10 years are in good agreement with doubling times of PFO in Arctic biota estimated from monitoring data. The model is further applied to predict future trends in PFO contamination levels using forecasted (2005-2050) direct emissions, including substantial reductions committed to by industry. Modeled ocean water concentrations in zones near to sources decline markedly after 2005, whereas modeled concentrations in the Arctic are predicted to continue to increase until approximately 2030 and show nosignificant decrease for the remaining 20 years of the model simulation. Since water is the primary exposure medium for Arctic biota, these model results suggest that concentrations in Arctic biota may continue to rise long after direct emissions have been substantially reduced or eliminated.		1								1					1							B	-	モデル、PFOS排出後の挙動	
276	蓄積性	Casal, Paulo; González-Gaya, Belén; Zhang, Yifeng; Reardon, Anthony J F; Martin, Jonathan W; Jiménez, Begoña; Dachs, Jordi	Accumulation of Perfluoroalkylated Substances	2017	Environ Sci Technol. 2017 Mar 7;51(5):2766-2775. doi: 10.1021/acs.est.6b05821. Epub 2017 Feb 24.	The bioaccumulation of perfluoroalkylated substances (PFASs) in plankton has previously been evaluated only in freshwater and regional seas, but not for the large oligotrophic global oceans. Plankton samples from the tropical and subtropical Pacific, Atlantic and Indian Oceans were collected during the Malaspina 2010 circumnavigation expedition, and analyzed for 14 ionizable PFASs, including perfluorooctanoate (PFOA), perfluorooctanesulfonate (PFOS) and their respective linear and branched isomers. PFOA and PFOS concentrations in plankton ranged from 0.1 to 43 ng g(dw)(-1) and from 0.5 to 6.7 ng g(dw)(-1), respectively. The relative abundance of branched PFOA in the northern hemisphere was correlated with distance to North America, consistent with the historical production and coherent with previously reported patterns in seawater. The plankton samples showing the highest PFOS concentrations also presented the largest relative abundances of branched PFOS, suggesting a selective cycling/fractionation of branched PFOS in the surface ocean mediated by plankton. Bioaccumulation factors (BAFs) for plankton were calculated for six PFASs, including short chain PFASs. PFASs Log BAFs (wet weight) ranged from 2.6 ± 0.8 for perfluorohexanesulfonic acid (PFHxS), to 4.4 ± 0.6 for perfluoroheptanoic acid (PFHpA). The vertical transport of PFASs due to the settling of organic matter bound PFAS (biological pump) was estimated from an organic matter settling fluxes climatology and the PFAS concentrations in plankton. The global average sinking fluxes were 0.8 ± 1.3 ng m(-2)d(-1) for PFOA, and 1.1 ± 2.1 ng m(-2)d(-1)for PFOS. The residence times of PFAS in the surface ocean, assuming the biological pump as the unique sink, showed a wide range of variability, from few years to millennia, depending on the sampling site and individual compound. Further process-based studies are needed to constrain the oceanic sink of PFAS.		1								1												B	-	プランクトン、生物濃縮、PFAS	
277	蓄積性	Chu, Shaogang; Letcher, Robert J; McGoldrick, Daryl J; Backus, Sean M	A New Fluorinated Surfactant Contaminant in	2016	Environ Sci Technol. 2016 Jan 19;50(2):669-75. doi: 10.1021/acs.est.5b05058. Epub 2015 Dec 28.	Environmental contamination and regulation of longer-chain perfluoroalkyl substances (PFASs) such as perfluorooctanesulfonate (PFOS) has given rise to the increased use of shorter-chain PFASs as alternatives in new products, although confirmation of their presence in the environment remains limited. In this study, the PFAS alternative, perfluoro-1-butane-sulfonamide (FBSA), was identified for the first time in biota in homogenate samples of fish by liquid chromatography-quadrupole time-of-flight mass spectrometry (LC-Q-ToF-MS) and quantified by ultra high performance liquid chromatography-triple quadrupole mass spectrometry (UHPLC-QQQ-MS/MS). In one flounder (Platichthys flesus) muscle sample from the Western Scheldt, The Netherlands, FBSA concentration was at 80.12 ng/g wet weight (w.w.) and was exceeded only by PFOS. FBSA was also detected in 32 out of 33 samples of freshwater fish collected (2009-2010) from water bodies across Canada. In lake trout (Salvelinus namaycush) from northern Canada (e.g., Lake Kusawa (Yukon Territory), Great Bear Lake (Northwest Territories and in the Arctic), and Lake Athabasca (northern Alberta)), the concentrations of FBSA ranged from below method detection limit (<0.01 ng/g w.w) to 0.44 ng/g w.w. and were much lower than those reported for lake trout from the more urbanized and industrialized Laurentian Great Lakes sites (3.17 ± 1.53 ng/g w.w.). In three species of fish purchased from a supermarket in Ottawa (ON, Canada), FBSA concentrations were the lowest of all fish and ranged from < MLOD to 0.29 ng/g w.w. and 0.03 to 0.76 ng/g w.w. in muscle and liver, respectively. FBSA is abioaccumulative contaminant in fish in Canada and possibly in The Netherlands. It is likely sourced from new alternative perfluorobutane-based products, as well as other shorter chain perfluoroalkyl-based products.			1								1											B	-	生物試料、ペルフオロブタンスルホンアミド	
278	環境中運命	Dasu, Kavitha; Lee, Linda S; Turco, Ronald F; Nies, Loring F	Aerobic biodegradation of 8:2 fluorotelomer ste	2013	Chemosphere. 2013 Apr;91(3):399-405. doi: 10.1016/j.chemosphere.2012.11.076. Epub 2013 Jan 3.	Aerobic biodegradation of 8:2 fluorotelomer stearate (FTS) and 8:2 fluorotelomer citrate triester (TBC) was evaluated in a forest soil in closed bottle microcosms. Loss of parent, production of 8:2 fluorotelomer alcohol (8:2 FTOH), which is released along with stearic acid (SA) by microbial ester linkage, and subsequent metabolites from FTOH degradation were monitored for up to 7months. Soil microcosms were extracted with ethyl acetate followed by two heated 90/10 v/v acetonitrile/200mM NaOH extractions. Cleavage of the ester linkage in the 8:2 FTS occurred (t1/2~28d), producing 8:2 FTOH and various levels of subsequent metabolites. Quantifying the generation of SA from ester cleavage in FTS was complicated by the natural production and degradation of SA in soil, which was probed in an additional FTS and SA study with the same soil that had been stored at 4° C for 12months. In the latter study, FTS degraded faster (t1/2~5d) such that SA production well above soil background levels was clearly observed along with rapid subsequent SA degradation. Cold storage was hypothesized to enrich fungal enzymes, which are known to be effective at hydrolytic cleavage. 8:2 TBC biotransformation was slow, but evident with the production of PFOA well above levels expected from known FTOH residuals. Slower degradation of TBC compared to FTS is likely due to steric hindrances arising from the close proximity of three 8:2 FT chains on the citrate backbone limiting the enzyme access.			1								1											B	-	土壌中の好気性分解、8:2フルオロテロマー酸	
279	環境中運命	Dasu, Kavitha; Liu, Jinxia; Lee, Linda S	Aerobic soil biodegradation of 8:2 fluorotelome	2012	Environ Sci Technol. 2012 Apr 3;46(7):3831-6. doi: 10.1021/es203978g. Epub 2012 Mar 16.	A laboratory investigation on the biotransformation of 8:2 fluorotelomer stearate monoester (8:2 FTS) in aerobic soils was conducted by monitoring the loss of 8:2 FTS, production of 8:2 fluorotelomer alcohol (8:2 FTOH) and stearic acid, which would be released by cleavage of the ester linkage, and subsequent degradation products from FTOH for 80 d. Soil microcosms were extracted with ethyl acetate followed by two heated 90/10 v/v acetonitrile/200 mM NaOH extractions. 8:2 FTS was degraded with an observed half-life (t(1/2)) of 10.3 d. The rate of 8:2 FTS biotransformation substantially decreased after 20 d with 22% of 8:2 FTS still remaining on day 80. No biotransformation of 8:2 FTS occurred in autoclaved soil controls, which remained sterile with 102 ± 6% recovery, through day 20. 8:2 FTOH was generated with cleavage of the ester linkage of 8:2 FTS followed by a rapid decline (t(1/2) ~ 2 d) due to subsequent biodegradation. All the expected 8:2 FTOH degradation products were detected including 8:2 fluorotelomer unsaturated and saturated carboxylic acids, 7:2s FTOH, 7:3 acid, and three perfluoroalkyl carboxylic acids with the most prominent being perfluorooctanoic acid (PFOA). PFOA consistently increased over time reaching 1.7 ± 0.07 mol % by day 80. Although cleavage of the ester linkage was evidenced by 8:2 FTOH production, an associated trend in stearic acid concentrations was not clear because of complex fatty acid metabolism dynamics in soil. Further analysis of mass spectrometry fragmentation patterns and chromatography supported the conclusion that hydrolysis of the ester linkage is predominantly the first step in thedegradation of 8:2 FTS with the ultimate formation of terminal products such as PFOA.			1								1											B	-	好気性土壌、生物変換、8:2フルオロテロマー酸	
280	蓄積性	de Solla, S R; De Silva, A O; Letcher, R J	Highly elevated levels of perfluorooctane sulfor	2012	Environ Int. 2012 Feb;39(1):19-26. doi: 10.1016/j.envint.2011.09.011. Epub 2011 Oct 29.	Per- and poly-fluorinated compounds (PFCs), which include perfluorinated carboxylates (PFCAs) and sulfonates (PFSAs) and various precursors, are used in a wide variety of industrial, commercial and domestic products. This includes aqueous film forming foam (AFFF), which is used by military and commercial airports as fire suppressants. In a preliminary assessment prior to this study, very high concentrations (>1 ppm wet weight) of the PFSA, perfluorooctane sulfonate (PFOS), were discovered in the plasma of snapping turtles (Chelydra serpentina) collected in 2008 from Lake Niapenco in southern Ontario, Canada. We presently report on a suite of C(6) to C(15) PFCAs, C(4), C(6), C(8) and C(10) PFSAs, several PFC precursors (e.g. perfluorooctane sulfonamide, PFOSA), and a cyclic perfluorinated acid used in aircraft hydraulic fluid, perfluoroethylcyclohexane sulfonate (PFECHS) in surface water from the Welland River and Lake Niapenco, downstream of the John C. Munro International Airport, Hamilton, Ontario, Canada. Amphipods, shrimp, and water were sampled from the Welland River and Lake Niapenco, as well as local references. The same suite of PFCs in turtle plasma from Lake Niapenco was compared to those from other southern Ontario sites. PFOS dominated the sum PFCs in all substrates (e.g., >99% in plasma of turtles downstream the Hamilton Airport, and 72.1 to 94.1% at all other sites). PFOS averaged 2223(±247.1SE) ng/g in turtle plasma from Lake Niapenco, and ranged from 9.0 to 171.4 elsewhere. Mean PFOS in amphipods and in water were 518.1(±83.8)ng/g and 130.3(±43.6) ng/L downstream of the airport, and19.1(±2.7) ng/g and 6.8(±0.5) ng/L at reference sites, respectively. Concentrations of selected PFCs declined with distance downstream from the airport. Although there was no known spill event or publicly reported use of AFFF associated with a fire event at the Hamilton airport, the airport is a likely major source of PFC contamination in the Welland River.			1								1											B	-	カナダ、河川、湖、端脚類、エビ、PFAS	
281	蓄積性	Falandysz, J; Taniyasu, S; Yamashita, N; Rostkowski, P; Zalewski, K; Kannan, K	Perfluorinated compounds in some terrestrial a	2007	J Environ Sci Health A Tox Hazard Subst Environ Eng. 2007 May;42(6):715-9. doi: 10.1080/10934520701304369.	Perfluorooctanesulfonate (PFOS) at 1.6-39 ng/g ww and 4.8-200 pg/mL, respectively, perfluorooctanoate (PFOA) at 0.06-0.28 ng/g ww and<0.05-1.8 pg/mL, and perfluorodecanoate (PFDA) at 0.13-0.57 ng/g ww and 0.05-1.8 pg/mL, were detected in all specimens of European Beaver's (Castor fiber) liver as well as in whole blood of Cod (Gadus morhua), Velvet Scoter (Melanitta fusca), Eider Duck (Sommateria mollisima), Long-tailed Duck (Clangula hyemalis), Razorbill (Alca torda), Red-throated Diver (Gavia stellata) sampled in Poland. At smaller concentrations and at less frequency was perfluorononanoate (PFNA) at 0.05-1.4 ng/g ww and<0.2-2 pg/mL, perfluorohexanoate (PFHxA) at 0.03-0.23 ng/g ww and<0.05-0.69 pg/mL, while perfluorohexanesulfonate (PFHxS) at 0.05-4.3 pg/mL and perfluorooctanesulfonamidoacetate (PFOSA) at 0.1-13 pg/mL were also found in Cod as well as in molluscivorous diving-ducks and fish-eating birds but not in Beaver, while perfluoroheptanoate (PFHpA) at<0.05-0.74 pg/mL was found only in Cod.			1								1											B	-	ポーランド、哺乳類の肝臓・全血、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
282	蓄積性	Falk, Sandy; Brunn, Hubertus; Schröter-Kermani, Christa; Failing, Klaus; Georgii, Sebastian; Tarricone, Kathrin; Stahl, Thorsten	Temporal and spatial trends of perfluoroalkyl s	2012	Environ Pollut. 2012 Dec;171:1-8. doi: 10.1016/j.envpol.2012.07.022. Epub 2012 Aug 4.	For more than 50 years perfluoroalkyl substances (PFASs) have found worldwide industrial and household uses. Some PFASs are presumed to be persistent and bioaccumulative. Roe deer (Capreolus capreolus) are thought to be a suitable bioindicator for the accumulation of organic xenobiotics. Due to the ubiquitous nature of PFASs in the environment a retrospective study on temporal trends was carried out. A total of 110 deer liver pools collected from 1989 to 2010 in Germany were analyzed for their levels of PFASs. The highest concentrations were measured for perfluorooctane sulfonate (PFOS) (median 6.3 μg/kg). Perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) were detected with median concentrations of 0.5 μg/kg, 1.2 μg/kg and 0.3 μg/kg, respectively, while concentrations of the other PFASs were below the limit of quantification. PFOS concentrations decreased significantly (r(s) = -0.741; p = <0.0001) from 9.2 μg/kg in 2000 to 1.8 μg/kg in 2010.		1									1									B	-	ドイツ、1989-2010、鹿の肝臓、PFAS	
283	環境中運命	Filipovic, Marko; Berger, Urs; McLachlan, Michael S	Mass balance of perfluoroalkyl acids in the Bal	2013	Environ Sci Technol. 2013 May 7;47(9):4088-95. doi: 10.1021/es400174y. Epub 2013 Apr 11.	A mass balance was assembled for perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorodecanoic acid (PFDA), and perfluorooctanesulfonic acid (PFOS) in the Baltic Sea. Inputs (from riverine discharge, atmospheric deposition, coastal wastewater discharges, and the North Sea) and outputs (to sediment burial, transformation of the chemical, and the North Sea), as well as the inventory in the Baltic Sea, were estimated from recently published monitoring data. Formation of the chemicals in the water column from precursors was not considered. River inflow and atmospheric deposition were the dominant inputs, while wastewater treatment plant (WWTP) effluents made a minor contribution (<5%). A mass balance of the Oder River watershed was assembled to explore the sources of the perfluoroalkyl acids (PFAAs) in the river inflow. It indicated that WWTP effluents made only a moderate contribution to riverine discharge (21% for PFOA, 6% for PFOS), while atmospheric deposition to the watershed was 1-2 orders of magnitude greater than WWTP discharges. The input to the Baltic Sea exceeded the output for all four PFAAs, suggesting that inputs were higher during 2005-2010 than during the previous 20 years despite efforts to reduce emissions of PFAAs. One possible explanation is the retention and delayed release of PFAAs from atmospheric deposition in the soils and groundwater of the watershed.		1									1									B	-	バルト海、流入と流出のマスバランス、PFAS	
284	環境中運命	Gellrich, V; Stahl, T; Knepper, T P	Behavior of perfluorinated compounds in soils	2012	Chemosphere. 2012 May;87(9):1052-6. doi: 10.1016/j.chemosphere.2012.02.011. Epub 2012 Mar 3.	Perfluorinated compounds (PFCs) can be detected worldwide in both, soil and water. In order to study the leaching behavior of this heterogeneous group of compounds in soil, flow-through column experiments have been conducted. Ten perfluoro carboxylates and four perfluoro sulfonates ranging from C4 to C14 in chain length, and contaminated sewage sludge, have been used to spike a standard soil. The aqueous column effluent was analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS) with direct injection. The observed percolation velocity seems to be strongly correlated with the length of the perfluorinated chain. Other factors that additionally contribute to the leaching behavior are the functional group of the PFC, the organic carbon content of the soil and the presence of other adsorbates. A mass balance calculation showed that perfluorobutanoic acid can adsorb strongly to the soil, when no PFC with longer carbon chain are present. Only about 60% of the added perfluorobutanoic acid could be detected in the percolate water. The missing amount started to elute again when longer chain PFC or stearate were added to the soil. Thus it would appear that larger and more lipophilic molecules can displace shorter PFC from their binding sites in the soil. The results of a monitoring study using 32 surface water samples and 150 groundwater samples confirm that the PFC with the highest concentrations in groundwater are the short chain PFC with less than 7 (fluorinated) carbon atoms. The dominating PFC in surface waters are perfluorooctanoic acid and perfluorooctane sulfonic acid.		1									1									B	-	カラム試験、土壌からの溶出、C4-14PFAS	
285	蓄積性	Gulkowska, Anna; Jiang, Qinting; So, Man Ka; Taniyasu, Sachi; Lam, Paul K S; Yamashita, Nobuyoshi	Persistent perfluorinated acids in seafood colle	2006	Environ Sci Technol. 2006 Jun 15;40(12):3736-41. doi: 10.1021/es060286t.	As an initial survey of human exposure to perfluorinated acids through food consumption in China, seven types of seafood collected from fish markets in two coastal cities were analyzed. Nine perfluorinated compounds were determined using HPLC coupled with ESI-MS/MS. Perfluorooctane sulfonate (PFOS) was the predominant fluorochemical and was found in all 27 seafood samples, including fish, molluscs, crabs, shrimp, oysters, mussels, and clams. Concentrations of PFOS in seafood samples ranged from 0.3 to 13.9 ng/g wet weight, with the highest concentration in mantis shrimp. The hazard ratios of noncancer risk through seafood consumption based on PFOS and perfluorooctanoic acid concentrations were calculated and were less than unity.		1									1									B	-	中国、7種の海産食品中のPFAS	
286	蓄積性	Haukås, M.; Berger, U.; Hop, H.; Gulliksen, B.; Gabrielsen, G. W.	Bioaccumulation of per- and polyfluorinated al	2007	Environ Pollut. 2007 Jul;148(1):360-71. doi: 10.1016/j.envpol.2006.09.021. Epub 2007 Jan 25.	The present study reports concentrations and biomagnification potential of per- and polyfluorinated alkyl substances (PFAS) in species from the Barents Sea food web. The examined species included sea ice amphipod (Gammarus wilkitzkii), polar cod (Boreogadus saida), black guillemot (Cepphus grylle) and glaucous gull (Larus hyperboreus). These were analyzed for PFAS, polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethanes (DDTs) and polybrominated diphenyl ethers (PBDEs). Perfluorooctane sulfonate (PFOS) was the predominant of the detected PFAS. Trophic levels and food web transfer of PFAS were determined using stable nitrogen isotopes (delta(15)N). No correlation was found between PFOS concentrations and trophic level within species. However, a non-linear relationship was established when the entire food web was analyzed. Biomagnification factors displayed values >;1 for perfluorohexane sulfonate (PFHxS), perfluorononanoic acid (PFNA), PFOS and SigmaPFAS(7). Multivariate analyses showed that the degree of trophic transfer of PFAS is similar to that of PCB, DDT and PBDE, despite their accumulation through different pathways.		1									1									B	-	バレンツ海食物連鎖	
287	環境中運命	Hurley M.D., Sulbaek Andersen M.P., Wallington T.J., Ellis D.A., Martin J.W., and Mabury S.A.	Atmospheric Chemistry of Perfluorinated Carb	2004	The Journal of Physical Chemistry A, 108 (4), 615620. doi: 10.1021/jp036343b	Relative rate techniques were used to study the kinetics of the reactions of OH radicals with a homologous series of perfluorinated acids, F(CF2)nCOOH (n = 1, 2, 3, 4), in 700 Torr of air at 296 ± 2 K. For n > 1, the length of the F(CF2)n group had no discernible impact on the reactivity of the molecule. For n = 1, k(OH + F(CF2)nCOOH) = (9.35 ± 2.08) × 10-14 cm3 molecule-1 s-1. For n = 2−4, k(OH + F(CF2)nCOOH) = (1.69 ± 0.22) × 10-13 cm3 molecule-1 s-1. Dimerization constants for 2F(CF2)nCOOH = (F(CF2)nCOOH)2 were determined to be 0.32 ± 0.03 Torr-1, 0.30 ± 0.03 Torr-1, 0.41 ± 0.04 Torr-1, and 0.46 ± 0.05 Torr-1 for n = 1, 2, 3, 4, respectively. Atmospheric lifetimes of F(CF2)nCOOH with respect to reaction with OH radicals are estimated to be approximately 230 days for n = 1 and 130 days for n > 1. Reaction with OH radicals is a minor atmospheric fate of F(CF2)nCOOH. The major atmospheric removal mechanism for F(CF2)nCOOH is believed to be wet and dry deposition which probably occurs on a time scale of the order of 10 days.											1									B	-	大気、OHラジカルとの反応速度	
288	環境中運命	Kirchgeorg, Torben; Dreyer, Annekatrin; Gabrieli, Jacopo; Kehrwald, Natalie; Sigl, Michael; Schwikowski, Margit; Boutron, Claude; Gambaro, Andrea; Barbante, Carlo; Ebinghaus, Ralf	Temporal variations of perfluoroalkyl substanc	2013	Environ Pollut. 2013 Jul;178:367-74. doi: 10.1016/j.envpol.2013.03.043. Epub 2013 Apr 19.	The occurrence and temporal variation of 18 perfluoroalkyl substances (PFASs) and 8 polybrominated diphenyl ethers (PBDEs) in the European Alps was investigated in a 10 m shallow firn core from Colle Gnifetti in the Monte Rosa Massif (4455 m above sea level). The firn core encompasses the years 1997-2007. Firn core sections were analyzed by liquid chromatography-tandem mass spectrometry (PFASs) and gas chromatography-mass spectrometry (PBDEs). We detected 12 PFASs and 8 PBDEs in the firn samples. Perfluorobutanoic acid (PFBA; 0.3-1.8 ng L(-1)) and perfluorooctanoic acid (PFOA; 0.2-0.6 ng L(-1)) were the major PFASs while BDE 99 (<MQL-4.5 ng L(-1)) and BDE 47 (n.d.-2.6 ng L(-1)) were the major PBDEs. This study demonstrates the occurrence of PFASs and PBDEs in the European Alps and provides the first evidence that PFASs compositions may be changing to PFBA-dominated compositions.		1									1									B	-	欧州アルプス、フィルンコア、18PFAS	
289	環境中運命	Kirchgeorg, T; Dreyer, A; Gabrielli, P; Gabrieli, J; Thompson, L G; Barbante, C; Ebinghaus, R	Seasonal accumulation of persistent organic p	2016	Environ Pollut. 2016 Nov;218:804-812. doi: 10.1016/j.envpol.2016.08.004. Epub 2016 Aug 21.	The seasonal accumulations of perfluorinated substances (PFAS), polybrominated diphenyl ethers (PBDE) and polycyclic aromatic hydrocarbons (PAH) were measured in a 10 m shallow firn core from a high altitude glacier at Mt. Ortles (Italy, 3830 m above sea level) in South Tyrol in the Italian Eastern Alps. The most abundant persistent organic pollutants of each group were perfluorobutanoic acid (PFBA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) (for PFASs); BDE 47, BDE 99, BDE 209 (for PBDEs) and phenanthrene (PHE), fluoranthene (FLA) and pyrene (PYR) (for PAHs). All compounds show different extents of seasonality, with higher accumulation during summer time compared to winter. This seasonal difference mainly reflects meteorological conditions with a low and stable atmospheric boundary layer in winter and strong convective activity in summer, transformation processes during the transport of chemicals and/or post-depositional alterations. Change in the composition of the water-soluble PFCAs demonstrates the influence of meltwater percolation through the firn layers.		1									1									B	-	オルトレス山、フィルンコア、季節的な蓄積、PFAS	
290	環境中運命	Labadie, Pierre; Chevreuil, Marc	Partitioning behaviour of perfluorinated alkyl c	2011	Environ Pollut. 2011 Feb;159(2):391-7. doi: 10.1016/j.envpol.2010.10.039. Epub 2010 Nov 26.	This paper reports on the partitioning behaviour of 15 perfluorinated compounds (PFCs), including C(4)-C(10) sulfonates and C(5)-C(14) carboxylic acids, between water, sediment and fish (European chub, Leuciscus cephalus) in the Orge River (nearby Paris). Total PFC levels were 73.0 ± 3.0 ng L(-1) in water and 8.4 ± 0.5 ng g(-1) in sediment. They were in the range 43.1-4997.2 ng g(-1) in fish, in which PFC tissue distribution followed the order plasma > liver > gills > gonads > muscle. Sediment-water distribution coefficients (logK(d)) and bioaccumulation factors (logBAF) were in the range 0.8-4.3 and 0.9-6.7, respectively. Both distribution coefficients positively correlated with perfluoroalkyl chain length. Field-based biota-sediment accumulation factors (BSAFs) are also reported, for the first time for PFCs other than perfluorooctane sulfonate. logBSAF ranged between -1.3 and 1.5 and was negatively correlated with the perfluoroalkyl chain length in the case of carboxylic acids.		1									1									B	-	魚と底泥の間の15PFASの分配	
291	環境中運命	Li, Fasong; Sun, Hongwen; Hao, Zhineng; He, Na; Zhao, Lijie; Zhang, Tao; Sun, Tiehang	Perfluorinated compounds in Haihe River and t	2011	Chemosphere. 2011 Jun;84(2):265-71. doi: 10.1016/j.chemosphere.2011.03.060. Epub 2011 Apr 27.	In this study, nine perfluorinated compounds (PFCs) were investigated in water and sediment of Haihe River (HR) and Dagu Drainage Canal (DDC), Tianjin, China. The total PFCs in water samples from DDC (40-174 ngL(-1)) was much greater than those from HR (12-74 ngL(-1)). PFC contamination was severe at lower reaches of HR due to industry activities, while high PFCs were found in the middle of DDC due to the effluents from wastewater treatment plants. Perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were the predominant PFCs in aqueous phase. The total PFCs in sediments from DDC (1.6-7.7 ngg(-1) dry weight) were lower as compared to HR (7.1-16 ngg(-1)), maybe due to the dredging of sediment in DDC conducted recently. PFOS was the major PFC in HR sediments followed by PFOA; while PFHxA was the major PFC in DDC sediments. Organic carbon calibrated sediment-water distribution coefficients (K(OC)) were calculated for HR. The Log K(OC) ranged from 3.3 to 4.4 for C7-C11 perfluorinated carboxylic acids, increasing by 0.1-0.6 log units with each additional CF(2) moiety. The log K(OC) for 8:2 fluorotelomer unsaturated acid was reported for the first time with a mean value of 4.0. The log Koc of PFOS was higher than perfluorononanoic acid by 0.8 log units.		1									1									B	-	中国、環境水・底泥、9PFAS	
292	環境中運命	López-Fontán J.L., Sarmiento F., and Schulz P.C.	The aggregation of sodium perfluorooctanoate	2005	Colloid and Polymer Science, 283 (8), 862-871. doi: 10.1007/s00396-004-1228-7	The self-aggregation of sodium perfluorooctanoate (SPFO) has been studied by pH, ion-selective electrodes, changes in Rhodamine 6G colour and fluorescence, conductivity, surface tension and viscosity measurements. It has been determined that the aggregation of SPFO is gradual. It starts to aggregate at 0.01 mol dm−3 with the formation of pre-micelles of perfluorooctanoate ions, which capture counterions at C=0.02 mol dm−3 and form micelles at a critical micelle concentration (CMC) of 0.03 mol dm−3. Micelles at the CMC are highly ionised and strongly hydrated. At C*=0.06 mol dm−3, a low ionisation degree was found, indicating the formation of a more compact micellar structure. Micelles at the CMC show energetic advantage in comparison with the adsorbed state at the air/solution interface, and this advantage increases at C* originating desorption.											1									C	-	自己凝集、PFOA	
293	環境中運命	Perkola, Noora; Sainio, Pirjo	Survey of perfluorinated alkyl acids in Finnish	2013	Environ Sci Pollut Res Int. 2013 Nov;20(11):7979-87. doi: 10.1007/s11356-013-1518-z. Epub 2013 Mar 20.	The objective of the Control of Hazardous Substances in the Baltic Sea (COHIBA) project is to support the implementation of the HELCOM Baltic Sea Action Plan regarding hazardous substances by developing joint actions to achieve the goal of "a Baltic Sea with life undisturbed by hazardous substances". One aim in the project was to identify the most important sources of 11 hazardous substances of special concern in the Baltic Sea. Among them are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). In this study, four perfluorinated alkyl acids (PFAAs) were studied: PFOA, PFOS, perfluorohexanoic acid (PFHxA) and perfluorodecanoic acid (PFDA). The occurrence of PFAAs in municipal and industrial wastewater treatment plant effluents (MWWTP1-3, IWWTP1), target industry effluent, storm water, landfill leachate and sludge was studied. Effluents were analysed six times and storm water, leachate and sludge were analysed twice, once in the warm season and once in the cold, during a 1-year sampling campaign. PFOS prevailed in two municipal effluents (MWWTP1 and 3) and industrial effluent (IWWTP1; 7.8-14, 8.0-640 and 320-1,300 ng/l, respectively). However, in one municipal effluent (MWWTP2) PFOA was, in a majority of sampling occasions, the predominant PFAA (9-15 ng/l) followed by PFOS (3.8-20 ng/l). The highest PFAA loads of the municipal effluents were found in the MWWTP3 receiving the biggest portion of industrial wastewater. In storm water the highest concentration was found for PFHxA (17 ng/l). The highest concentration of PFOS and PFOA were 9.9 and 5.1 ng/l, respectively. PFOS, PFOA and PFHxA were detectedin every effluent, storm water and landfill leachate sample, whereas PFDA was detected in most of the samples (77%). In the target industry, PFOS concentrations varied between 1,400 and 18,000 μg/l. In addition, on one sampling occasion PFOA and PFHxA were found (0.027 and 0.009 μg/l, respectively). For effluents, PFAA mass flows into the Baltic Sea were calculated. For municipal wastewater treatment plants average mass flows per day varied for PFOS between 1,073 and 38,880 mg/day, for PFOA 960 and 2,700 mg/day, for PFHxA 408 and 1,269 mg/day and for PFDA 84 and 270 mg/day. In IWWTP mass flows for PFOS, PFOA, PFHxA and PFDA were 495 mg/d, 28 mg/d, 23 mg/d and 0.6 mg/g, respectively.		1									1									B	-	バルト海、排水処理施設・雨水・浸出水・汚泥中の濃度、4PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
294	蓄積性	Powley, C. R.; George, S. W.; Russell, M. H.; Hoke, R. A.; Buck, R. C.	Polyfluorinated chemicals in a spatially and ter	2008	Chemosphere. 2008 Jan;70(4):664-72. doi: 10.1016/j.chemosphere.2007.06.067. Epub 2007 Aug 14.	This study reports on an investigation of the presence of polyfluorinated chemicals in a spatially and temporally integrated set of biological samples representing an Arctic food web. Zooplankton, Arctic cod, and seal tissues from the western Canadian Arctic were analyzed for perfluoroalkyl sulfonates [PFAS], perfluorocarboxylates [PFCAs], and other polyfluorinated acids. Perfluorooctane sulfonate [PFOS] was found in all samples [0.20-34 ng/g] and in the highest concentrations. PFCAs from nine to 12 carbons were quantified in most of the samples [0.28-6.9 ng/g]. PFCAs with carbon chain lengths of eight or less were not detected. Likewise, 44775 fluorotelomer acid [8-2 FTA] and 44775 fluorotelomer unsaturated acid [8-2 FTUA], products of fluorotelomer environmental transformation, were not detected. 2H,2H,3H,3H, heptadecafluoro decanoic acid [7-3 Acid], an additional metabolite from fluorotelomer biological transformation, was detected only in seal liver tissue [0.5-2.5 ng/g]. The ratios of branched to linear PFOS isomers in fish and seal tissue were not similar and did not match that of technical PFOS as manufactured. No branched PFCA isomers were detected in any samples. It is concluded that differing pharmacokinetics complicate the use of branched to linear ratios of PFCAs in attributing their presence to a specific manufacturing process. A statistical analysis of thedata revealed significant correlations between PFOS and the PFCAs detected as well as among the PFCAs themselves. The 44745 Acid was not correlated with either PFCAs or PFAS, which suggests that it may have a different exposure pathway.		1									1					1						B	-	大西洋の食物連鎖、動物プランクトン・北極タラ・シール組織、PFAS	
295	環境中運命	Sindiku, Omotayo; Orata, Francis; Weber, Roland; Osibanjo, Oladele	Per- and polyfluoroalkyl substances in selecte	2013	Chemosphere. 2013 Jul;92(3):329-35. doi: 10.1016/j.chemosphere.2013.04.010. Epub 2013 May 3.	Levels of seven major perfluoroalkyl carboxylates (PFCAs) and three perfluoroalkyl sulfonates (PFSAs) were analyzed for the first time in sludge from wastewater treatment plants from Nigeria. Measurements were performed using an analytical methodology using solid-phase extraction (SPE) and ultra high performance liquid chromatography tandem mass spectrometry (UHPLC-MS-MS). The method detection limit and method quantification limit was 3pg/g and 9.5pg/g for both analytes (PFCAs and PFSAs) respectively. Typical recoveries ranged from 50% to 104% for spiked mass labeled internal standards of 1ng (absolute value) to 1g of sample. All sludge samples taken from industrial, domestic and hospital wastewater treatment plants contained measurable levels of PFASs. Levels of the quantified perfluoroalkyl carboxylates and perfluoroalkyl sulfonates concentrations ranged from 10 to 597 and 14 to 540pg/g, respectively. The concentrations were therefore lower compared to sewage sludge samples reported in other regions in the world. Perfluoroalkyl carboxylates with carbon chain having ≥8 fluorinated carbons were detected in the analyzed sewage sludge samples at higher levels compared to carboxylates with <8 fluorinated carbon chain. The measured concentrations indicate that no PFAS point source for the 10 investigated sewage treatment plants existed. Furthermore the low levels in the four municipal sewage treatment plants in Lagos is a first indication that even in an African megacity like Lagos the PFASs release from households are low until now. The highest PFOS level was found in a hospital sewage sludge (539.6pg/g)possibly indicating (minor) release from medical equipment where some are known to contain PFOS. The PFASs in waste water sludge from a brewery warrant further investigations.		1									1											B	-	ナイジェリア、排水汚泥、7PFCAと3PFSA	
296	蓄積性	Taylor, Matthew D; Johnson, Daniel D	Preliminary investigation of perfluoroalkyl subs	2016	Mar Pollut Bull. 2016 Oct 15;111(1-2):509-513. doi: 10.1016/j.marpolbul.2016.06.023. Epub 2016 Jun 9.	Perfluoroalkyl substances (PFASs) are being increasingly detected in a range of aquatic and terrestrial ecosystems, often resulting from the use of legacy fire-fighting foams. This study conducted an initial investigation of the concentrations of PFASs in the commercially and recreationally exploited species Dusky Flathead, Mud Crab, School Prawn, Sea Mullet, Yellowfin Bream, Eastern King Prawn and Sand Whiting, across two contaminated estuaries. All samples contained perfluoro-n-octane sulfonate (PFOS) except four Yellowfin Bream samples (two from each estuary). Perfluoro-n-octanoic acid (PFOA) was detected only in School Prawn samples from Fullerton Cove, while perfluoro-n-hexane sulfonate (PFHxS) was detected in prawn muscle and in fish liver samples from both estuaries. This study presents one of the first surveys of PFAS in a range of edible saltwater fish and crustaceans in Australia, and these baseline levels of contamination will prove useful for informing future surveys of these emerging contaminants.		1									1											B	-	ダスキー・フラットヘッド、ノコギリガザミ、スクールエビ、ボラ、イエローフィン ブリム、イースタンキングエビ、サンドホワイティング中のPFAS	
297	生分解性	Thompson, Jack; Eaglesham, Geoff; Reungoat, Julien; Poussade, Yvan; Bartkow, Michael; Lawrence, Michael; Mueller, Jochen F	Removal of PFOS, PFOA and other perfluoroalk	2011	Chemosphere. 2011 Jan;82(1):9-17. doi: 10.1016/j.chemosphere.2010.10.040. Epub 2010 Nov 3.	This paper examines the fate of perfluorinated sulfonates (PFSAs) and carboxylic acids (PFCAs) in two water reclamation plants in Australia. Both facilities take treated water directly from WWTPs and treat it further to produce high quality recycled water. The first plant utilizes adsorption and filtration methods alongside ozonation, whilst the second uses membrane processes and advanced oxidation to produce purified recycled water. At both facilities perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA) were the most frequently detected PFCs. Concentrations of PFOS and PFOA in influent (WWTP effluent) ranged up to 3.7 and 16 ng L^{-1} respectively, and were reduced to 0.7 and 12 ng L^{-1} in the finished water of the ozonation plant. Throughout this facility, concentrations of most of the detected perfluoroalkyl compounds (PFCs) remained relatively unchanged with each successive treatment step. PFOS was an exception to this, with some removal following coagulation and dissolved air flotation/sand filtration (DAFF). At the second plant, influent concentrations of PFOS and PFOA ranged up to 39 and 29 ng L^{-1}. All PFCs present were removed from the finished water by reverse osmosis (RO) to concentrations below detection and reporting limits (0.4-1.5 ng L^{-1}). At both plants the observed concentrations were in the low parts per trillion range, well below provisional health based drinking water guidelines suggested for PFOS and PFOA.		1									1											B	-	オーストラリア、排水の再生水用処理、PFASの処理	
298	環境中運命	Wang, Ning; Szostek, Bogdan; Buck, Robert C; Folsom, Patrick W; Sulecki, Lisa M; Gannon, John T	8-2 fluorotelomer alcohol aerobic soil biodegra	2009	Chemosphere. 2009 May;75(8):1089-96. doi: 10.1016/j.chemosphere.2009.01.033. Epub 2009 Feb 12.	The biodegradation pathways and metabolite yields of [3-(14)C] 8-2 fluorotelomer alcohol [8-2 FTOH, F(CF(2))(7)(14)CF(2)CH(2)CH(2)OH) in aerobic soils were investigated. Studies were conducted under closed (static) and continuous headspace air flow to assess differences in degradation rate and metabolite concentrations in soil and headspace. Aerobic degradation pathways in soils were in general similar to those in aerobic sludge and bacterial culture. (14)C mass balance was achieved in soils incubated for up to 7 months. Up to 35% (14)C dosed was irreversibly bound to soils and was only recoverable by soil combustion. The average PFOA yield was approximately 25%. Perfluorohexanoic acid (PFHxA) yield reached approximately 4%. (14)CO(2) yield was 6.8% under continuous air flow for 33 days. Three metabolites not previously identified in environmental samples were detected: 3-OH-7-3 acid [F(CF(2))(7)CHOHCH(2)COOH], 7-2 FT ketone [F(CF(2))(7)COCH(3)] and 2H-PFOA [F(CF(2))(6)CFHCOOH]. No perfluorononanoic acid (PFNA) was observed. The formation of 2H-PFOA, PFHxA, and (14)CO(2) shows that multiple -CF(2)- groups were removed from 8-2 FTOH. 7-3 Acid [F(CF(2))(7)CH(2)CH(2)COOH] reached a yield of 11% at day 7 and did not change thereafter. 7-3 Acid was incubated in aerobic soil and did not degrade to PFOA. 7-2 sFTOH [F(CF(2))(7)CH(OH)CH(3)], a transient metabolite, was incubated and degraded principally to PFOA. 7-3 Acid may be a unique metabolite from 8-2 FTOH biodegradation. The terminal ratio of PFOA to 7-3 acid ranged between 1.8-2.5 in soils and 0.6-3.2 in activated sludge, sediment, and mixed bacterial culture.This ratio may be useful in evaluating environmental samples to distinguish the potential contribution of 8-2 FTOH biodegradation to PFOA observed versus PFOA originating from other sources.		1									1								1			B	-	試験室実験、生物処理・分解物の生成、8-2フッソ化テローマーアルコール	
299	環境中運命	Wang, Ning; Szostek, Bogdan; Buck, Robert C; Folsom, Patrick W; Sulecki, Lisa M; Capka, Vladimir; Berti, William R; Gannon, John T	Fluorotelomer alcohol biodegradation-direct ev	2005	Environ Sci Technol. 2005 Oct 1;39(19):7516-28. doi: 10.1021/es0506760.	There is increasing scientific interest to understand the environmental fate of fluorotelomer alcohols (FTOHs) and fluorotelomer-based products which may break down to FTOHs. Both are expected to enter aqueous waste streams, which would be processed in a wastewater treatment plant and therein subject to microbial biodegradation. We investigated the biodegradation of 3-14C, 1H,1H,2H,2H-perfluorodecanol [CF3(CF2)6(14)CF2CH2CH2OH, 14C-8-2 FTOH] in mixed bacterial culture and activated sludge. 14CO2 and 14C-organic volatiles in the headspace of the sealed bottles and bottles with continuous air flow were analyzed up to 4 months. After sample extraction with acetonitrile, 14C-labeled biotransformation products (metabolites) were quantified by LC/ARC (on-line liquid chromatography/ accurate radioisotope counting) and identified by quadrupole time-of-flight (Q-TOF) mass spectrometry and GC/MSD (mass selective detector). Three metabolites not yet reported in the literature have been identified as CF3(CF2)6(14)CHOHCH3 (7-2 sFTOH), CF3(CF2)6(14)CH=CHCOOH (7-3 unsaturated acid or 7-3 u acid), and CF3(CF2)6(14)CH=CHCONH2 (7-3 u amide) along with five previously reported metabolites [CF3(CF2)6(14)CF2CH2CHO (8-2 FTAL), CF3(CF2)6 (14)CF2CH2COOH (8-2 acid), CF3(CF2)6(14)CF=CHCOOH (8-2 u acid), CF3(CF2)6(14)CH2CH2COOH (7-3 acid), and CF3(CF2)6(14)COOH (PFOA)]. No CF3(CF2)6(14)CF2COOH (14C-PFNA) was observed, indicating that alpha-oxidation does not take place. It was found that strong adsorption to the activated sludge and subsequent transformation, even under continuous air flow, greatly reducedpartitioning of 8-2 FTOH or any transformation products to air. CF3(CF2)4COOH (PFHA; perfluorohexanoic acid) was observed and increased in mixed bacterial culture over 28 days and accounted for about 1% of the initial 14C-8-2 FTOH concentration from day 28 to day 90. 14CO2 accounted for 1% of initial 14C in activated sludge with continuous air flow at day 1 and increased over time. In closed bottles, 14CO2 in the headspace of activated sludge medium increased to 12% of the available 14C over 135 days with periodic addition of ethanol, as compared to 3% when no additional ethanol was added. These results show that replenishment of organic carbon enhanced microbial mineralization of multiple--CF2--groups in the fluorocarbon chain of 14C-8-2 FTOH. At day 90 the net increase of fluoride ion in the mixed bacterial culture was 93 microg L(-1), equivalent to 12% of total mineralization (destruction) of the 14C-8-2 FTOH. These results demonstrate that perfluorinated carbon bonds of 14C-8-2 FTOH are defluorinated and mineralized by microorganisms under conditions which may occur in a wastewater treatment plant, forming shorter fluorinated carbon metabolites.		1									1				1							B	-	実験、混合細菌培養・活性汚泥での微生物分解、FTOH	
300	蓄積性	Ye, Xibiao; Schoenfuss, Heiko L; Jahns, Nathan D; Delinsky, Amy D; Strynar, Mark J; Varns, Jerry; Nakayama, Shoji F; Helfant, Larry; Lindstrom, Andrew B	Perfluorinated compounds in common carp (Cy	2008	Environ Int. 2008 Oct;34(7):932-8. doi: 10.1016/j.envint.2008.02.003. Epub 2008 Apr 25.	Ten different perfluoroalkyl acids (PFAAs), including perfluooctane sulfonate (PFOS), were measured in 30 common carp (Cyprinus carpio) fillets collected from three sites on the Upper Mississippi River in Minnesota in an effort to evaluate the potential impact of PFAA emissions in this area. Samples upstream of the city of St. Cloud (reference site) had median PFOS concentrations of 8.1 ng/g wet weight (ng/g wet wt), but median levels increased significantly downstream in the Minneapolis-St. Paul urban area, with concentrations from the Pig's Eye Lake site at 26 ng/g wet wt ($p = 0.0015$) and the Spring Lake site at 40 ng/g wet wt ($p = 0.0004$). This latter PFOS concentration is within the advisory range for limiting fish consumption to one meal a week according to the Minnesota Department of Health. Other PFAAs were also found to increase significantly between the reference site and the Minneapolis-St. Paul area, but maximal concentrations remained below 2.0 ng/g wet wt. This study demonstrates the bioaccumulation of PFAAs in a ubiquitous fish species in a major urban area known to have historical inputs of various PFAA compounds. The full extent of this contamination and the potential for accumulation in other species remain to be evaluated.		1									1											B	-	米国ミシシッピ川の鯉の切り身、PFAS	
301	環境中運命	Yeung, Leo W Y; De Silva, Amila O; Loi, Eva I H; Marvin, Chris H; Taniyasu, Sachi; Yamashita, Nobuyoshi; Mabury, Scott A; Muir, Derek C G; Lam, Paul K S	Perfluoroalkyl substances and extractable orga	2013	Environ Int. 2013 Sep;59:389-97. doi: 10.1016/j.envint.2013.06.026. Epub 2013 Jul 31.	Fourteen perfluoroalkyl substances (PFASs) including short-chain perfluorocarboxylates (PFCAs, C4-C6) and perfluoroalkane sulfonates (PFSAs, C4 and C6) were measured in surface sediment samples from 26 stations collected in 2008 and sediment core samples from three stations (Niagara, Mississauga, and Rochester basins) collected in 2006 in Lake Ontario. Perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), and perfluoroundecanoate (PFUnDA) were detected in all 26 surface sediment samples, whereas perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonamide (FOSA), perfluorododecanoate (PFDoDA) and perfluorobutanoate (PFBA) were detected in over 70% of the surface sediment samples. PFOS was detected in all of the sediment core samples (range: 0.492-30.1ngg(-1) d.w.) over the period 1952-2005. The C8 to C11 PFCAs, FOSA, and PFBA increased in early 1970s. An overall increasing trend in sediment PFAS concentrations/fluxes from older to more recently deposited sediments was evident in the three sediment cores. The known PFCAs and PFSAs accounted for 2-44% of the anionic fraction of the extractable organic fluorine in surface sediment, suggesting that a large proportion of fluorine in this fraction remained unknown. Sediment core samples collected from Niagara basin showed an increase in unidentified organic fluorine in recent years (1995-2006). These results suggest that the use and manufacture of fluorinated organic compounds other than known PFCAs and PFSAs has diversified and increased.		1									1											B	-	オンタリオ湖、底泥、14PFAS	
302	環境中運命	Young, Cora J; Mabury, Scott A	Atmospheric perfluorinated acid precursors: ch	2010	Rev Environ Contam Toxicol. 2010;208:1-109. doi: 10.1007/978-1-4419-6880-7_1.	Perfluorocarboxylic acids (PFCAs) can be found from the hydrolysis of perfluoroacyl fluorides and chlorides, which can be produced in three separate ways in the atmosphere. Alternatively, PFCAs can be formed directly in the gas phase through reaction of perfluoroacyl peroxy radicals or perfluorinated aldehyde hydrates. All five mechanisms have been elucidated using smog chamber techniques. Yields of the PFCAs from this process vary from less than 10% to greater than 100%, depending on the mechanism. The formation of perfluorosulfonic acids in the atmosphere can also occur, though the mechanism has not been entirely elucidated. A large number of compounds have been confirmed as perfluorinated acid precursors, including CFC-replacement compounds, anesthetics, fluorotelomer compounds, and perfluorosulfonamides. Levels of some of these compounds have been measured in the atmosphere, but concentration for the majority have yet to be detected. It is clear that atmospheric oxidation of volatile precursors contributes to the overall burden of PFAs, though the extent to which this occurs is compound and environment dependent and is difficult to assess accurately.		1									1								1			B	-	大気、生成、PFCA	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
303	環境中運命	Zhang, Chaojie; Yan, Hong; Li, Fei; Hu, Xiang; Zhou, Qi	Sorption of short- and long-chain perfluoroalky	2013	J Hazard Mater. 2013 Sep 15;260:689-99. doi: 10.1016/j.jhazmat.2013.06.022. Epub 2013 Jun 17.	Perfluoroalkyl surfactants (PASs) have attracted increasing concerns in recent years due to their global distribution, persistence, bioaccumulation and potential toxicity. Since sludge was a significant source of PASs to environment, the sorption of short (C2-C6) and long-chain (C7-C15) PASs on different sewage sludge was investigated in this study. The equilibrium data were well represented by the Freundlich isotherm and were generally nonlinear. In order to elucidate the sorption mechanism of PASs to sludge, effect of sludge property, solution chemistry and molecular structure were also investigated in details. The dominant sludge parameter influencing sorption of PASs was protein in extracellular polymeric substances. The sorption of PASs onto sludge increased as solution pH decreased. For all the PASs homologues, enhanced adsorption occurred with increasing calcium concentration in solution. For PASs with C5-C15, sorption on sludge increases with increasing alkyl chain length, while for PASs with C2-C5, the association of sludge decreases when the alkyl chain length increases. The perfluorinated sulfonic acid (PFSA) demonstrated substantially stronger sorption than perfluorinated carboxylic acid (PFCA) analog. Evidence for both hydrophobic and electrostatic interactions was found.		1										1										B	-	汚泥へのPFASの収着	
304	環境中運命	Anderson RH, Long GC, Porter RC, et al.	Occurrence of select perfluoroalkyl substance	2016	Chemosphere. 2016 May:150:678-685. doi: 10.1016/j.chemosphere.2016.01.014. Epub 2016 Jan 16.	The use of aqueous film-forming foam (AFFF) to extinguish hydrocarbon-based fires is recognized as a significant source of environmental poly- and perfluoroalkyl substances (PFASs). Although the occurrence of select PFASs in soil and groundwater at former fire-training areas (FTAs) at military installations operable since 1970 has been consistently confirmed, studies reporting the occurrence of PFASs at other AFFF-impacted sites (e.g. emergency response locations, AFFF lagoons, hangar-related AFFF storage tanks and pipelines, and fire station testing and maintenance areas) are largely missing from the literature. Further, studies have mostly focused on a single site (i.e., FTAs at military installations) and, thus, lack a comparison of sites with diverse AFFF release history. Therefore, the purpose of this investigation was to evaluate select PFAS occurrence at non-FTA sites on active U.S. Air Force installations with historic AFFF use of varying magnitude. Concentrations of fifteen perfluoroalkyl acids (PFAAs) and perfluorooctane sulfonamide (PFOSA), an important PFOS precursor, were measured from several hundred samples among multiple media (i.e., surface soil, subsurface soil, sediment, surface water, and groundwater) collected from forty AFFF-impacted sites across ten installations between March and September 2014, representing one of the most comprehensive datasets on environmental PFAS occurrence to date. Differences in detection frequencies and observed concentrations due to AFFF release volume are presented along with rigorous data analyses that quantitatively demonstrate phase-dependent (i.e., solid-phase vs aqueous-phase) differences in the chemical signature as a function of carbon chain-length and in situ PFOS (and to a slightly lesser extent PFHxS) formation, presumably due to precursor biotransformation.cells and megakaryocytes. They constitute direct and convincing evidence indicating the combined effect of various cytokines released by epidermal cells on the proliferation and maturation of hematopoietic precursor cells into different immunocompetent cells in the skin.			1												1						B	-	AFFFの影響のある地域、土壌、底泥、表流水、地下水中の15PFAS	
305	環境中運命	Barber, Jonathan L; Berger, Urs; Chaemfa, Chakra; Huber, Sandra; Jahnke, Annika; Temme, Christian; Jones, Kevin C	Analysis of per- and polyfluorinated alkyl subst	2007	J Environ Monit. 2007 Jun;9(6):530-41. doi: 10.1039/b701417a. Epub 2007 May 21.	Air samples were collected from 4 field sites in Europe: 2 sites from the UK, Hazelrigg (semi-rural) and Manchester (urban); 1 site from Ireland: Mace Head (rural); and 1 site from Norway: Kjeller (rural). Additionally, air samples were taken from indoor locations in Tromsø, Norway. Air samples were collected using high-volume air samplers employing sampling modules containing glass-fibre filters (GFFs, particle phase), and glass columns with a polyurethane foam (PUF)-XAD-2-PUF sandwich (gaseous phase). Typical outdoor air volumes required for the determination of per- and polyfluorinated alkyl substances (PFAS) ranged from 500-1800 m3. GFFs and PUF-XAD columns were analysed separately to obtain information on phase partitioning. All air samples were analysed for volatile, neutral PFAS, with selected GFF samples halved for analysis of both neutral and airborne particle-bound ionic PFAS. Volatile PFAS were extracted from air samples by cold-column immersion with ethyl acetate, and were analysed by gas chromatography-mass spectrometry in the positive chemical ionisation mode (GC-PCI-MS). Ionic PFAS were extracted from GFFs by sonication in methanol, and were analysed by liquid chromatography-time-of-flight-mass spectrometry (LC-TOF-MS) using electrospray ionisation in the negative ion mode (ESI-). Perfluorooctanoate (PFOA) was often the predominant analyte found in the particulate phase at concentrations ranging from 1-818 pg m(-3), and 8:2 fluorotelomer alcohol (FTOH) and 6:2 FTOH were the prevailing analytes found in the gas phase, at 5-243 pg m(-3) and 5-189 pg m(-3), respectively. These threePFAS were ubiquitous in air samples. Many other PFAS, both neutral and ionic, were also present, and levels of individual analytes were in the 1-125 pg m(-3) range. Levels of some PFAS exceeded those of traditional persistent organic pollutants (POPs). In this study, the presence of 12:2 FTOH and fluorotelomer olefins (FTolefins), and ionic PFAS other than perfluorooctane sulfonate (PFOS) and PFOA, are reported in air samples for the first time. Concentrations of neutral PFAS were several orders of magnitude higher in indoor air than outdoor air, making homes a likely important diffuse source of PFAS to the atmosphere. Our repeated findings of non-volatile ionic PFAS in air samples raises the possibility that they might directly undergo significant atmospheric transport on particles away from source regions, and more atmospheric measurements of ionic PFAS are strongly recommended.				1	1									1						B	-	欧州、大気、PFAS	
306	蓄積性	Bossi, Rossana; Riget, Frank F; Dietz, Rune	Temporal and spatial trends of perfluorinated c	2005	Environ Sci Technol. 2005 Oct 1;39(19):7416-22. doi: 10.1021/es0508469.	Perfluorinated compounds (PFCs), such as perfluorooctane sulfonate (PFOS) and related compounds, have been identified as global pollutants and have shown their bioaccumulation into higher trophic levels in the food chain. PFCs have been found in remote areas far from sources, such as the Arctic. In this study spatial and temporal trends in the concentrations of selected PFCs were measured using archived liver samples of ringed seal (Phoca hispida) from East and West Greenland. The samples were collected in four different years at each location, between 1986 and 2003 in East Greenland and between 1982 and 2003 in West Greenland. PFOS was the major contributor to the burden of PFCs in samples, followed by perfluoroundecanoic acid (PFUnA). Perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) were also detected in most samples. Perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonamide (PFOSA) were only found sporadically. Perfluorooctanoic acid was not found in detectable concentrations in any sample. Regression analysis of logarithmic transformed PFOS, PFDA, and PFUnA median concentrations indicated a significant temporal trend with increasing concentrations at both locations. A spatial trend in PFOS concentrations (ANOVA, $p < 0.0001$) was observed between the two sampling locations, with significantly higher concentrations in seals from East Greenland.				1										1						B	-	ワモンアザラシ、保管されていた肝臓中のPFAS	
307	蓄積性	Butt, Craig M; Muir, Derek C G; Stirling, Ian; Kwan, Michael; Mabury, Scott A	Rapid response of Arctic ringed seals to chang	2007	Environ Sci Technol. 2007 Jan 1;41(1):42-9. doi: 10.1021/es061267m.	Temporal trends in perfluoroalkyl compounds (PFCs) were investigated in liver samples from two ringed seal (Phoca hispida) populations in the Canadian Arctic, Arviat (Western Hudson Bay) (1992, 1998, 2004, 2005) and Resolute Bay (Lancaster Sound) (1972, 1993, 2000, 2004, 2005). PFCs analyzed included C7-C15 perfluorinated carboxylates (PFCAs) and their suspected precursors, the 8:2 and 10:2 fluorotelomer saturated and unsaturated carboxylates (FTCAs, FTUCAs), C4, C6, C8, C10 sulfonates, and perfluorooctane sulfonamide (PFOSA). Liver samples were homogenized, liquid-liquid extracted with methyl tert-butyl ether, cleaned up using hexafluoropropanol, and analyzed by liquid chromatography with negative electrospray tandem mass spectrometry (LC-MS/MS). C9-C15 PFCAs showed statistically significant increasing concentrations during 1992-2005 and during 1993-2005 at Arviat and Resolute Bay, respectively. Doubling times ranged from 19.4 to 15.8 years for perfluorododecanoate (PFDoA) to 10.0-7.7 years for perfluorononanoate (PFNA) at Arviat and Resolute Bay but were shorter when excluding the 2005 samples. Conversely, perfluorooctane sulfonate (PFOS) and PFOSA concentrations showed maximum concentrations during 1998 and 2000 at Arviat and Resolute Bay, with statistically significant decreases from 2000 to 2005. In the case of Arviat, two consecutive decreases were measured from 1998 to 2003 and from 2003 to 2005. PFOS disappearance half-lives for seals at Arviat and Resolute Bay were 3.2 and 4.6 years. These results indicate that the ringed seals and their food web are rapidly responding to the phase out of perfluorooctanesulfonyl fluoride based compounds by 3M in 2001. Further, the relatively short doubling times of the PFCAs and PFOS disappearance half-lives support the hypothesis of atmospheric transport as the main transport mechanism of PFCs to the arctic environment.				1										1						B	-	北極諸島、ワモンアザラシ、肝臓中のPFAS	
308	環境中運命	Ellis, David A; Martin, Jonathan W; De Silva, Amila O; Mabury, Scott A; Hurley, Michael D; Sulbaek Andersen, Mads P; Wallington, Timothy J	Degradation of fluorotelomer alcohols: a likely	2004	Environ Sci Technol. 2004 Jun 15;38(12):3316-21. doi: 10.1021/es049860w.	Human and animal tissues collected in urban and remote global locations contain persistent and bioaccumulative perfluorinated carboxylic acids (PFCAs). The source of PFCAs was previously unknown. Here we present smog chamber studies that indicate fluorotelomer alcohols (FTOHs) can degrade in the atmosphere to yield a homologous series of PFCAs. Atmospheric degradation of FTOHs is likely to contribute to the widespread dissemination of PFCAs. After their bioaccumulation potential is accounted for, the pattern of PFCAs yielded from FTOHs could account for the distinct contamination profile of PFCAs observed in arctic animals. Furthermore, polar bear liver was shown to contain predominately linear isomers (>99%) of perfluorononanoic acid (PFNA), while both branched and linear isomers were observed for perfluorooctanoic acid, strongly suggesting a sole input of PFNA from "telomer"-based products. The significance of the gas-phase peroxy radical cross reactions that produce PFCAs has not been recognized previously. Such reactions are expected to occur during the atmospheric degradation of all polyfluorinated materials, necessitating a reexamination of the environmental fate and impact of this important class of industrial chemicals.	1		1										1		1				B	-	スモッグチェンバー、FTOH、大気分解	
309	環境中運命	Ellis, D A; Martin, J W; Mabury, S A; Hurley, M D; Andersen, M P Sulbaek; Wallington, T J	Atmospheric lifetime of fluorotelomer alcohols	2003	Environ Sci Technol. 2003 Sep 1;37(17):3816-20. doi: 10.1021/es034136j.	Relative rate techniques were used to study the kinetics of the reactions of Cl atoms and OH radicals with a series of fluorotelomer alcohols, F(CF2CF2)nCH2CH2OH (n = 2, 3, 4), in 700 Torr of N2 or air, diluent at 296 +/- 2K. The length of the F(CF2CF2)n- group had no discernible impact on the reactivity of the molecule. For n = 2, 3, or 4, k(Cl + F(CF2CF2)nCH2CH2OH) = (1.61 +/- 0.49) x 10(-11) and k(OH + F(CF2CF2)nCH2CH2OH) = (1.07 +/- 0.22) x 10(-12) cm3 molecule(-1) s(-1). Consideration of the likely rates of other possible atmospheric loss mechanisms leads to the conclusion that the atmospheric lifetime of F(CF2CF2)nCH2CH2OH (n > or = 2) is determined by reaction with OH radicals and is approximately 20 d.	1												1						B	-	反応速度、Cl元素・OHラジカル、FTOH、大気	
310	環境中運命	Jahnke, Annika; Berger, Urs; Ebinghaus, Ralf; Temme, Christian	Latitudinal gradient of airborne polyfluorinated	2007	Environ Sci Technol. 2007 May 1;41(9):3055-61. doi: 10.1021/es062389h.	Neutral, volatile polyfluorinated alkyl substances (PFAS) were determined in high-volume air samples collected onboard the German research vessel Polarstern during cruise ANTXXIII-1 between Bremerhaven, Germany (53 degrees N) and Capetown, Republic of South Africa (33 degrees S) in fall 2005. An optimized and validated analytical protocol was used for the determination of several fluorotelomer alcohols (FTOHs) as well as N-alkylated fluorooctane sulfonamides and sulfonamidoethanols (FOSAs/FOSEs). Quantitative analyses were done by gas chromatography-mass spectrometry. This study provides the first concentration data of airborne PFAS from the Southern Hemisphere. Results indicate a strongly decreasing concentration gradient from the European continent toward less industrialized regions. The study confirms that airborne PFAS are mainly restricted to the Northern Hemisphere with a maximum concentration of 190 pg/m3 (8:2 FTOH) in the first sample collected in the channel between the European mainland and the UK. However, south of the equator, trace amounts of several FTOHs and FOSAs with a maximum of 14 pg/m3 (8:2 FTOH) could still be detected. Furthermore, a selection of ionic PFAS including perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) were determined in the particulate phase of high-volume air samples by liquid chromatography-mass spectrometry. Levels of ionic PFAS were almost 2 orders of magnitude lower than those of neutral PFAS, with maximum concentrations in the first sample of 2.5 pg/m3 (PFOS) and 2.0 pg/m3 (PFOA).				1										1						B	-	ドイツ、大気中のPFAS	
311	蓄積性	Keller, Jennifer M; Kannan, Kurunthachalam; Taniyasu, Sachi; Yamashita, Nobuyoshi; Day, Rusty D; Arendt, Michael D; Segars, Al L; Kucklick, John R	Perfluorinated compounds in the plasma of log	2005	Environ Sci Technol. 2005 Dec 1;39(23):9101-8. doi: 10.1021/es050690c.	Perfluorinated compounds (PFCs) have been measured in blood of humans and wildlife and are considered globally distributed contaminants. We examined 12 PFCs in the plasma of 73 loggerhead sea turtles (Caretta caretta) and 6 Kemp's ridley sea turtles (Lepidochelys kempii) captured from inshore waters of Core Sound, North Carolina (NC), and offshore waters of South Carolina, Georgia, and Florida (SC-FL). Perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) were the dominant compounds, with respective mean concentrations of 11.0 ng/mL and 3.20 ng/mL for loggerhead turtles and 39.4 ng/mL and 3.57 ng/mL for Kemp's ridley turtles. Mean PFOS concentrations were 2- to 12-fold higher than typical mean sigmaPCB concentrations (approximately 5 ng/g wet mass) measured previously in sea turtle blood. More than 79% of the samples had detectable levels of perfluorocarboxylates (PFCAs) with 8-12 carbons, whereas only 17% or less of samples had detectable levels of PFCAs with 6 or 7 carbons. No samples had detectable levels of PFCAs with 4 or 5 carbons. In loggerhead turtles, sigmaPFC concentrations were not influenced by sex ($p > 0.05$), but were higher in turtles captured from inshore waters of NC than in turtles from offshore waters of SC-FL ($p = 0.009$). A backward stepwise multiple regression model showed that sigmaPFC concentrations were (1) significantly higher in Kemp's ridley turtles than loggerhead turtles ($p < 0.0001$), (2) higher in larger turtles ($p = 0.018$; carapace length used as a proxy for age), and (3) higher in turtles captured toward the north ($p = 0.006$). These findings suggest that bioaccumulation of PFCsin sea turtles is influenced by species, age, and habitat.			1	1										1						B	-	アカウミガメ・ケンプヒメウミガメの血漿、12PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
312	蓄積性	Martin, Jonathan W; Smithwick, Marla M; Braune, Birgit M; Hoekstra, Paul F; Muir, Derek C G; Mabury, Scott A	Identification of long-chain perfluorinated acid	2004	Environ Sci Technol. 2004 Jan 15;38(2):373-80. doi: 10.1021/es034727+.	Recently it was discovered that humans and animals from various urban and remote global locations contained a novel class of persistent fluorinated contaminants, the most pervasive of which was perfluorooctane sulfonate (PFOS). Lower concentrations of perfluorooctanoate, perfluorohexane sulfonate, and heptadecafluorooctane sulfonamide have also been detected in various samples. Although longer perfluoroalkyl carboxylates (PFCAs) are used in industry and have been detected in fish following a spill of aqueous film forming foam, no studies have been conducted to examine the widespread occurrence of long-chain PFCAs (e.g., CF3(CF2)xCOO-, where x > 6). To provide a preliminary assessment of fluorinated contaminants, including PFCAs, in the Canadian Arctic, polar bears, ringed seals, arctic fox, mink, common loons, northern fulmars, black guillemots, and fish were collected at various locations in the circumpolar region. PFOS was the major contaminant detected in most samples and in polar bear liver was the most prominent organohalogen (mean PFOS = 3.1 microg/g wet weight) compared to individual polychlorinated biphenyl congeners, chlordane, or hexachlorocyclohexane-related chemicals in fat. Using two independent mass spectral techniques, it was confirmed that all samples also contained ng/g concentrations of a homologous series of PFCAs, ranging in length from 9 to 15 carbons. Sum concentrations of PFCAs (sum(PFCAs)) were lower than total PFOS equivalents (sum(PFOS)) in all samples except for mink. In mink, perfluorononanoate (PFNA) concentrations exceeded PFOS concentrations, indicatingthat PFNA and other PFCAs should be considered in future risk assessments. Mammals feeding at higher trophic levels had greater concentrations of PFOS and PFCAs than mammals feeding at lower trophic positions. In general, odd-length PFCAs exceeded the concentration of even-length PFCAs, and concentrations decreased with increasing chain length in mammals. PFOS and PFCA concentrations were much lower for animals living in the Canadian Arctic than for the same species living in mid-latitude regions of the United States. Future studies should continue to monitor all fluorinated contaminants and examine the absolute and relative toxicities for this novel suite of PFCAs.			1													1						B	-	生物試料中のPFAS	
313	環境中運命	Moody CA, Field JA.	Perfluorinated surfactants and the environmen	2000	Environ Sci Technol. 34(18):3864-3870. doi: 10.1021/es991359u.	The recent identification of one class of fluorinated surfactants in groundwater impacted by fire-fighting activity has created an awareness of the potential environmental issues resulting from the use of aqueous film forming foam (AFFF) agents. Aqueous film forming foams are used to extinguish hydrocarbon-fuel fires and their repeated usage, particularly at military sites, has led to AFFF-contaminated groundwater. Formulations of AFFF agents include fluorinated surfactants, which are an important class of specialty chemicals that have physio-chemical properties that differentiate them from hydrocarbon surfactants. Little is known about the occurrence, transport, biodegradation, and toxicity of fluorinated surfactants in the environment. The fact that fluorinated surfactants, as well as other AFFF components, co-occur with priority pollutants (e.g., jet fuel components and chlorinated solvents) complicates studies on their fate and effect in the environment. Research is needed to sufficiently identify those fluorinated surfactants present in commercial AFFF products and environmental samples and to characterize their environmental properties. Additionally, the environmental behavior of the AFFF mixtures and complex AFFF-wastewaters needs to be investigated.																					B	-	総説、AFFF使用によるPFASの環境汚染	
314	蓄積性	Smithwick, Marla; Muir, Derek C G; Mabury, Scott A; Solomon, Keith R; Martin, Jonathan W; Sonne, Christian; Born, Erik W; Letcher, Robert J; Dietz, Rune	Perflouroalkyl contaminants in liver tissue from	2005	Environ Toxicol Chem. 2005 Apr;24(4):981-6. doi: 10.1897/04-258r.1.	Perfluoroalkyl substances were determined in polar bears (Ursus maritimus) collected in East Greenland (69 degrees 00'N to 74 degrees 00"N) to compare with other populations and to examine effects of age and gender on concentrations of these contaminants. Hepatic tissue (n = 29) was analyzed for perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate, heptadecafluorooctane sulfonamide (PFOSA), and perfluoroalkyl carboxylates (PFCAs) with C9-C15 perfluorinated carbon chains by liquid chromatography tandem mass spectrometry. Concentrations of PFOS found in samples from East Greenland (mean = 2,470+/-1,320 ng/g wet weight) were similar to Hudson Bay, Canada, and both populations had significantly greater concentrations than those reported for Alaska, suggesting a spatial trend. Male bears showed a significant increase in concentration up to age six for PFCAs with C10-C14 carbon chains (r2 > or = 0.50, p < or = 0.05). Significant correlations were found between adjacent chain length PFCAs, (e.g., PFNA to PFDA: p < 0.05; r2 = 0.90). This may indicate a common source for these chemicals, although the specifics of source and mode of transport are unknown. No significant correlations were found between concentrations of PFCAs in liver tissue and previously reported polychlorinated biphenyl (PCB) congeners analyzed in fat samples from the same bears.			1													1						B	-	ホッキョクグマ、PFAS	
315	環境中運命	Stahl, Thorsten; Riebe, Rika Alessa; Falk, Sandy; Failing, Klaus; Brunn, Hubertus	Long-term lysimeter experiment to investigate	2013	J Agric Food Chem. 2013 Feb 27;61(8):1784-93. doi: 10.1021/jf305003h. Epub 2013 Feb 18.	To study the behavior of perfluoroalkyl substances (PFASs) in soil and the carry-over from soil to plants, technical mixtures of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) at a concentration of 25 mg/kg soil were applied to 1.5 m(3) monolithic soil columns of a lysimeter. Growth samples and percolated water were analyzed for PFASs throughout a period of 5 years. In addition to PFOA/PFOS plant compartments and leachate were found to be contaminated with short-chain PFASs. Calculation showed significant decreasing trends (p < 0.05) for all substances tested in the growth samples. Short-chain PFASs and PFOA pass through the soil much more quickly than PFOS. Of the 360 g of PFOA and 367.5 g of PFOS applied to the soil, 96.88% PFOA and 99.98% PFOS were still present in the soil plot of the lysimeter after a period of 5 years. Plants accumulated 0.001% PFOA and 0.004% PFOS. Loss from the soil plot through leachate amounted to 3.12% for PFOA and 0.013% for PFOS.	1	1													1						B	-	実験、土壌中のPFASの浸出	
316	蓄積性	Wang, Yuan; Yeung, Leo W Y; Taniyasu, Sachi; Yamashita, Nobuyoshi; Lam, James C W; Lam, Paul K S	Perfluorooctane sulfonate and other fluorocher	2008	Environ Sci Technol. 2008 Nov 1;42(21):8146-51. doi: 10.1021/es8006386.	To our knowledge, this is the first study reporting concentrations of perfluorinated compounds (PFCs) in waterbird eggs in south China. Concentrations of 11 PFCs (PFOS, PFHxS, PFBS, PFOSA, PFDoDA, PFUnDA, PFDA, PFNA, PFOA, PFHpA, PFHxA) were measured in night heron, great egret, and little egret eggs from south China (Hong Kong, Xiamen, Quanzhou). PFOS was found to be the dominant PFC in the waterbird eggs. Total concentrations of the 11 PFCs in waterbird eggs ranged from 27.0 ng/g ww (great egret from Hong Kong) to 160 ng/g ww (night heron from Quanzhou). Significant differences in PFOS concentrations were found among species, but not among locations. The composition profiles of the individual PFCs among egg samples were generally similar. Positive correlations were found between PFOS and some of the PFCAs in the egg samples from Hong Kong. Concentrations of some of the PFCs were significantly correlated with total PCB concentrations reported in a previous study in the night heron egg samples, but not in the great egret samples. Preliminary risk assessment suggests that there is no immediate risk of a reduction in offspring survival in waterbirds in south China due to PFOS, but more information is needed on the potential effects of PFCs in waterbirds.		1	1	1											1						B	-	中国、水鳥の卵、11PFAS	
317	環境中運命	Wang, Zhanyun; Boucher, Justin M; Scheringer, Martin; Cousins, Ian T; Hungerbühler, Konrad	Toward a Comprehensive Global Emission Inve	2017	Environ Sci Technol. 2017 Apr 18;51(8):4482-4493. doi: 10.1021/acs.est.6b06191. Epub 2017 Apr 4.	Here a new global emission inventory of C4-C10 perfluoroalkanesulfonic acids (PFSAs) from the life cycle of perfluorooctanesulfonyl fluoride (POSF)-based products in 1958-2030 is presented. In particular, we substantially improve and expand the previous frameworks by incorporating missing pieces (e.g., emissions to soil through land treatment, overlooked precursors) and updating parameters (e.g., emission factors, degradation half-lives). In 1958-2015, total direct and indirect emissions of perfluorooctanesulfonic acid (PFOS) are estimated as 1228-4930 tonnes, and emissions of PFOS precursors are estimated as 1230-8738 tonnes and approximately 670 tonnes for x-perfluorooctanesulfonamides/sulfonamido ethanols (xFOSA/Es) and POSF, respectively. Most of these emissions occurred between 1958 and 2002, followed by a substantial decrease. This confirms the positive effect of the ongoing transition to phase out POSF-based products, although this transition may still require substantial time and cause substantial additional releases of PFOS (8-153 tonnes) and xFOSA/Es (4-698 tonnes) in 2016 to 2030. The modeled environmental concentrations obtained by coupling the emission inventory and a global multimedia mass-balance model generally agree well with reported field measurements, suggesting that the inventory captures the actual emissions of PFOS and xFOSA/Es for the time being despite remaining uncertainties. Our analysis of the key uncertainties and open questions of and beyond the inventory shows that, among others, degradation of side-chain fluorinated polymers in the environment and landfills can be a long-term, (potentially) substantial source of PFOS.			1	1												1		1				B	-	排出インベントリ、PFAS	
318	環境中運命	Young, Cora J; Furdui, Vasile I; Franklin, James; Koerner, Roy M; Muir, Derek C G; Mabury, Scott A	Perfluorinated acids in Arctic snow: new evider	2007	Environ Sci Technol. 2007 May 15;41(10):3455-61. doi: 10.1021/es0626234.	Perfluorinated acids (PFAs) are ubiquitously found in water and biota, including remote regions such as the High Arctic. Under environmental conditions, PFAs exist mainly as anions and are not expected to be subject to long-range atmospheric transport in the gas phase. Fluorinated telomer alcohols (FTOHs) are volatile and can be atmospherically oxidized to form perfluorocarboxylic acids. Analogously, fluorosulfamido alcohols can be oxidized to form perfluorooctane sulfonate (PFOS). High Arctic ice caps experience contamination solely from atmospheric sources. By examining concentrations of PFAs in ice cap samples, it is possible to determine atmospheric fluxes to the Arctic. Ice samples were collected from high Arctic ice caps in the spring of 2005 and 2006. Samples were concentrated using solid-phase extraction and analyzed by LC-MS-MS. PFAs were observed in all samples, dating from 1996 to 2005. Concentrations were in the low-mid pg L(-1) range and exhibited seasonality, with maximum concentrations in the spring-summer. The presence of perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFUnA) on the ice cap was indicative of atmospheric oxidation as a source. Ratios of PFAs to sodium concentrations were highly variable, signifying PFA concentrations on the ice cap were unrelated to marine chemistry. Fluxes of the PFAs were estimated to the area north of 65 degrees N for the 2005 season, which ranged from 114 to 587 kg year(-1) for perfluorooctanoic acid (PFOA), 73 to 860 kg year(-1) for perfluorononanoic acid (PFNA), 16 to 84 kg year(-1) for PFDA, 26 to 62 kg year(-1) for PFUnA, and 18 to48 kg year(-1) for PFOS. The PFOA and PFNA fluxes agreed with FTOH modeling estimations. A decrease in PFOS concentrations through time was observed, suggesting a fast response to changes in production. These data suggest that atmospheric oxidation of volatile precursors is a primary source of PFAs to the Arctic.			1													1						B	-	北極の極冠、PFAS	
319	蓄積性	Ahrens, Lutz; Siebert, Ursula; Ebinghaus, Ralf	Temporal trends of polyfluoroalkyl compounds	2009	Chemosphere. 2009 Jun;76(2):151-8. doi: 10.1016/j.chemosphere.2009.03.053. Epub 2009 Apr 25.	Temporal trends of polyfluoroalkyl compounds (PFCs) were examined in liver samples from harbor seals (Phoca vitulina) collected from the German Bight (1999-2008). Concentrations of various PFCs, including C(4)-C(10) perfluoroalkyl sulfonates (PFSAs), perfluorooctane sulfinate (PFOSi), perfluorooctane sulfonamide (FOSA) and C(8)-C(15) perfluoroalkyl carboxylic acids (PFCAs) were quantified. Perfluorooctane sulfonate (PFOS) was the predominant compound with a maximum concentration of 3676 ng g(-1) ww (1996), making up on average 94% of the measured PFCs. Significantly higher concentrations were found in <7 month old in comparison to >or=7 month old harbor seals for C(6)-C(8) PFSAs, perfluorododecanoic acid (PFDoDA) and FOSA, whereas perfluorodecanoic acid (PFDA) showed significantly lower concentrations in the younger harbor seals ($p<0.05$). These results suggest a transplacental transfer of PFCs to the foetus and/or consumption of different contaminated food. Regression analysis of logarithmic transformed PFC mean concentrations indicated a significant temporal trend with decreasing concentrations for C(5)-C(7) PFSAs ($p<0.001$), PFOSi ($p=0.028$), FOSA ($p<0.001$) and perfluorooctanoic acid (PFOA) ($p=0.031$) between 1999 and 2008. Furthermore, PFOS decreased by 49% between 1999 and 2008, which correspond with decreasing concentration levels of its metabolic precursors PFOSi and FOSA of 83% and 95% in the same time period. However, the decreasing trend of PFOS is not significant ($p=0.067$). The reason for the decline during the past 10 years could be an effect of the replacement of these PFCs by shorter chained and lessbioaccumulative compounds. But the observations of increasing perfluorodecane sulfonate (PFDS) levels ($p=0.070$), the high concentrations of PFOS and constant levels of C(9)-C(13) PFCAs indicates that further work on the reduction of environmental emissions of PFCs are necessary.				1												1						B	-	ゴマフアザラシの肝臓、PFAS	
320	環境中運命	Ahrens, Lutz; Shoeib, Mahiba; Harner, Tom; Lee, Sum Chi; Guo, Rui; Reiner, Eric J	Wastewater treatment plant and landfills as so	2011	Environ Sci Technol. 2011 Oct 1;45(19):8098-105. doi: 10.1021/es1036173. Epub 2011 Apr 5.	Polyfluoroalkyl compounds (PFCs) were determined in air around a wastewater treatment plant (WWTP) and two landfill sites using sorbent-impregnated polyurethane foam (SIP) disk passive air samplers in summer 2009. The samples were analyzed for five PFC classes (i.e., fluorotelomer alcohols (FTOHs), perfluorooctane sulfonamides (FOSAs), sulfonamidoethanols (FOSEs), perfluoroalkyl sulfonic acids (PFSAs), and perfluoroalkyl carboxylic acids (PFCAs)) to investigate their concentration in air, composition and emissions to the atmosphere. ΣPFC concentrations in air were 3-15 times higher within the WWTP (2280-24 040 pg/m(3)) and 5-30 times higher at the landfill sites (2780-26 430 pg/m(3)) compared to the reference sites (597-1600 pg/m3). Variations in the PFC pattern were observed between the WWTP and landfill sites and even within the WWTP site. For example, FTOHs were the predominant PFC class in air for all WWTP and landfill sites, with 6:2 FTOH as the dominant compound at the WWTP (895-12 290 pg/m(3)) and 8:2 FTOH dominating at the landfill sites (1290-17 380 pg/m(3)). Furthermore, perfluorooctane sulfonic acid (PFOS) was dominant within the WWTP (43-171 pg/m(3)), followed by perfluorobutanoic acid (PFBA) (55-116 pg/m(3)), while PFBA was dominant at the landfill sites (101-102 pg/m(3)). It is also noteworthy that the PFCA concentrations decreased with increasing chain length and that the emissions for the even chain length PFCAs outweighed emissions for the odd chain length compounds. Furthermore, highly elevated PFC concentrations were found near the aeration tanks compared to the other tanks(i.e., primary and secondary clarifier) and likely associated with increased volatilization during aeration that may be further enhanced through aqueous aerosol-mediated transport. ΣPFC yearly emissions estimated using a simplified dispersion model were 2560 g/year for the WWTP, 99 g/year for landfill site 1, and 1000 g/year for landfill site 2. These results highlight the important role of WWTPs and landfills as emission sources of PFCs to the atmosphere.	1													1						B	-	排水処理施設・埋立地周辺の大気、PFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
321	環境中運命	Armstrong, Dana L; Lozano, Nuria; Rice, Clifford P; Ramirez, Mark; Torrents, Alba	Temporal trends of perfluoroalkyl substances i	2016	J Environ Manage. 2016 Jan 1;165:88-95. doi: 10.1016/j.jenvman.2015.09.023. Epub 2015 Sep 27.	While the recycling of wastewater biosolids via land-application is a sustainable practice for nutrient recovery and soil reclamation that has become increasingly common worldwide, concerns remain that this practice may become a source of toxic, persistent organic pollutants to the environment. This study concentrates on assessing the presence and the temporal trends of 12 perfluoroalkyl substances (PFASs), pollutants of global consequence, in limed Class B biosolids from a municipal water resource recovery facility (WRRF), also know as a wastewater treatment plant. PFASs are of significant concern due to their extensive presence and persistence in environmental and biotic samples worldwide, most notably human blood samples. Class B biosolids were collected from the WRRF, prior to land-application, approximately every two to three months, from 2005 to 2013. Overall, this study found that concentrations of the 7 detectable PFAS compounds remained unchanged over the 8-year period, a result that is consistent with other temporal studies of these compounds in sewage sludges. From these analyzed compounds, the highest mean concentrations observed over the study period were 25.1 ng/g dw, 23.5 ng/g dw, and 22.5 ng/g dw for perfluorononanoic acid (PFNA), perfluorooctanoic acid (PFOA), and perfluorooctanesulfonic acid (PFOS), respectively, and these compounds were detected at concentrations 2.5-5 times higher than the remaining, detectable PFASs. Furthermore, it was observed that PFOS, while demonstrating no overall change during the study, exhibited a visible spike in concentration from late 2006 to early 2007. This study indicates thatconcentrations of PFASs in WRRFs have been stagnant over time, despite regulation. This study also demonstrates that the use of glass jars with polytetrafluoroethylene-lined lids, a common storage method for environmental samples, will not influence PFOA and PFNA concentrations in archived biosolids samples.			1														1			B	-	微生物固形物中のPFAS	
322	蓄積性	Barbosa, Vera; Maulvault, Ana Luísa; Alves, Ricardo N; Kwadijk, Christian; Kotterman, Michiel; Tediosi, Alice; Fernández-Tejedor, Margarita; Sloth, Jens J; Granby, Kit; Rasmussen, Rie R; Robbens, Johan; De Witte, Bavo; Trabalón, Laura; Fernandes, José O; Cunha, Sara C; Marques, António	Effects of steaming on contaminants of emergi	2018	Food Chem Toxicol. 2018 Aug;118:490-504. doi: 10.1016/j.fct.2018.05.047. Epub 2018 May 19.	Seafood consumption is a major route for human exposure to environmental contaminants of emerging concern (CeCs). However, toxicological information about the presence of CeCs in seafood is still insufficient, especially considering the effect of cooking procedures on contaminant levels. This study is one among a few who evaluated the effect of steaming on the levels of different CeCs (toxic elements, PFCs, PAHs, musk fragrances and UV-filters) in commercially relevant seafood in Europe, and estimate the potential risks associated with its consumption for consumers. In most cases, an increase in contaminant levels was observed after steaming, though varying according to contaminant and seafood species (e.g. iAs, perfluorobutanoate, dibenzo(ah)anthracene in Mytilus edulis, HHCB-Lactone in Solea sp., 2-Ethylhexyl salicylate in Lophius piscatorius). Furthermore, the increase in some CeCs, like Pb, MeHg, iAs, Cd and carcinogenic PAHs, in seafood after steaming reveals that adverse health effects can never be excluded, regardless contaminants concentration. However, the risk of adverse effects can vary. The drastic changes induced by steaming suggest that the effect of cooking should be integrated in food risk assessment, as well as accounted in CeCs regulations and recommendations issued by food safety authorities, in order to avoid over/underestimation of risks for consumer health.	1	1	1	1												1			B	-	海産食品中の化学物質、PFASを含む	
323	蓄積性	Binnington, Matthew J; Lei, Ying D; Pokiak, Lucky; Pokiak, James; Ostertag, Sonja K; Loseto, Lisa L; Chan, Hing M; Yeung, Leo W Y; Huang, Haiyong; Wania, Frank	Effects of preparation on nutrient and environr	2017	Environ Sci Process Impacts. 2017 Aug 16;19(8):1000-1015. doi: 10.1039/c7em00167c.	For Canadian Arctic indigenous populations, marine mammal (MM) traditional foods (TFs) represent sources of both important nutrients and hazardous environmental contaminants. Food preparation is known to impact the nutrient and environmental contaminant content of processed items, yet the impacts of preparation on indigenous Arctic MM TFs remain poorly characterized. In order to determine how the various processes involved in preparing beluga blubber TFs affect their levels of nutrients and environmental contaminants, we collected blubber samples from 2 male beluga whales, aged 24 and 37 years, captured during the 2014 summer hunting season in Tuktoyaktuk, Northwest Territories, and processed them according to local TF preparation methods. We measured the levels of select nutrients [selenium (Se), polyunsaturated fatty acids (PUFAs)] and contaminants [organochlorine pesticides, perfluoroalkyl and polyfluoroalkyl substances (PFASs), polybrominated diphenyl ethers, polychlorinated biphenyls, polycyclic aromatic hydrocarbons (PAHs), mercury (Hg)] in raw and prepared (boiled, roasted, aged) beluga blubber TFs. The impacts of beluga blubber TF preparation methods on nutrient and environmental contaminant levels were inconsistent, as the majority of processes either did not appear to influence concentrations or affected the two belugas differently. However, roasting and ageing beluga blubber consistently impacted certain compounds: roasting blubber increased concentrations of hydrophilic substances (Se and certain PFASs) through solvent depletion and deposited PAHs from cookfire smoke. The solid-liquid phase separation involved inageing blubber depleted hydrophilic elements (Se, Hg) and some ionogenic PFASs from the lipid-rich liquid oil phase, while PUFA levels appeared to increase, and hydrophobic persistent organic pollutants were retained. Ageing blubber adjacent to in-use smokehouses also resulted in considerable PAH deposition to processed samples. Our findings demonstrated that contaminant concentration differences were greater between the two sets of whale samples, based on age differences, than they were within each set of whale samples, due to variable preparation methods. When considering means to minimize human contaminant exposure while maximizing nutrient intake, consumption of aged liquid from younger male whales would be preferred, based on possible PUFA enhancement and selective depletion of hydrophilic environmental contaminants in this food item.			1														1			B	-	食品（調理前後）中の栄養塩、汚染物質（PFASを含む）	
324	蓄積性	Chu, Shaogang; Wang, Jun; Leong, Gladys; Woodward, Lee Ann; Letcher, Robert J; Li, Qing X	Perfluoroalkyl sulfonates and carboxylic acids i	2015	Chemosphere. 2015 Nov;138:60-6. doi: 10.1016/j.chemosphere.2015.05.043. Epub 2015 Jun 1.	The Great Pacific Garbage Patch (GPGP) is a gyre of marine plastic debris in the North Pacific Ocean, and nearby is Midway Atoll which is a focal point for ecological damage. This study investigated 13 C4-C16 perfluorinated carboxylic acids (PFCAs), four (C4, C6, C8 and C10) perfluorinated sulfonates and perfluoro-4-ethylcyclohexane sulfonate [collectively perfluoroalkyl acids (PFAAs)] in black-footed albatross tissues (collected in 2011) from Midway Atoll. Of the 18 PFCAs and PFSAs monitored, most were detectable in the liver, muscle and adipose tissues. The concentrations of PFCAs and PFSAs were higher than those in most seabirds from the arctic environment, but lower than those in most of fish-eating water birds collected in the U.S. mainland. The concentrations of the PFAAs in the albatross livers were 7-fold higher than those in Laysan albatross liver samples from the same location reported in 1994. The concentration ranges of PFOS were 22.91-70.48, 3.01-6.59 and 0.53-8.35 ng g(-1) wet weight (ww), respectively, in the liver, muscle and adipose. In the liver samples PFOS was dominant, followed by longer chain PFUdA (8.04-18.70 ng g(-1) ww), PFTrDA, and then PFNA, PFDA and PFDoA. Short chain PFBA, PFPeA, PFBS and PFODA were below limit of quantification. C8-C13 PFCAs showed much higher composition compared to those found in other wildlife where PFOS typically predominated. The concentrations of PFUdA in all 8 individual albatross muscle samples were even higher than those of PFOS. This phenomenon may be attributable to GPGP as a pollution source as well as PFAA physicochemical properties.	1														1			B	-	クロアシアホウドリの細胞中のPFAS	
325	蓄積性	Gobelius, Laura; Lewis, Jeffrey; Ahrens, Lutz	Plant Uptake of Per- and Polyfluoroalkyl Subst	2017	Environ Sci Technol. 2017 Nov 7;51(21):12602-12610. doi: 10.1021/acs.est.7b02926. Epub 2017 Oct 19.	Fire training facilities and other areas suffer from serious per- and polyfluoroalkyl substance (PFAS) contamination in soil, surface water, and groundwater due to regular practices with PFAS-containing aqueous firefighting foams (AFFFs). Therefore, the uptake of 26 PFASs in plants and the contamination of soil and groundwater has been investigated at a fire training site at Stockholm Arlanda airport, Stockholm (Sweden) in 2016. Elevated Σ(26)PFAS levels were detected in soil and groundwater ranging from 16 to 160 ng g(-1) dry weight (dw) and 1200-34 000 ng L(-1), respectively. Samples from different plant species and tissues (i.e., roots, trunk/cores, twigs, leaves/needles) of the local plant community were taken, namely silver birch (Betula pendula), Norway spruce (Picea abies), bird cherry (Prunus padus), mountain ash (Sorbus aucuparia), ground elder (Aegopodium podagraria), long beechfern (Phegopteris connectilis), and wild strawberry (Fragaria vesca). The plants showed a high variability of concentrations with highest Σ(26)PFAS concentrations in vegetative compartments with up to 97 ng g(-1) wet weight (ww) and 94 ng g(-1) ww in birch leaves and spruce needles, respectively. Annual ground cover plants such as long beechfern and ground elder, and bushes like bird cherry showed concentrations up to 6.9, 23, and 21 ng g(-1) ww, respectively. The bioconcentration factors (BCFs; plant/soil ratios) were highest in foliage, while the total tree burden of Σ(26)PFASs per tree was up to 11 mg for birch and 1.8 mg for spruce. Considering a shelterwood system with mixed stands of silver birch and spruce in combinationwith regular harvest of leaves and birch sap and an understory of ground elder, it is potentially feasible to remove 1.4 g of Σ(26)PFASs per year and hectare from (heavily) contaminated sites. An alternative approach is the coppicing of birch trees in combination with an understory of ground elder, potentially removing 0.65 g yr(-1) ha(-1) of Σ(26)PFASs, while a simple meadow with ground elder can remove 0.55 g yr(-1) ha(-1) Σ(26)PFASs.	1		1													1			B	-	植物への吸収、土壌と水中の26PFAS	
326	蓄積性	Holmström, Katrin E; Johansson, Anna-Karin; Bignert, Anders; Lindberg, Peter; Berger, Urs	Temporal trends of perfluorinated surfactants	2010	Environ Sci Technol. 2010 Jun 1;44(11):4083-8. doi: 10.1021/es100028f.	Perfluorinated alkyl substances (PFAS) are today known to be globally distributed environmental contaminants. In the present study, concentrations of PFAS were analyzed in Swedish peregrine falcon eggs (Falco peregrinus), collected between 1974 and 2007. Analytes included in the study were perfluorinated carboxylates (PFCAs; carbon chain lengths C6-C15), perfluorinated sulfonates (PFSAs; C4, C6, C8, and C10), and perfluorooctane sulfonamide (PFOSA). The predominant PFAS was perfluorooctane sulfonate, PFOS (83 ng/g wet weight (w wt) mean concentration in samples from 2006), followed by perfluorotridecanoate, PFTriA (7.2 ng/g w wt) and perfluoroundecanoate, PFUnA (4.2 ng/g w wt). PFCA concentrations increased exponentially over the studied time. In contrast, concentrations of PFOS and perfluorohexane sulfonate (PFHxS) increased initially but leveled off after the mid 1980s. This is different from previously observed temporal trends in marine organisms. The present study is the first to establish temporal trends for PFAS in terrestrial biota. The results indicate potential differences between marine and terrestrial biota regarding sources of PFAS exposure and response to emission changes. The toxicological implications of PFAS exposure for the falcons are not known, but according to recent findings impaired hatching success and sublethal toxicological effects from PFOS exposure in the Swedish peregrine falcon cannot be ruled out.				1												1			B	-	スウェーデンハヤブサの卵中のPFAS	
327	蓄積性	Kratzer, Johanna; Ahrens, Lutz; Roos, Anna; Bäcklin, Britt-Marie; Ebinghaus, Ralf	Temporal trends of polyfluoroalkyl compounds	2011	Chemosphere. 2011 Sep;84(11):1592-600. doi: 10.1016/j.chemosphere.2011.05.036. Epub 2011 Jun 15.	Temporal trends of polyfluoroalkyl compounds (PFCs) were examined in grey seal (Halichoerus grypus) liver from the Baltic Sea over a period of 35 years (1974-2008). In total, 17 of 43 PFCs were found, including the perfluoroalkyl sulfonates (C(4)-C(10) PFSAs), perfluorooctanesulfinate (PFOSi), long chain perfluoroalkyl carboxylates (C(7)-C(14) PFCAs), and perfluoroalkyl sulfonamides (i.e., perfluorooctane sulfonamide (FOSA) and N-ethyl perfluorooctane sulfonamide (EtFOSA)), whereas saturated and unsaturated fluorotelomer carboxylates, shorter chain PFCAs and perfluoroalkyl phosphonic acids were not detected. Perfluorooctane sulfonate (PFOS) was the predominant compound (9.57-1,444 ng g(-1) wet weight (ww)), followed by perfluorononanoate (PFNA, 0.47-109 ng g(-1) ww). C(6)-C(8) PFSAs, PFOSi and C(7)-C(13) PFCAs showed statistically significant increasing concentrations between 1974 and 1997, with a peak in 1997 and then decreased or levelled off (except for C(12) and C(13) PFCAs). FOSA had a different temporal trend with a maximum in 1989 followed by significant decreasing concentrations until 2008. Toxicological implications for grey seals are limited, but the maximal PFOS concentration found in this study was about 40 times lower than the predicted lowest observed effect concentrations (LOEC). The statistically significant decreasing concentrations or levelling off for several PFCs in the relative closed marine ecosystem of the Baltic Sea indicate a rapidly responding to reduced emissions to the marine environment. However, the high concentrations of PFOS and continuing increasing concentrations of the longerchain PFCAs (C(12)-C(14)) shows that further work on the reduction of environmental emissions of PFCs are necessary.				1												1			B	-	ハイイロアザラシの肝臓中のPFAS	
328	蓄積性	Löfstrand, Karin; Jörundsdóttir, Hrönn; Tomy, Gregg; Svavarsson, Jörundur; Weihe, Pál; Nygård, Torgeir; Bergman, Åke	Spatial trends of polyfluorinated compounds in	2008	Chemosphere. 2008 Aug;72(10):1475-1480. doi: 10.1016/j.chemosphere.2008.05.011. Epub 2008 Jun 24.	Polyfluorinated alkyl compounds (PFCs) are a group of chemicals of growing concern that have been detected in biological and abiotic samples worldwide. This study reports the concentrations of a suite of PFCs: perfluorooctyl sulfonate (PFOS), perfluorooctyl sulfonamide (PFOSA) and perfluorinated carboxylic acids (PFCAs) in guillemot (Uria aalge) eggs, collected in North-Western Europe, from Iceland, the Faroe Islands, Sweden and two locations in Norway. The highest concentrations of PFOS were found in samples from Sweden (mean 400 ng g(-1) wet weight (w.w.)), which were almost five times higher than concentrations found in Norwegian samples (mean 85 ng g(-1)w.w. from both sample sites). The concentrations found in Icelandic and Faroe samples were lowest (mean 16 and 15 ng g(-1)w.w., respectively). Only Swedish samples differed significantly from the other locations. In general, PFCAs show a different spatial trend than PFOS. Perfluorooctanoic acid (PFOA) was not detected in any sample and perfluorononanoic acid (PFNA) was only detected in samples from Sweden. The most abundant PFCA was perfluoroundecanoic acid (PFUA) with highest concentrations in samples from Sweden (mean 82 ng g(-1)w.w.), samples from the Faroe Islands had the second highest concentration (mean 57 ng g(-1)w.w.) and samples from Iceland and Norway had concentrations ranging between 18 and 30 ng g(-1)w.w. The original hypothesis was based on the idea that PFC concentrations are the highest close to more densely populated and industrialized areas and lower levels in remote areas. However, the geographic pattern is more complicated than predicted and variesamong different PFCs.				1												1			B	-	イベリアウミガラスの卵中のPFAS	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
329	蓄積性	Müller, Claudia E; De Silva, Amila O; Small, Jeff; Williamson, Mary; Wang, Xiaowa; Morris, Adam; Katz, Sharon; Gamberg, Mary; Muir, Derek C G	Biomagnification of perfluorinated compounds	2011	Environ Sci Technol. 2011 Oct 15;45(20):8665-73. doi: 10.1021/es201353v. Epub 2011 Sep 9.	The biomagnification behavior of perfluorinated carboxylates (PFCAs) and perfluorinated sulfonates (PFSAs) was studied in terrestrial food webs consisting of lichen and plants, caribou, and wolves from two remote northern areas in Canada. Six PFCAs with eight to thirteen carbons and perfluorooctane sulfonate (PFOS) were regularly detected in all species. Lowest concentrations were found for vegetation (0.02-0.26 ng/g wet weight (ww) sum (Σ) PFCAs and 0.002-0.038 ng/g ww PFOS). Wolf liver showed highest concentrations (10-18 ng/g ww Σ PFCAs and 1.4-1.7 ng/g ww PFOS) followed by caribou liver (6-10 ng/g ww Σ PFCAs and 0.7-2.2 ng/g ww PFOS). Biomagnification factors were highly tissue and substance specific. Therefore, individual whole body concentrations were calculated and used for biomagnification and trophic magnification assessment. Trophic magnification factors (TMF) were highest for PFCAs with nine to eleven carbons (TMF = 2.2-2.9) as well as PFOS (TMF = 2.3-2.6) and all but perfluorooctanoate were significantly biomagnified. The relationship of PFCA and PFSA TMFs with the chain length in the terrestrial food chain was similar to previous studies for Arctic marine mammal food web, but the absolute values of TMFs were around two times lower for this study than in the marine environment. This study demonstrates that challenges remain for applying the TMF approach to studies of biomagnification of PFCAs and PFSAs, especially for terrestrial animals.			1															1			B	-	地上の食物連鎖、PFAS	
330	蓄積性	Persson, Sara; Rotander, Anna; Kärrman, Anna; van Bavel, Bert; Magnusson, Ulf	Perfluoroalkyl acids in subarctic wild male min	2013	Environ Int. 2013 Sep;59:425-30. doi: 10.1016/j.envint.2013.06.025. Epub 2013 Aug 6.	This study investigates the influence of biological and environmental factors on the concentrations of perfluoroalkyl acids (PFAAs) in a top predator; the American mink. Perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS) and perfluoroalkyl carboxylates (PFCAs) with C8-C13 perfluorinated carbon chains were analyzed in livers from wild male mink liver (n=101) from four areas in Sweden representing two inland environments (rural and highly anthropogenic, respectively) and two different coastal environments. Mean PFOS concentrations were 1250ng/g wet weight and some mink from the urban inland area had among the highest PFOS concentrations ever recorded in mink (up to 21 800ng/g wet weight). PFBS was detected in 89% of the samples, but in low concentrations (mean 0.6ng/g ww). There were significant differences in PFAA concentrations between the geographical areas (p<0.001-0.01). Age, body condition and body weight did not influence the concentrations significantly, but there was a seasonal influence on the concentrations of perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFUnDA) (p<0.01 and p<0.05, respectively), with lower concentrations in autumn samples than in samples taken in the winter and spring. It is thus recommended to take possible seasonal differences into account when using mink exposure data. The overall results suggest that the mink is a suitable sentinel species for assessing and monitoring environmental levels of PFAAs.	1															1			B	-	野生の雄のミンクの肝臓、PFAS	
331	蓄積性	Route, William T; Russell, Robin E; Lindstrom, Andrew B; Strynar, Mark J; Key, Rebecca L	Spatial and temporal patterns in concentration	2014	Environ Sci Technol. 2014 Jun 17;48(12):6653-60. doi: 10.1021/es501055d. Epub 2014 Jun 5.	Perfluorinated chemicals (PFCs) are of concern due to their widespread use, persistence in the environment, tendency to accumulate in animal tissues, and growing evidence of toxicity. Between 2006 and 2011 we collected blood plasma from 261 bald eagle nestlings in six study areas from the upper Midwestern United States. Samples were assessed for levels of 16 different PFCs. We used regression analysis in a Bayesian framework to evaluate spatial and temporal trends for these analytes. We found levels as high as 7370 ng/mL for the sum of all 16 PFCs (ΣPFCs). Perfluorooctanesulfonate (PFOS) and perfluorodecanesulfonate (PFDS) were the most abundant analytes, making up 67% and 23% of the PFC burden, respectively. Levels of ΣPFC, PFOS, and PFDS were highest in more urban and industrial areas, moderate on Lake Superior, and low on the remote upper St. Croix River watershed. We found evidence of declines in ΣPFCs and seven analytes, including PFOS, PFDS, and perfluorooctanoic acid (PFOA); no trend in two analytes; and increases in two analytes. We argue that PFDS, a long-chained PFC with potential for high bioaccumulation and toxicity, should be considered for future animal and human studies.	1															1			B	-	261のハクトウワシ血漿中のPFAS	
332	蓄積性	Rubarth, J.; Dreyer, A.; Guse, N.; Einax, J. W.; Ebinghaus, R.	Perfluorinated compounds in red-throated dive	2011	Environ Chem. 8: 419–428. doi: 10.1071/EN10142	Twenty poly- and perfluorinated compounds (PFCs) were investigated in four red-throated divers (Gavia stellata) from the German Baltic Sea sampled in 2005 Concentrations of perfluoroalkyl sulfonates (PFSAs), perfluoroalkyl carboxylates (PFCAs), alkylated perfluoroalkyl sulfonamides, alkylated perfluoroalkyl sulfonamidoethanols and perfluorooctane sulfonamides were determined in blood, brain, fatty tissue, gall bladder, heart, kidney, liver, lung, muscle and spleen by high-performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS). For quantification standard addition was applied. Twelve compounds were detected with average total PFC concentrations ranging from 42 ng g(-1) in muscle to 220 ng g(-1) in liver samples. Perfluorooctane sulfonate (PFOS) was the major compound in each of the 40 tissue samples. Except for brain, perfluoroundecanoate was the dominant PFCA. In brain samples preferential enrichment of long-chain PFSAs and PFCAs was observed. The total PFC body burden was estimated to 100 +/- 39 mu g. Multivariate statistical analyses supported the identification of the preferred accumulation location' of individual PFCs in the birds' body.			1													1			B	-	アビの血液、脳、脂肪細胞、胆嚢、心臓、腎臓、肝臓、肺、筋肉、脾臓中のPFAS	
333	バイオモニタリング	Antignac, Jean-Philippe; Veyrand, Bruno; Kadar, Hanane; Marchand, Philippe; Oleko, Amivi; Le Bizec, Bruno; Vandentorren, Stéphanie	Occurrence of perfluorinated alkylated substar	2013	Chemosphere. 2013 May;91(6):802-8. doi: 10.1016/j.chemosphere.2013.01.088. Epub 2013 Mar 7.	A previously developed and validated methodology based on liquid chromatography coupled to high resolution mass spectrometry was used for determine the concentration levels of 14 perfluoroalkylated substances (PFASs) in a set of 48 breast milk samples collected from French women in the frame of the ELFE pilot study. In accordance with other similar studies conducted at european and international levels, PFOS, PFOA, and PFHxS were detected and quantified in most of the analyzed samples (90%, 98% and 100%, respectively), and appeared as major contributors to the total PFAS exposure (38%, 37%, 25%, respectively), whereas the other targeted PFAS were very rarely, if not, found at the limits of detection of the method. Also in agreement with other published data, the concentration levels measured for the detected substances varied from <0.05 to 0.33 μg/L for PFOS (median=0.079), from <0.05 to 0.22 μg/L for PFOA (median=0.075), and from 0.04 to 0.07 μg/L for PFHxS (median=0.050). On the basis of this relatively limited data set, no statistically significant relation was observed between these exposure levels and developmental outcomes, in particular the weight at birth. Similarly, no relation was observed between the measured PFAS levels and various socio-demographical parameters including the consumption of seafood, alcohol, smoking, or socio-economical level. These results suggest a need for further research and better knowledge regarding the sources, pharmacokinetics, and factors of exposure for other substances belonging to this class of emerging contaminants.	1						1							1					B	C	exposure source	フランスでの母乳中PFAS濃度の測定（n=48）。PFBAは８例で検出され平均値、中央値が示されているが、PFHxA、PFHpA、PFNAは１例でのみ検出された。
334	バイオモニタリング	Nilsson, Helena; Kärrman, Anna; Westberg, Håkan; Rotander, Anna; van Bavel, Bert; Lindström, Gunilla	A time trend study of significantly elevated per	2010	Environ Sci Technol. 2010 Mar 15;44(6):2150-5. doi: 10.1021/es9034733.	A time trend study focusing on ski waxing technicians' exposure to perfluorinated chemicals (PFCs) from fluorinated wax fumes was performed in 2007/2008. Levels of eight perfluorocarboxylates and three perfluorosulfonates were analyzed in monthly blood samples from eight technicians. Samples were collected before the ski season, i.e., preseason, then at four FIS World Cup competitions in cross country skiing, and finally during an unexposed 5-month postseason period. The perfluorinated carboxylates perfluoroheptanoic acid (PFHpA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) bioaccumulate, and continued exposure may contribute to elevated levels in ski technicians compared to the general population. The wax technicians' median blood level of PFOA is 112 ng/mL compared to 2.5 ng/mL in the general Swedish population. A significant correlation was found between number of working years and levels of perfluorocarboxylates. The PFOA levels in three technicians with "low" initial levels of PFOA (<10.0 ng/mL in preseason blood) increased by 254, 134, and 120%, whereas five technicians with "high" initial levels (>100 ng/mL in preseason sample) were at steady state. PFHxA is suggested to have a short half-life in humans relative the other perfluorocarboxylates. The levels of perfluorosulfonates were unaffected by the wax exposure.	1	1	1			1	1									1			B	B	PK	スキーのワックスがけをする技術者の血中濃度を継続的に測定し、PFHpA、PFNA、PFDA、PFUnDAなどを検出した。PFHxAの半減期は短いと述べている。高濃度曝露を受けた作業者の血中濃度が示されている。
335	バイオモニタリング	Pérez, F.; Nadal, M.; Navarro-Ortega, A.; Fàbrega, F.; Domingo, J. L.; Barceló, D.; Farré, M.	Accumulation of perfluoroalkyl substances in h	2013	Environ Int 59: 354-362. doi: 10.1016/j.envint.2013.06.004.	Perfluoroalkyl substances (PFASs) are environmental pollutants with an important bioaccumulation potential. However, their metabolism and distribution in humans are not well studied. In this study, the concentrations of 21 PFASs were analyzed in 99 samples of autopsy tissues (brain, liver, lung, bone, and kidney) from subjects who had been living in Tarragona (Catalonia, Spain). The samples were analyzed by solvent extraction and online purification by turbulent flow and liquid chromatography coupled to tandem mass spectrometry. The occurrence of PFASs was confirmed in all human tissues. Although PFASs accumulation followed particular trends depending on the specific tissue, some similarities were found. In kidney and lung, perfluorobutanoic acid was the most frequent compound, and at highest concentrations (median values: 263 and 807ng/g in kidney and lung, respectively). In liver and brain, perfluorohexanoic acid showed the maximum levels (median: 68.3 and 141ng/g, respectively), while perfluorooctanoic acid was the most contributively in bone (median: 20.9ng/g). Lung tissues accumulated the highest concentration of PFASs. However, perfluorooctane sulfonic acid and perfluorooctanoic acid were more prevalent in liver and bone, respectively. To the best of our knowledge, the accumulation of different PFASs in samples of various human tissues from the same subjects is here reported for thevery first time. The current results may be of high importance for the validation of physiologically based pharmacokinetic models, which are being developed for humans. However, further studies on the distribution of the same compounds in the human body are still required.	1	1	1	1		1	1			1				1	1			1	B	A	PK	スペインのTarragona Countyで死亡した一般人20名の肝臓、腎臓、脳、肺、骨に含まれる21種類のPFAS（PFBA、PFPeA、PFHxA、PFHpA、PFOA、PFNA、PFDA、PFUdA、PFDoA、PFTrDA、PFTeDA、PFHxDA、PFDOA、PFBS、PFHxS、PFOS、PFDS、FHEA、FOEA、FDEA）を測定し、臓器によって蓄積量の多い分子種が異なることを示した。一般人の臓器中PFAS濃度を示している。
336	バイオモニタリング	Song, X.; Tang, S.; Zhu, H.; Chen, Z.; Zang, Z.; Zhang, Y.; Niu, X.; Wang, X.; Yin, H.; Zeng, F.; He, C.	Biomonitoring PFAAs in blood and semen sam	2018	Environ Int 113: 50-54. doi: 10.1016/j.envint.2018.01.010.	Perfluoroalkyl acids (PFAAs) have been suspected to act as endocrine disruptors and adversely affect human reproductive health. We aimed to investigate the association between PFAAs in blood and semen, explore a potential link between PFAAs exposure and semen quality in the population of the Pearl River Delta (PRD) region in China, one of the "world factories". The monitoring results demonstrated that the population (103 male participants) from the PRD region in this study had higher PFAAs levels in blood and semen than some other areas in China. PFOS was found at the highest mean concentrations of 118.16 ng/mL in blood and 5.31 ng/mL in semen among the nine PFAAs. Significant associations were found between concentrations of several analytes in blood and semen, including Σ9 PFAAs (r = 0.475, P < .01), PFOA (r = 0.215, P = .029), PFHS (r = 0.458, P < .01) and PFOS (r = 0.981, P < .01). BMI was the most important factor to PFAAs, but there was no significant difference in PFAAs concentrations in blood and semen collected from participants with different smoking and drinking habits, education background and occupations. Negative correlations were significantly observed between sperm motility and PFBA, PFPeA, PFHxA, PFBS, PFOA, PFHS, PFOS and Σ9PFAAs in semen. Therefore, exposure to PFAAs may result in a decline in semenmobility in participants from the PRD region.	1					1	1	1			1					1			B	B	中国の工業地帯で男性103名の血液と精液中のPFAS濃度を測定し、血中、精液中濃度の相関、および、精子の運動性との相関を調べた。血中濃度は一般中国人より高かった。PFBA, PFPeA, PFHxA, PFBS, PFOA, PFHS, PFOS濃度、および総PFAS濃度と精子の運動性は負の相関を示した。中国の工業地帯でばく露を受けている男性の血中濃度、および精子の運動性への影響を示した。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
337	バイオモニタリング	Fraser, Alicia J; Webster, Thomas F; Watkins, Deborah J; Strynar, Mark J; Kato, Kayoko; Calafat, Antonia M; Vieira, Verónica M; McClean, Michael D	Polyfluorinated compounds in dust from homes	2013	Environ Int. 2013 Oct;60:128-36. doi: 10.1016/j.envint.2013.08.012. Epub 2013 Sep 14.	We aimed to characterize levels of polyfluorinated compounds (PFCs) in indoor dust from offices, homes, and vehicles; to investigate factors that may affect PFC levels in dust; and to examine the associations between PFCs in dust and office workers' serum. Dust samples were collected in 2009 from offices, homes, and vehicles of 31 individuals in Boston, MA and analyzed for nineteen PFCs, including perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), fluorotelomer alcohols (FTOHs), and sulfonamidoethanols (FOSEs). Serum was collected from each participant and analyzed for eight PFCs including PFOA and PFOS. Perfluorononanoate, PFOA, perfluoroheptanoate, perfluorohexanoate, PFOS and 8:2 FTOH had detection frequencies >50% in dust from all three microenvironments. The highest geometric mean concentration in office dust was for 8:2 FTOH (309ng/g), while PFOS was highest in homes (26.9ng/g) and vehicles (15.8ng/g). Overall, offices had the highest PFC concentrations, particularly for longer-chain carboxylic acids and FTOHs. Perfluorobutyrate was prevalent in homes and vehicles, but not offices. PFOA serum concentrations were not associated with PFC dust levels after adjusting for PFC concentrations in office air. Dust concentrations of most PFCs are higher in offices than in homes and vehicles. However, indoor dust may not be a significant source of exposure to PFCs for office workers. This finding suggests that our previously published observation of an association between FTOH concentrations in office air and PFOA concentrations in office workers was not due to confounding by PFCs in dust.	1	1	1	1		1	1		1	1										B	C	exposure source	米国マサチューセッツ州の住民31名を対象に、職場、自宅、自動車内の粉塵を回収し、PFBS, PFHxS, PFOS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnA, PFDoAを含むPFAS濃度を測定した。参加者の血中PFAS濃度と粉塵中濃度との間に有意な相関はなかった。また自宅より職場の方が粉塵中PFAS濃度が高かった。粉塵中のPFAS濃度の情報は珍しい。
338	バイオモニタリング	Jiang, W.; Zhang, Y.; Zhu, L.; Deng, J.	Serum levels of perfluoroalkyl acids (PFAAs) w	2014	Environ Int 64: 40-47. doi: 10.1016/j.envint.2013.12.001	Perfluoroalkyl acids (PFAAs) are a group of chemicals used for many applications and widely present in the environment and humans. In this study, serum levels of PFAAs and isomers of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) were analyzed in 141 Chinese pregnant women. Among all the samples, total PFOS (ΣPFOS, mean concentration 7.32ng/mL) was predominant, followed by ΣPFOA (mean 4.78ng/mL) and perfluorodecanoate (PFDA, mean 1.45ng/mL). On average, the proportion of linear PFOS (n-PFOS) was 0.667 of ΣPFOS, which was higher than the general population, implying that maternal women could excrete branched PFOS isomers to the fetus by transplacental transfer. Moreover, the proportion of n-PFOS decreased significantly with the increasing concentration of ΣPFOS in the serum samples (r=-0.342, p<0.001). The mean proportion of n-PFOA in the serum samples was 99.0%, which was much higher than the technical ECF (electrochemical fluorination) products (ca. 70%). The small proportion of branched isomers of PFOA suggests that there is still a source of ECF PFOA in China. Significant correlations (p<0.005) were observed between the concentrations of some PFAAs with certain medical parameters in the pregnant women. For example, the levels of most perfluorinated carboxylic acids (PFCAs) were found to correlate with albumin significantly, which might bea sign of immunotoxicity of these chemicals. The adverse effects of PFAA exposure to pregnant women may increase the health risk of the fetus. Interestingly, not only the PFAA concentrations but also the percentages of PFOS and PFOA isomers were correlated with certain medical parameters. This implies that the compositions of PFOS or PFOA should be considered in human health risk assessment in the future.		1	1			1														B	B	B-minor	中国の141名の妊婦の血中、PFOA, PFOSの異性体（直鎖型、分枝型）とその合計、及び、PFHxS, PFHxA, PFHpA, PFNA, PFDA, PFUdA, PFDoA濃度を測定し、血液生化学検査値との相関を調べた。
339	バイオモニタリング	Nilsson, Helena; Kärrman, Anna; Rotander, Anna; van Bavel, Bert; Lindström, Gunilla; Westberg, Håkan	Biotransformation of fluorotelomer compound	2013	Environ Int. 2013 Jan;51:8-12. doi: 10.1016/j.envint.2012.09.001. Epub 2012 Nov 6.	Levels of perfluorocarboxylates (PFCAs) in biological compartments have been known for some time but their transport routes and distribution patterns are not properly elucidated. The opinions diverge whether the exposure of the general population occurs indirect through precursors or direct via PFCAs. Previous results showed that ski wax technicians are exposed to levels up to 92 000 ng/m(3) of 8:2 fluorotelomer alcohol (FTOH) via air and have elevated blood levels of PFCAs. Blood samples were collected in 2007-2011 and analyzed for C(4)-C(18) PFCAs, 6:2, 8:2 and 10:2 unsaturated fluorotelomer acids (FTUCAs) and 3:3, 5:3 and 7:3 fluorotelomer acids (FTCAs) using UPLC-MS/MS. Perfluorooctanoic acid (PFOA) was detected in levels ranging from 1.90 to 628 ng/mL whole blood (wb). Metabolic intermediates 5:3 and 7:3 FTCA were detected in all samples at levels up to 6.1 and 3.9 ng/mL wb. 6:2, 8:2 and 10:2 FTUCAs showed maximum levels of 0.07, 0.64 and 0.11 ng/mL wb. Also, for the first time levels of PFHxDA and PFOcDA were detected in the human blood at mean concentrations up to 4.22 ng/mL wb and 4.25 ng/mL wb respectively. The aim of this study was to determine concentrations of PFCAs and FTOH metabolites in blood from ski wax technicians.		1				1														B	B	exposure source	スキーワックス塗布を行う技術者は気中から高濃度の8:2 FTOHにばく露される。その血中に、PFOA, PFOSのみならずPFBA, PFPeA, PFHxA, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTDA, PFHxDA, PFOcDA, 及び、PFBS, PFHxS, PFDSが検出されるか検討した
340	バイオモニタリング	Poothong, S.; Thomsen, C.; Padilla-Sanchez, J. A.; Papadopoulou, E.; Haug, L. S.	Distribution of novel and well-known poly- and	2017	Environ Sci Technol 51: 13388-13396. doi: 10.1021/acs.est.7b03299	Currently, there is limited knowledge on the distribution of poly- and perfluoroalkyl substances (PFASs) in different blood matrices, particularly for novel PFASs such as polyfluoroalkyl phosphate esters (PAPs) and perfluoroalkyl phosphonates (PFPAs). To explore this, serum, plasma, and whole blood from 61 adults in Oslo, Norway were collected. The largest number of PFASs were detected in whole blood. For PAPs and PFPAs, the highest frequencies of detection and concentrations were observed in plasma. PAPs contributed to 8% of total PFASs in plasma (median, 0.81 ng mL-1). Perfluorohexylphosphonate (PFHxPA) was the dominant PFPA, regardless of blood matrix. The relative composition profiles of PFASs in blood matrices differed. For some specific PFASs such as perfluorooctanesulfonamide (PFOSA) and perfluorohexanoate (PFHxA), the highest concentrations were observed in whole blood. The PFAS concentration ratios varied between blood matrices, depending on the compounds. However, similar ratios were observed for 6:2 polyfluoroalkyl phosphate diester (6:2diPAP) as well as well-known PFASs such as perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA). Besides the determination of 25 PFASs in human blood, this study also lead to better understanding of biomonitoring data from different blood matrices, which is key knowledge for performing both exposure assessments and epidemiological studies.		1				1			1	1							1			B	C		ノルウェーの61名の成人の血液中のpolyfluoroalkyl phosphate esters (PAPs)、及びperfluoroalkyl phosphonates (PFPAs)濃度を中心に多種類のPFAS濃度を調べた。全血、血清、血漿について測定することで、化合物によって分布が異なることが明らかにされた。
341	バイオモニタリング	Schecter, Arnold; Malik-Bass, Noor; Calafat, Antonia M; Kato, Kayoko; Colacino, Justin A; Gent, Tyra L; Hynan, Linda S; Harris, T Robert; Malla, Sunitha; Birnbaum, Linda	Polyfluoroalkyl compounds in Texas children fr	2012	Environ Health Perspect. 2012 Apr;120(4):590-4. doi: 10.1289/ehp.1104325. Epub 2011 Dec 19.	BACKGROUND: For > 50 years, polyfluoroalkyl compounds (PFCs) have been used worldwide, mainly as surfactants and emulsifiers, and human exposure to some PFCs is widespread. OBJECTIVES: Our goal was to report PFC serum concentrations from a convenience sample of Dallas, Texas, children from birth to < 13 years of age, and to examine age and sex differences in PFC concentrations. METHODS: We analyzed 300 serum samples collected in 2009 for eight PFCs by online solid phase extraction-high performance liquid chromatography-isotope dilution-tandem mass spectrometry. RESULTS: Perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were detected in > 92% of participants; the other PFCs measured were detected less frequently. Overall median concentrations of PFOS (4.1 ng/mL) were higher than those for PFOA (2.85 ng/mL), PFNA (1.2 ng/mL), and PFHxS (1.2 ng/mL). For PFOS, PFOA, PFNA, and PFHxS, we found no significant differences (p < 0.05) by sex, significantly increasing concentrations for all four chemicals by age, and significantly positive correlations between all four compounds. CONCLUSIONS: We found no significant differences in the serum concentrations of PFOS, PFOA, PFNA, and PFHxS by sex, but increasing concentrations with age. Our results suggest that these 300 Texas children from birth through 12 years of age continued to be exposed to several PFCs in late 2009, years after changes in production of some PFCs in the United States.		1	1			1														B	B		米国テキサス州の0-13歳までの子供（300名）の血清中PFOA, PFOS濃度に加え、PFNA, PFHxS, Et-PFOSA-AcOH, Me-PFOSA-AcOH, PFDA, PFOSA濃度を測定した。2009年の時点でもこれらのPFASが検出されている。
342	バイオモニタリング	Seo, S. H.; Son, M. H.; Choi, S. D.; Lee, D. H.; Chang, Y. S.	Influence of exposure to perfluoroalkyl substar	2018	Environ Int 113: 149-161. doi: 10.1016/j.envint.2018.01.025	This study demonstrated the 10-year trend of 13 perfluoroalkyl substances (PFASs) serum levels among 786 adults living in Seoul, Korea. PFAS levels gradually increased from 2006 to 2013, decreasing thereafter. We found that PFAS levels were higher in male than in female participants and were positively correlated with age. PFASs were not significantly correlated with body mass index, although we observed positive correlations with total cholesterol, low-density lipoprotein cholesterol, and triglycerides and negative correlations with high-density lipoprotein cholesterol. Uric acid and free thyroxine (fT4) also showed positive correlations with major congeners while correlations between thyroid stimulating hormone and PFASs were inconsistent. We demonstrated significant correlations between fT4 and perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and perfluorodecanoic acid (PFDA). There were significant differences in PFHxS and perfluorododecanoic acid (PFDoDA) levels between participants with and without diabetes. Furthermore, principal component analysis suggested possible differences in disease manifestation based on the congener distribution of PFASs. This study is the first study of temporal trends of 13 PFAS congeners in serum samples obtained from the Korean general population; it is currently longest and largest scale study of this type.		1	1			1	1							1				1		B	A		韓国の786名の成人の血中PFOA, PFOS濃度に加え、PFHxA, PFHpA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFBS, PFHxS, PFDS濃度を2006年から2013年まで継続的に測定し、その経年変化を示している。また、性、年齢、BMI等の様々な因子との相関を調べた。
343	バイオモニタリング	Li Xiao; Zhang JianQing; Liu Wei; Li XiaoNa; Zhang Xin; Jiang YouSheng; Zhou Jian; Jin YiHe	Serum levels of perfluorinated compounds in th	2011	Chin Sci Bull 56: 3092-3099. doi: 10.1007/s11434-011-4616-7	Perfluorinated compounds (PFCs) have been detected in many environmental matrices, biota, and nonoccupationally exposed populations in China recently. However, little is known about the distribution and levels of various PFCs in the general population living in areas where there is PFC exposure. In the present study, the levels and prevalence of ten target PFCs were determined in 227 serum samples from a population of nonoccupationally exposed individuals in Shenzhen, China. Results indicated that human exposure to PFCs was prevalent in Shenzhen. Perfluorooctanoate (PFOA) was the dominant PFC contaminant in the serum samples, with a median concentration of 6.72 ng/mL, followed by perfluorooctane sulfonate (PFOS) with a median concentration of 2.07 ng/mL. Other PFCs were detected at much lower concentrations, with median concentrations ranging from 0.02 to 0.87 ng/mL. Statistically, no significant (P>0.05) gender differences were observed for any of the PFCs. Significant (P<0.01) positive correlations were found between age and serum concentrations of the target PFCs, except for perfluorobutane sulfonate (R = −0.16, P = 0.01), perfluorohexanoic acid (R = 0.08, P = 0.22), and perfluoroheptanoic acid (R = −0.11, P = 0.10). Based on the one-compartment pharmacokinetic model, the total daily intakes of PFOA and PFOS for the general population in Shenzhen were calculated as 0.63 and 0.20 ng/kg body weight/day, respectively.		1		1		1														B	D		
344	バイオモニタリング	Bao, Jia; Lee, Yungling Leo; Chen, Pau-Chung; Jin, Yi-He; Dong, Guang-Hui	Perfluoroalkyl acids in blood serum samples fro	2014	Environ Sci Pollut Res Int. 2014 Jun;21(12):7650-5. doi: 10.1007/s11356-014-2594-4. Epub 2014 Mar 13.	Severe perfluoroalkyl acid (PFAA) contamination resulting from the fast-growing semiconductor, electrochemical, and optoelectronic industries has been determined in the river water in the vicinity of the Taipei area, Taiwan, during recent years. However, little is known about body burdens of the PFAA contaminations in local residents, especially children living in the Taipei area recently. In this study, ten target PFAA analytes consisted of three perfluorosulfonates (PFSAs) and seven perfluorocarboxylates (PFCAs) in the blood serum samples, collected from 225 healthy children with an average age of 13.6 years in the Taipei area from 2009 to 2010, were analyzed via high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). As the dominant PFAA contaminant in the blood serum samples from Taiwanese children, perfluorooctane sulfonate (PFOS) contributed 86% of all the target PFAA analytes, while the other nine analytes contributed less than 5% individually. PFOS showed the highest median up to 29 ng/mL, ranging from 0.03 to 148 ng/mL, which was higher than that observed in the serum samples collected from Taiwanese children between 2006 and 2008. Statistically, serum concentrations of perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), and perfluorooctanoic acid (PFOA) had significantly positive correlations with ages of children (p < 0.05). Furthermore, serum PFBS, PFHxS, and PFOA concentrations in the male children were considerably higher than those in the female children (p = 0.049, p = 0.000, p = 0.000).				1			1													B	C		2009-2010年に採取した台湾の小児（平均13.6歳）225名の血中PFAS濃度を測定した。PFCAsが7種類、PFSAsが3種類である。性・年齢の影響などを解析した。
345	バイオモニタリング	Glynn, A.; Berger, U.; Bignert, A.; Ullah, S.; Aune, M.; Lignell, S.; Darnerud, P. O.	Perfluorinated alkyl acids in blood serum from	2012	Environ Sci Technol 46: 9071-9079. doi: 10.1021/es301168c	We investigated temporal trends of blood serum levels of 13 perfluorinated alkyl acids (PFAAs) and perfluorooctane sulfonamide (FOSA) in primiparous women (N = 413) from Uppsala County, Sweden, sampled 3 weeks after delivery 1996-2010. Levels of the short-chain perfluorobutane sulfonate (PFBS) and perfluorohexane sulfonate (PFHxS) increased 11%/y and 8.3%/y, respectively, and levels of the long-chain perfluorononanoate (PFNA) and perfluorododecanoate (PFDA) increased 4.3%/y and 3.8%/y, respectively. Concomitantly, levels of FOSA (22%/y), perfluorooctane sulfonate (PFOS, 8.4%/y), perfluorodecane sulfonate (PFDS, 10%/y), and perfluorooctanoate (PFOA, 3.1%/y) decreased. Thus, one or several sources of exposure to the latter compounds have been reduced or eliminated, whereas exposure to the former compounds has recently increased. We explored if maternal levels of PFOS, PFOA, and PFNA during the early nursing period are representative for the fetal development period, using serial maternal serum samples, including cord blood (N = 19). PFAA levels in maternal serum sampled during pregnancy and the nursing period as well as in cord blood were strongly correlated. Strongest correlations between cord blood levels and maternal levels were observed for maternal serum sampled shortly before or after the delivery (r = 0.70-0.89 for PFOS and PFOA). A similar pattern was observed for PFNA, although the correlationswere less strong due to levels close to the method detection limit in cord blood.				1	1		1		1				1		1			1		B	A		1996-2010年にスウェーデンの初回妊娠女性413名の出産3週間後の血液を採取し、13種類のPFASの血清中濃度を測定し、化学種ごとの増加、減少傾向を調べた。増加傾向を示すものと減少傾向を示すものがあった。また、一部の妊婦（N=19）については臍帯血中濃度との相関を調べた。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
346	バイオモニタリング	Olsen, Geary W; Mair, David C; Lange, Cleston C; Harrington, Laura M; Church, Timothy R; Goldberg, Corinne L; Herron, Ross M; Hanna, Hank; Nobiletti, John B; Rios, Jorge A; Reagen, William K; Ley, Carol A	Per- and polyfluoroalkyl substances (PFAS) in	2017	Environ Res. 2017 Aug;157:87-95. doi: 10.1016/j.envres.2017.05.013. Epub 2017 May 18.	In 2015, thirteen per- and polyfluoroalkyl substances (PFAS), including perfluorohexanesulfonate (PFHxS), perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), and perfluorodecanoate (PFDA) were analyzed in human plasma that were collected from a total of 616 American Red Cross male and female blood donors (ages 20-69) at 6 regional blood collection centers. Plasma samples were analyzed using a validated solvent precipitation-isotope dilution direction-liquid chromatography tandem mass spectrometry method. The data were analyzed in conjunction with prior cross-sectional investigations [2000-2001 (n =645), 2006 (n =600), and 2010 (n =600)] to determine PFAS trends. Age- and sex-adjusted geometric mean serum (2000-2001) and plasma (2006, 2010, 2015) concentrations (ng/mL) were, respectively: PFHxS (2.3, 1.5, 1.3, 0.9); PFOS (35.1, 14.5, 8.4, 4.3); PFOA (4.7, 3.4, 2.4, 1.1); PFNA (0.6, 1.0, 0.8, 0.4); and PFDA (0.2, 0.3, 0.3, 0.1). The percentage decline in these geometric mean concentrations from 2000-2001 to 2015 were: PFHxS (61%); PFOS (88%); PFOA (77%); PFNA (33%); and PFDA (50%). The results indicate a continued decline of PFHxS, PFOS, and PFOA concentrations in American Red Cross blood donors. For the remaining PFAS measured in 2015, including the shorter chain perfluoroalkyls perfluorobutanesulfonate (PFBS) and perfluorohexanoate (PFHxA), the majority of samples were below the lower limit of quantitation.		1		1				1			1	1				1					1	B	A		米国赤十字に献血で2001, 2006, 2010, 2015年に集められたそれぞれ約600サンプルの血清中の13種類のPFAS濃度を測定した。化学種ごとに増加するものと減少するものがあった。
347	バイオモニタリング	Calafat, A. M.; Kato, K.; Hubbard, K.; Jia, T.; Botelho, J. C.; Wong, L. Y.	Legacy and alternative per- and polyfluoroalky	2019	Environ Int. 2019 Oct;131:105048. doi: 10.1016/j.envint.2019.105048. Epub 2019 Jul 31.	Concerns are heightened from detecting environmentally persistent man-made per- and polyfluoroalkyl substances (PFAS) in drinking water systems around the world. Many PFAS, including perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), remain in the human body for years. Since 1999-2000, assessment of exposure to PFOS, PFOA, and other select PFAS in the U.S. general population has relied on measuring PFAS serum concentrations in participants of the National Health and Nutrition Examination Survey (NHANES). Manufacturers have replaced select chemistries ("legacy" PFAS) with PFAS with shorter biological half-lives (e.g., GenX, perfluorobutanoate [PFBA]) which may efficiently eliminate in urine. However, knowledge regarding exposure to these compounds is limited. We analyzed 2682 urine samples for 17 legacy and alternative PFAS in 2013-2014 NHANES participants ≥6 years of age. Concentrations of some of these PFAS, measured previously in paired serum samples from the same NHANES participants, suggested universal exposure to PFOS and PFOA, and infrequent or no exposure to two short-chain PFAS, perfluorobutane sulfonate and perfluoroheptanoate. Yet, in urine, PFAS were seldom detected; the frequency of not having detectable concentrations of any of the 17 PFAS was 67.5%. Only two were detected in >1.5% of the population: PFBA -0.133 and perfluorohexanoate (PFHxA, 22.6%); the 90th percentile urine concentrationswere 0.1 μg/L (PFBA), and 0.3 μg/L (PFHxA). These results suggest that exposures to short-chain PFAS are infrequent or at levels below those that would result in detectable concentrations in urine. As such, these findings do not support biomonitoring of short-chain PFAS or fluorinated alternatives in the general population using urine, and highlight the importance of selecting the adequate biomonitoring matrix.					1			1														B	B		米国の2013-2014のNHANESの対象者の尿中、および血清中PFAS濃度をLegacy及びAlternativeの両方について測定した。しかし、尿中でPFASが検出される割合は低く、尿中で検出されたのはPFBA (13.3%) 及びPFHxA（22.6%）だった。
348	バイオモニタリング	Kotlarz, Nadine; McCord, James; Collier, David; Lea, C Suzanne; Strynar, Mark; Lindstrom, Andrew B; Wilkie, Adrien A; Islam, Jessica Y; Matney, Katelyn; Tarte, Phillip; Polera, M E; Burdette, Kemp; DeWitt, Jamie; May, Katlyn; Smart, Robert C; Knappe, Detlef R U; Hoppin, Jane A	Measurement of Novel, Drinking Water-Associ	2020	Environ Health Perspect. 2020 Jul;128(7):77005. doi: 10.1289/EHP6837. Epub 2020 Jul 22.	BACKGROUND: From 1980 to 2017, a fluorochemical manufacturing facility discharged wastewater containing poorly understood per- and polyfluoroalkyl substances (PFAS) to the Cape Fear River, the primary drinking water source for Wilmington, North Carolina, residents. Those PFAS included several fluoroethers including HFPO-DA also known as GenX. Little is known about the bioaccumulation potential of these fluoroethers. OBJECTIVE: We determined levels of fluoroethers and legacy PFAS in serum samples from Wilmington residents. METHODS: In November 2017 and May 2018, we enrolled 344 Wilmington residents ≥6 years of age into the GenX Exposure Study and collected blood samples. Repeated blood samples were collected from 44 participants 6 months after enrollment. We analyzed serum for 10 fluoroethers and 10 legacy PFAS using liquid chromatography-high-resolution mass spectrometry. RESULTS: Participants' ages ranged from 6 to 86 y, and they lived in the lower Cape Fear Region for 20 y on average (standard deviation: 16 y). Six fluoroethers were detected in serum; Nafion by-product 2, PFO4DA, and PFO5DoA were detected in >85% of participants. PFO3OA and NVHOS were infrequently detected. Hydro-EVE was present in a subset of samples, but we could not quantify it. GenX was not detected above our analytical method reporting limit (2 ng/mL). In participants with repeated samples, the median decrease in fluoroether levels ranged from 28% for PFO5DoA to 65% for PFO4DA in 6 months due to wastewater discharge control. Four legacy PFAS (PFHxS, PFOA, PFOS, PFNA) were detected in most (≥97%) participants; these levels were higher than U.S. national levelsfor the 2015-2016 National Health and Nutrition Examination Survey. The sum concentration of fluoroethers contributed 24% to participants' total serum PFAS (median: 25.3 ng/mL). CONCLUSION: Poorly understood fluoroethers released into the Cape Fear River by a fluorochemical manufacturing facility were detected in blood samples from Wilmington, North Carolina, residents. Health implications of exposure to these novel PFAS have not been well characterized.					1			1														B	B		米国ノースカロライナ州のPFAS工場による汚染の影響を血清レベルで調査。2017-2018年、対象者は６歳以上の344名。10種類のfluoroetherと10種類のlegacy PFASを測定した。
349	バイオモニタリング	Laitinen, Juha Ari; Koponen, Jani; Koikkalainen, Janne; Kiviranta, Hannu	Firefighters' exposure to perfluoroalkyl acids a	2014	Toxicol Lett. 2014 Dec 1;231(2):227-32. doi: 10.1016/j.toxlet.2014.09.007. Epub 2014 Oct 17.	The aim of this study was to assess eight firefighters' exposure to Sthamex 3% AFFF (aqueous film forming foam) in the simulation of aircraft accidents at Oulu airport in Finland. Study was conducted in 2010 before limitation for the use of PFOA and PFOS in AFFFs. Due to prospective limitation also eight commercially available AFFFs were evaluated from occupational and environmental point of view to find substitutive AFFFs for future. The firefighters' exposure to twelve perfluoroalkyl acids (PFAS) was analyzed in order to observe the signs of accumulation during three consecutive training sessions. The firefighters' short-term exposure to 2-butoxyethanol (EGBE) was analyzed by urinalysis of 2-butoxyacetic acid (2-BAA). For the background information also the concentration of PFAS in used AFFF-liquid was analyzed. Fire fighters' serum PFHxS and PFNA concentrations seemed to increase during the three training sessions although they were not the main PFAS in used AFFF. The statistical significance for the elevations was not able to test due to limited size of test group. In two training sessions, the average urinary excretions of 2-BAA exceeded the reference limit of the occupationally unexposed population. In the evaluations of the firefighting foams, non-fluorine based products were favored and the alcohol resistance properties of foams were recommended for consideration due to the increasing use of biofuels.				1					1									1				B	B	B-minor	フィンランドの空港で、PFOA, PFOSの消火剤への使用が禁止される前の2010年に、8人の消防士の消火訓練での血清PFAS（12種類）濃度を3回の訓練ごとに測定した。n数が少ない。
350	バイオモニタリング	Byrne, Samuel; Seguinot-Medina, Samarys; Miller, Pamela; Waghiyi, Vi; von Hippel, Frank A; Buck, C Loren; Carpenter, David O	Exposure to polybrominated diphenyl ethers ar	2017	Environ Pollut. 2017 Dec;231(Pt 1):387-395. doi: 10.1016/j.envpol.2017.08.020. Epub 2017 Aug 17.	BACKGROUND: Many Alaska Native communities rely on a traditional marine diet that contains persistent organic pollutants (POPs). The indoor environment is also a source of POPs. Polybrominated diphenyl ethers (PBDEs) and perfluoroalkyl substances (PFASs) are present both in the traditional diet and the home indoor environment. OBJECTIVES: We assessed exposure to PBDEs and PFASs among residents of two remote Alaska Native villages on St. Lawrence Island. Ninespine stickleback (Pungitious pungitious) and Alaska blackfish (Dallia pectoralis) were used to detect accumulation of these compounds in the local environment. METHODS: Concentrations of PBDEs and PFASs were measured in dust collected from 49 households on St. Lawrence Island, as well as in blood serum from 85 island residents. Resident ninespine stickleback and Alaska blackfish were used as sentinels to detect accumulation of PBDEs and PFASs in the food web. RESULTS: Serum concentrations of perfluorononanoic acid (PFNA) and perfluoroundecanoic acid (PFUnDA) were elevated, despite low concentrations of PFASs in dust samples. Concentrations of PBDEs in dust and serum were similar to those from the contiguous United States. Statistical associations between dust and serum concentrations are apparent for a small number of PBDEs, suggesting a possible route of exposure. Predominant compounds were similar between human sera and stickleback; however, blackfish accumulated PFASs not found in either stickleback or human sera. CONCLUSION: Household dust contributes to PBDE exposure, but not PFAS exposure. Elevated concentrations of long chain PFASs in serum are likelydue to exposure from traditional foods. The presence of both PFASs and PBDEs in sentinel fish species suggests atmospheric deposition and bioaccumulation, as well as local environmental contamination.				1					1									1				B	B		汚染がないと考えられるアラスカのNativeの人々85名（18-45歳、男女）の屋内粉塵と血清PBDE、PFAS濃度を2013-2014に測定。PBDEは屋内粉塵と血清濃度に相関があったが、PFASはなかった。魚のPFAS濃度が相関していた
351	バイオモニタリング	von Ehrenstein, O. S.; Fenton, S. E.; Kato, K.; Kuklenyik, Z.; Calafat, A. M.; Hines, E. P.	Polyfluoroalkyl chemicals in the serum and mil	2009	Reprod Toxicol. 2009 Jun;27(3-4):239-245. doi: 10.1016/j.reprotox.2009.03.001. Epub 2009 Mar 6.	Polyfluoroalkyl chemicals (PFCs) comprise a group of man-made organic compounds, some of which are persistent contaminants with developmental toxicity shown in laboratory animals. There is a paucity of human perinatal exposure data. The US EPA conducted a pilot study (Methods Advancement for Milk Analysis) including 34 breastfeeding women in North Carolina. Milk and serum samples were collected at 2–7weeks and 3–4 months postpartum; 9 PFCswere assessed in milk and 7 in serum. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) were found in nearly 1 of the serum samples. PFOS and PFOA were found at the highest concentrations. PFCswere belowthe limit of quantification in most milk samples. Serum concentrations of PFOS, PFOA and PFHxSwere lower ($p < 0.01$) at the second visit compared to the first visit. Living				1					1									1				B	B		米国ノースカロライナ州で2003-2004に行われたパイロットスタディ。35名の妊婦の母乳、血清中PFAS濃度を測定。主にPFOS, PFOA, PFHxSが検出された。
352	バイオモニタリング	Wu, Xiangmei May; Bennett, Deborah H; Calafat, Antonia M; Kato, Kayoko; Strynar, Mark; Andersen, Erik; Moran, Rebecca E; Tancredi, Daniel J; Tulve, Nicolle S; Hertz-Picciotto, Irva	Serum concentrations of perfluorinated compo	2015	Environ Res. 2015 Jan;136:264-73. doi: 10.1016/j.envres.2014.09.026. Epub 2014 Nov 20.	Perfluorinated compounds (PFCs) have been widely used in industrial applications and consumer products. Their persistent nature and potential health impacts are of concern. Given the high cost of collecting serum samples, this study is to understand whether we can quantify PFC serum concentrations using factors extracted from questionnaire responses and indirect measurements, and whether a single serum measurement can be used to classify an individual's exposure over a one-year period. The study population included three demographic groups: young children (2-8 years old) (N=67), parents of young children (<55 years old) (N=90), and older adults (>55 years old) (N=59). PFC serum concentrations, house dust concentrations, and questionnaires were collected. The geometric mean of perfluorooctane sulfonic acid (PFOS) was highest for the older adults. In contrast, the geometric mean of perfluorooctanoic acid (PFOA) was highest for children. Serum concentrations of the parent and the child from the same family were moderately correlated (Spearman correlation (r)=0.26-0.79, p<0.05), indicating common sources within a family. For adults, age, having occupational exposure or having used fire extinguisher, frequencies of consuming butter/margarine, pork, canned meat entrées, tuna and white fish, freshwater fish, and whether they ate microwave popcorn were significantly positively associated with serum concentrations of individual PFCs. For children, residential dust concentrations, frequency of wearing waterproof clothes, frequency of having canned fish, hotdogs, chicken nuggets, French fries, andchips, and whether they ate microwave popcorn were significant positive predictors of individual PFC serum concentrations. In addition, the serum concentrations collected in a subset of young children (N=20) and the parents (N=42) one year later were strongly correlated (r=0.68-0.98, p<0.001) with the levels measured at the first visits, but showed a decreasing trend. Children had moderate correlation (r=0.43) between serum and dust concentrations of PFOS, indicating indoor sources contribute to exposure. In conclusion, besides food intake, occupational exposure, consumer product use, and exposure to residential dust contribute to PFC exposure. The downward temporal trend of serum concentrations reflects the reduction of PFCs use in recent years while the year-to-year correlation indicates that a single serum measurement could be an estimate of exposure relative to the population for a one-year period in epidemiology studies.				1					1													B	B		米国カルフォルニア集の子供と成人の2007-2009年の血清PFAS濃度と屋内粉塵や生活習慣との関連を調べ、1年後にも採血して相関があることをしめした。
353	バイオモニタリング	Alves, Andreia; Jacobs, Griet; Vanermen, Guido; Covaci, Adrian; Voorspoels, Stefan	New approach for assessing human perfluoroa	2015	Talanta. 2015 Nov 1;144:574-83. doi: 10.1016/j.talanta.2015.07.009. Epub 2015 Jul 4.	In the recent years hair has been increasingly used as alternative matrix in human biomonitoring (HBM) of environmental pollutants. Sampling advantages and time integration of exposure assessment seems the most attractive features of hair matrix. In the current study, a novel miniaturized method was developed and validated for measuring 15 perfluoroalkyl substances (PFAS), including perfluoro n-butanoic acid (PFBA), perfluoro n-pentanoic acid (PFPeA), perfluoro n-hexanoic acid (PFHxA), perfluoro n-heptanoic acid (PFHpA), perfluor n-octanoic acid (PFOA), perfluoro n-nonanoic acid (PFNA), perfluoro tetradecanoic acid (PFTeDA), perfluorobutane sulfonic acid (PFBS), perfluoro pentane sulfonic acid (PFPeS), perfluorohexane sulfonic acid (PFHxS), perfluoroheptane sulfonic acid (PFHpS), perfluorooctane sulfonic acid (PFOS), perfluorononane sulfonic acid (PFNS), perfluorodecane sulfonic acid (PFDS) and perfluorododecane sulfonic acid (PFDoS) in human hair by liquid chromatography tandem mass spectrometry (LC-MS/MS). After extraction using ethyl acetate, dispersive ENVI-Carb was used for clean-up. Good intra- and inter-day precision for low (LQ 5 ng/g hair) and high spike (HQ 15n g/g) levels were achieved (in general RSD <10%). The accuracy was assessed using recoveries (%), which ranged between 68-118% (LQ) and 70-121% (HQ). The instrumental limit of detection (LODi) and limit of quantification (LOQi) were between 1-4 pg/g hair and 3-13 pg/g hair, respectively. The method limit of quantification (LOQm) ranged between 6 and 301 pg/g hair. The PFAS levels were measured in 30 human hair samples indicating that the levels are low (14-1534pg/g hair). Some PFAS were not present in any hair sample (e.g. PFHpA, PFTeDA, PFNA, PFPeS, PFHpS, PFOS and PFNS), while other PFAS were frequently detected (PFBA, PFPeA, PFHxA, PFOA, PFBS, PFHxS, PFOS, PFDS and PFDoS) in human hair. Although levels in general were low, there is evidence of higher human exposure to some analytes, such as PFBA, PFPeA, PFHxA, PFOA, PFBS, PFHxS, and PFDoS. The current study shows that hair is a suitable alternative non-invasive matrix for exposure assessment of PFAS.			1		1					1							1	1				C	B		ベルギーの30名の一般人の毛髪（2013年採取）からPFAS15種類を抽出、測定した。検出されないものもあった。

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
354	バイオモニタリング	Bao, Jia; Liu, Li; Wang, Xin; Jin, Yi-He; Dong, Guang-Hui	Human exposure to perfluoroalkyl substances	2017	Environ Sci Pollut Res Int. 2017 Apr;24(10):9194-9201. doi: 10.1007/s11356-017-8620-6. Epub 2017 Feb 20.	Severe perfluoroalkyl substance (PFAS) contaminations have been observed in both surface water and groundwater in the vicinity of Fuxin, China, over the past years, attributing to the fast-growing fluorochemical industries locally. However, little is known about the overall daily intake of PFAS contaminations by Fuxin residents recently. In the present study, ten target PFAS analytes in the blood serum samples collected from 100 non-occupationally exposed healthy residents in Fuxin, with an average age of 47.6 years, together with 14 drinking water samples obtained from the public water system (PWS) of Fuxin were analyzed via high-performance liquid chromotography-tandem mass spectrometry (HPLC-MS/MS). As the dominant PFAS contaminant, the serum concentrations of perfluorooctanoic acid (PFOA) in Fuxin residents ranged between <0.05 and 160 ng/mL, with a median concentration of 9.4 ng/mL, which was higher than those reported previously for Fuxin and other areas worldwide. In drinking water samples, PFOA had a median value of 8.5 ng/L, ranging from 7.7 to 8.8 ng/L. Based upon the simplified one-compartment pharmacokinetic model, the total daily intake of PFOA for individuals residing in Fuxin ranged from 0.30 to 1.76 ng/kg bw/day, with a median of 0.79 ng/kg bw/day; furthermore, daily consumption of drinking water from the PWS in Fuxin appeared to contribute 35% of overall PFOA burden in local residents, which was approximately 3-fold higher compared to that estimated for Fuxin residents in 2009.				1						1													B	C		フッ素関連工場がある中国遼寧省のFuxin市の一般住民100名の血清PFASと飲料水中濃度を測定。主にPFOAについて解析した論文
355	バイオモニタリング	Bjerregaard-Olesen, Christian; Bach, Cathrine C; Long, Manhai; Ghisari, Mandana; Bossi, Rossana; Bech, Bodil H; Nohr, Ellen A; Henriksen, Tine B; Olsen, Jørn; Bonefeld-Jørgensen, Eva C	Time trends of perfluorinated alkyl acids in ser	2016	Environ Int. 2016 May;91:14-21. doi: 10.1016/j.envint.2016.02.010. Epub 2016 Feb 16.	We aimed to estimate the levels and time trends of perfluorinated alkyl acids (PFAAs) in serum of 1533 Danish pregnant nulliparous women between 2008 and 2013. The selection criterion of only including nulliparous women was chosen to avoid confounding from parity. The serum samples were analyzed for sixteen PFAAs using solid phase extraction and liquid chromatography tandem mass spectrometry (LC-MS/MS). We investigated the time trends for seven PFAAs, which were detected in more than 50% of the samples: perfluorohexane sulfonate (PFHxS), perfluoroheptane sulfonate (PFHpS), perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnA). We found that the serum levels of all seven PFAAs decreased during the period from 2008 to 2013; on average PFHxS decreased with 7.0% per year, PFHpS with 14.8%, PFOS with 9.3%, PFOA with 9.1%, PFNA with 6.2%, PFDA with 6.3%, and PFUnA with 7.1% per year. Adjustment for maternal age, body mass index (BMI), educational level and gestational age at blood sampling did not change the time trends much. To our knowledge, we are the first to report decreasing trends of PFNA, PFDA and PFUnA since year 2000, thereby indicating that the phase-out of these compounds are beginning to show an effect on human serum levels.				1						1						1		1				1	B	A		デンマークの初産の妊婦1533名の血清中の16種類のPFAS濃度を2008～2013年に測定し、分子種ごとに経時変化を調べた。
356	バイオモニタリング	Cariou, R.; Veyrand, B.; Yamada, A.; Berrebi, A.; Zalko, D.; Durand, S.; Pollono, C.; Marchand, P.; Leblanc, J. C.; Antignac, J. P.; Le Bizec, B.	Perfluoroalkyl acid (PFAA) levels and profiles i	2015	Environ Int. 2015 Nov;84:71-81. doi: 10.1016/j.envint.2015.07.014. Epub 2015 Jul 29.	One major concern regarding perfluoroalkyl acids (PFAAs) is their potential role in onset of health troubles consecutive to early exposure during the perinatal period. In the present work, the internal exposure levels of 18 targeted PFAAs were determined in ca. 100 mother-newborn pairs recruited in France between 2010 and 2013 In serum, the cumulated concentrations of the 7 most frequently detected compounds were 5.70ng/mL and 2.83ng/mL (median values) in maternal and cord serum, respectively. Perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexylesulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) contributed to around 0.9 of the total PFAAs contamination, with concentration levels and contamination profiles in accordance with other published work in Europe. Levels measured in breast milk were far lower (20 to 150 fold) than those determined in serum. Associations between the different monitored substances as well as between levels determined in the different investigated biological matrices mostly do not appear statistically significant. The estimated materno-foetal transfer would be thus substance-dependant, mainly driven by the physico-chemical properties of the different PFAAs (nature of polar group and length of alkylated side chain). We conclude that trans-placental passage and breastfeeding are both significant routes of human exposure to PFAAs.				1						1						1		1					B	B		フランスの母子ペア約100組の母体血、臍帯血、母乳中の18種類のPFAS濃度を2010-2013年に測定。分子種ごとに見ると各サンプル間の濃度の相関は低い。
357	バイオモニタリング	Ehresman, D. J.; Froehlich, J. W.; Olsen, G. W.; Chang, S. C.; Butenhoff, J. L.	Comparison of human whole blood, plasma, an	2007	Environ Res. 2007 Feb;103(2):176-84. doi: 10.1016/j.envres.2006.06.008. Epub 2006 Aug 8.	Interest in human exposure to perfluorinated acids, including perfluorobutanesulfonate (PFBS), perfluorohexanesulfonate (PFHS), perfluorooctanesulfonate (PFOS), and perfluorooctanoate (PFOA) has led to their measurement in whole blood, plasma and serum. Comparison of measurements in these different blood-based matrices, however, has not been rigorously investigated to allow for across-matrix comparisons. This research evaluated concentrations of PFBS, PFHS, PFOS, and PFOA in whole blood collected in heparin (lithium) and ethylenediamine tetraacetic acid (EDTA), plasma samples collected in heparin and EDTA, and serum (from whole blood allowed to clot). Blood samples were collected from 18 voluntary participants employed at 3M Company. Solid phase extraction methods were used for all analytical sample preparations, and analyses were completed using high-pressure liquid chromatography/tandem mass spectrometry methods. Serum concentrations ranged from: limit of quantitation (LOQ, 5 ng/mL) to 25 ng/mL for PFBS; LOQ (5 ng/mL) to 75 ng/mL for PFHS; LOQ (5 ng/mL) to 880 ng/mL for PFOS; and LOQ (5 or 10 ng/mL) to 7320 ng/mL for PFOA. Values less than the LOQ were not included in the statistical analyses of the mean of the ratios of individual values for the matrices. PFBS was not quantifiable in most samples. Serum to plasma ratios for PFHS, PFOS, and PFOA were 1:1 and this ratio was independent of the level of concentrations measured. Serum or plasma to whole blood ratios, regardless of the anticoagulant used, approximated 2:1. The difference between plasma and serum and whole blood corresponded to volume displacement by red blood cells, suggesting that the fluorochemicals are not found intracellularly or attached to the red blood cells.				1						1						1		1					B	C		米国3Mの作業者の血清、血漿、全血中のPFBS, PFHxS, PFOS, and PFOA濃度を測定し、各分画への分布を調べた。赤血球にはほとんど存在していないとの結論
358	バイオモニタリング	Fromme, Hermann; Wöckner, Mandy; Roscher, Eike; Völkel, Wolfgang	ADONA and perfluoroalkylated substances in p	2017	Int J Hyg Environ Health. 2017 Apr;220(2 Pt B):455-460. doi: 10.1016/j.ijheh.2016.12.014. Epub 2017 Jan 4.	Perfluorinated compounds are fully fluorinated anthropogenic substances that have been used in various products, applications, and industrial processes. Due to their persistence and toxic effects, some of them are restricted, and therefore replacement products have been developed. The aim of the study was to quantify the body burden of different perfluorinated substances in two adult populations living close to or about 80km apart from a former perfluorooctanoate (PFOA) production plant who are exposed via drinking water, and in a control population. In this plant, the replacement emulsifier 3H-perfluoro-3-[(3-methoxy-propoxy)propanoic acid] (ADONA) has been used in the production of fluoropolymers since 2008. We quantified 7 perfluorinated compounds and ADONA in a total of 396 plasma samples collected at different time points. With regard to samples collected in 2015 or 2016, the highest 95th percentile levels were 13.5 μg/l for perfluorooctane sulfonate (PFOS), 3.0 μg/l for perfluorononanoate (PFNA), and 1.5 μg/l for perfluorohexane sulfonate (PFHxS). For PFOA, the highest 95th percentile was found at the site close to the facility (85.5 μg/l), while in the control region the value was 2.4 μg/l. Overall, the concentration of PFOA and PFOS declined over time in all study regions. ADONA was detected only in few samples slightly above the limit of quantification (0.2 μg/l). While health risks related to ADONA are unlikely under the present exposure situation, the exposure to PFOA via tap water should be reduced markedly, especially for the population living close to the plant.				1						1								1					B	B		ドイツのPFAS工場近辺及び80km離れた2つの集団で7種類のPFASおよび3H-perfluoro-3-[(3-methoxy-propoxy)propanoic acid](ADONA)の血漿中濃度を測定した（396名、2015-2016）。
359	バイオモニタリング	Fu, Yaning; Wang, Tieyu; Wang, Pei; Fu, Quanliang; Lu, Yonglong	Effects of age, gender and region on serum cor	2014	Chemosphere. 2014 Sep;110:104-10. doi: 10.1016/j.chemosphere.2014.02.020. Epub 2014 Mar 13.	133 Serum samples collected from Henan donors aged from 0 to 88years were analyzed for 12 perfluorinated compounds (PFCs). Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) accounted for 69.19% of the total PFCs in serum samples, with a median concentration of 1.43 and 1.47ngmL(-)(1), respectively. Other PFCs were detected at much lower concentrations, with median concentrations ranging from 0.03 to 0.37ngmL(-)(1). PFOA and PFOS were positively correlated (r=0.219) in serum samples, indicating that they may have common exposure pathways. For all donors (0-88years), significant increases in PFOA (r=0.239, p<0.01), perfluorononanoic acid (PFNA) (r=0.185, p<0.05) and PFOS (r=0.175, p<0.05) concentrations over age were found. Median concentrations of PFOA, PFNA, perfluorodecanoic acid (PFDA), and PFOS were higher in males than in females. Higher PFOA concentrations were found in urban populations than in rural populations. Since PFCs exposure in general population is prevalent, further studies are needed to explore its possible impacts on epidemiological factors.				1						1						1							B	B		中国河南省の住民133名の血清中12種類のPFAS濃度を測定した（2011年）。
360	バイオモニタリング	Gebbink, Wouter A; Glynn, Anders; Berger, Urs	Temporal changes (1997-2012) of perfluoroalk	2015	Environ Pollut. 2015 Apr;199:166-73. doi: 10.1016/j.envpol.2015.01.024. Epub 2015 Feb 4.	Concentrations (including isomer patterns) and temporal changes (1997-2012) of perfluoroalkyl acids (PFAAs) and selected perfluorooctane sulfonate (PFOS) and perfluoroalkyl carboxylic acid (PFCA) precursors were determined in serum samples from Swedish women. Perfluorooctane sulfonamide (FOSA) and perfluorooctane sulfonamidoacetic acid (FOSAA), as well as its N-methyl and N-ethyl derivatives (MeFOSAA and EtFOSAA) were consistently detected. Highest PFOS precursor concentrations were found for EtFOSAA (before year 2000) or MeFOSAA and FOSAA (after 2000). Disappearance half-lives for all PFOS precursors were shorter compared to PFOS. 4:2/6:2 and 6:2/6:2 polyfluoroalkyl phosphate diesters (diPAPs) were detected in <60% of the samples, whereas 6:2/8:2 and 8:2/8:2 diPAPs were detected in >60% of the samples, but showed no significant change in concentrations over time. Linear and sum-branched isomers were quantified separately for three PFAAs and three precursors. Significant changes between 1997 and 2012 in the % linear isomer were observed for PFOA and FOSA (increase) and PFOS (decrease).				1						1								1					B	B		スウェーデン女性の血清濃度1997-2012
361	バイオモニタリング	Gómez-Canela, Cristian; Fernández-Sanjuan, María; Farrés, Mireia; Lacorte, Silvia	Factors affecting the accumulation of perfluoro	2015	Environ Sci Pollut Res Int. 2015 Jan;22(2):1480-6. doi: 10.1007/s11356-014-3439-x. Epub 2014 Aug 28.	The aim of this study is to evaluate the presence of perfluoroalkyl substances (PFASs) in the blood of 46 residents from Barcelona and to study the factors that affect exposure. Compounds analysed included perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), perfluorobutane sulfonate (PFBS), perfluorooctanoate acid (PFOA) and perfluorononanoate acid (PFNA). Blood was liquid-liquid extracted and PFASs were determined by liquid chromatography coupled to tandem mass spectrometry. Good recoveries (between 97 ± 14 and 105 ± 13 %) were obtained and method detection limits were from 0.03 to 0.07 ng mL(-1). Σ PFASs ranged from 0.11 to 4.37 ng mL(-1). PFOS was the main compound detected at 0.09-3.35 ng mL(-1), followed by PFOA and PFHxS. PFBS and PFNA were seldom detected. Working conditions, smoking and gender did not cause any significant differences among Σ PFASs levels in the blood while age and parity produced decreased concentrations. On the other hand, laboratory working conditions produced significant higher PFOA levels compared to the general population. Compared to other studies, the PFASs levels in blood from Barcelona residents is low (mean Σ PFASs of 1.67 ± 0.88 ng mL(-1)) and with little variation among the studied population.				1						1								1					B	B	B-minor	Balcerona住民の血中の5種類のPFASとその変動要因解析
362	バイオモニタリング	Gyllenhammar, Irina; Berger, Urs; Sundström, Maria; McCleaf, Philip; Eurén, Karin; Eriksson, Sara; Ahlgren, Sven; Lignell, Sanna; Aune, Marie; Kotova, Natalia; Glynn, Anders	Influence of contaminated drinking water on pe	2015	Environ Res. 2015 Jul;140:673-83. doi: 10.1016/j.envres.2015.05.019. Epub 2015 Jun 14.	In 2012 a contamination of drinking water with perfluoroalkyl acids (PFAAs) was uncovered in the City of Uppsala, Sweden. The aim of the present study was to determine how these substances have been distributed from the contamination source through the groundwater to the drinking water and how the drinking water exposure has influenced the levels of PFAAs in humans over time. The results show that PFAA levels in groundwater measured 2012-2014 decreased downstream from the point source, although high Σ PFAA levels (>100ng/L) were still found several kilometers from the point source in the Uppsala aquifer. The usage of aqueous film forming fire-fighting foams (AFFF) at a military airport in the north of the city is probably an important contamination source. Computer simulation of the distribution of PFAA-contaminated drinking water throughout the City using a hydraulic model of the pipeline network suggested that consumers in the western and southern parts of Uppsala have received most of the contaminated drinking water. PFAA levels in blood serum from 297 young women from Uppsala County, Sweden, sampled during 1996-1999 and 2008-2011 were analyzed. Significantly higher concentrations of perfluorobutane sulfonic acid (PFBS) and perfluorohexane sulfonic acid (PFHxS) were found among women who lived in districts modeled to have received contaminated drinking water compared to unaffected districts both in 1996-1999 and 2008-2011, indicating that the contamination was already present in the late 1990s. Isomer-specific analysis of PFHxS in serum showed that women in districts with contaminated drinking water also had an increased percentage ofbranched isomers. Our results further indicate that exposure via contaminated drinking water was the driving factor behind the earlier reported increasing temporal trends of PFBS and PFHxS in blood serum from young women in Uppsala.				1						1								1					B	B	exposure source	ウプサラの汚染水道水の影響を調べた
363	バイオモニタリング	Haug, Line S; Thomsen, Cathrine; Becher, Georg	Time trends and the influence of age and gend	2009	Environ Sci Technol. 2009 Mar 15;43(6):2131-6. doi: 10.1021/es802827u.	Fifty-seven pooled archived human serum samples were analyzed to assess the time trends as well as influence of age and gender on selected perfluorinated compounds (PFCs) in Norwegian residents. The study comprised determinations of 19 PFCs in serum samples pooled according to year of collection from 28 years in the period 1976 to 2007. A 9-fold increase in the serum concentrations of perfluorooctyl sulfonate, perfluorooctanoic acid, and perfluoroheptyl sulfonate was measured for men (40-50 years) from 1977 to the mid 1990s where the concentrations reached a plateau before starting to decrease around year 2000. A similar trend was also seen for perfluorohexyl sulfonate, perfluorononanoic acid, perfluorodecanoic acid, and perfluoroundecanoic acid, but no clear decline was observed for these PFCs in the recent years. No statistically significant difference was observed between the PFC levels in the male and female serum pools, though the statistical power is low due to few data points. For most PFCs, the concentrations in the human serum samples were found to increase with age in the pools from 2007, while the results for 1976, 1987, and 1998 were more varying. Several PFCs were significantly intercorrelated.				1						1								1					B	B		ノルウェーで保存された血液（1976 to 2007）の19種類のPFASの濃度変化。プールされた血清なのでn数少ない

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
364	バイオモニタリング	Nyberg, Elisabeth; Awad, Raed; Bignert, Anders; Ek, Caroline; Sallsten, Gerd; Benskin, Jonathan P	Inter-individual, inter-city, and temporal trends	2018	Environ Sci Process Impacts. 2018 Aug 16;20(8):1136-1147. doi: 10.1039/c8em00174j.	Inter-individual, inter-city, and temporal trends of 19 per- and polyfluoroalkyl substances (PFASs) were investigated in human milk collected in Stockholm (1972-2016) and Gothenburg (2007-2015), Sweden. The concentrations of perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), and perfluorotridecanoate (PFTrDA) in human milk from Stockholm increased significantly over the entire monitoring periods, whereas branched (Br) and linear (L) isomers of perfluorooctane sulfonamide (FOSA) decreased. In human milk from Gothenburg, significant downward trends were detected for perfluorododecanoate (PFDoDA), PFHxS and Br-perfluorooctane sulfonate (Br-PFOS) over the last decade. This declining trend was also observed for perfluorohexanoate (PFHxA), PFHxS, perfluorooctanoate (PFOA) and Br-PFOS in Stockholm over the same time period. No significant differences were observed in concentrations or relative PFAS profiles between Stockholm and Gothenburg. However, a comparison of the PFAS profile in Stockholm milk revealed distinct profiles for the time periods 1972-1996, 2000-2012, and 2013-2016, reflecting a shift in exposure over time. The lower bound estimated daily intake (EDI) for ΣPFAS concentrations in infants ranged from 7.1-40 ng per kg body weight per day (ng/kg bw/d) in Stockholm and from 5.2-25 ng/kg bw/d in Gothenburg over the studied time period, consistent with other European countries. Overall these data indicate that exposure to some legacy PFASs via breastmilk is declining, presumably as a result of regulation and phase-outinitiatives. However, increasing concentrations for other PFASs and a shift in the overall PFAS profile in recent years may pose an ongoing health risk to infants.				1						1							1			1		B	A		1972-2016年のスウェーデンの母乳中19種類のPFAS濃度の比較
365	バイオモニタリング	Olsen, Geary W; Lange, Cleston C; Ellefson, Mark E; Mair, David C; Church, Timothy R; Goldberg, Corinne L; Herron, Ross M; Medhdizadehkashi, Zahra; Nobiletti, John B; Rios, Jorge A; Reagen, William K; Zobel, Larry R	Temporal trends of perfluoroalkyl concentratio	2012	Environ Sci Technol. 2012 Jun 5;46(11):6330-8. doi: 10.1021/es300604p. Epub 2012 May 11.	Eleven perfluorinated alkyl acids (PFAAs) were analyzed in plasma from a total of 600 American Red Cross adult blood donors from six locations in 2010. The samples were extracted by protein precipitation and quantified by using liquid chromatography tandem mass spectrometry (HPLC/MS/MS). The anions of the three perfluorosulfonic acids measured were perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS). The anions of the eight perfluorocarboxylic acids were perfluoropentanoate (PFPeA), perfluorohexanoate (PFHxA), perfluoroheptanoate (PFHpA), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnA), and perfluorododecanoate (PFDoA). Findings were compared to results from different donor samples analyzed at the same locations collected in 2000-2001 (N = 645 serum samples) and 2006 (N = 600 plasma samples). Most measurements in 2010 were less than the lower limit of quantitation for PFBS, PFPeA, PFHxA, and PFDoA. For the remaining analytes, the geometric mean concentrations (ng/mL) in 2000-2001, 2006, and 2010 were, respectively, PFHxS: (2.25, 1.52, 1.34); PFOS (34.9, 14.5, 8.3); PFHpA (0.13, 0.09, 0.05); PFOA (4.70, 3.44, 2.44); PFNA (0.57, 0.97, 0.83); PFDA (0.16, 0.34, 0.27), and PFUnA (0.10, 0.18, 0.14). The percentage decline (parentheses) in geometric mean concentrations from 2000-2001 to 2010 were PFHxS (40%), PFOS (76%), and PFOA (48%). The decline in PFOS suggested a population halving time of 4.3 years. This estimate is comparable to the geometric mean serum elimination half-life of 4.8years reported in individuals. This similarity supports the conclusion that the dominant PFOS-related exposures to humans in the United States were greatly mitigated during the phase-out period.				1						1												B	B		2000-2010年の米国の献血サンプル600について11種類のPFAS濃度を調べた
366	バイオモニタリング	Rotander, A.; Toms, L. M.; Aylward, L.; Kay, M.; Mueller, J. F.	Elevated levels of PFOS and PFHxS in firefight	2015	Environ Int. 2015 Sep;82:28-34. doi: 10.1016/j.envint.2015.05.005. Epub 2015 May 22.	Exposure to aqueous film forming foam (AFFF) was evaluated in 149 firefighters working at AFFF training facilities in Australia by analysis of PFOS and related compounds in serum. A questionnaire was designed to capture information about basic demographic factors, lifestyle factors and potential occupational exposure (such as work history and self-reported skin contact with foam). The results showed that a number of factors were associated with PFAA serum concentrations. Blood donation was found to be linked to low PFAA levels, and the concentrations of PFOS and PFHxS were found to be positively associated with years of jobs with AFFF contact. The highest levels of PFOS and PFHxS were one order of magnitude higher compared to the general population in Australia and Canada. Study participants who had worked ten years or less had levels of PFOS that were similar to or only slightly above those of the general population. This coincides with the phase out of 3M AFFF from all training facilities in 2003, and suggests that the exposures to PFOS and PFHxS in AFFF have declined in recent years. Self-reporting of skin contact and frequency of contact were used as an index of exposure. Using this index, there was norelationship between PFOS levels and skin exposure. This index of exposure is limited as it relies on self-report and it only considers skin exposure to AFFF, and does not capture other routes of potential exposure. Possible associations between serum PFAA concentrations and five biochemical outcomes were assessed. The outcomes were serum cholesterol, triglycerides, high-density lipoproteins, low density lipoproteins, and uric acid. No statistical associations between any of these endpoints and serum PFAA concentrations were observed.				1						1						1						B	B		149人のオーストラリアの消防士の血清PFAS濃度と生化学指標値
367	バイオモニタリング	Salihovic, Samira; Kärrman, Anna; Lind, Lars; Lind, P Monica; Lindström, Gunilla; van Bavel, Bert	Perfluoroalkyl substances (PFAS) including str	2015	Environ Int. 2015 Sep;82:21-7. doi: 10.1016/j.envint.2015.05.003. Epub 2015 May 22.	Per- and polyfluoroalkyl substances (PFASs) are a class of compounds with unique chemical properties that have been shown useful in a wide variety of applications because they provide materials with reduced surface tension and exceptional non-stick properties. PFASs are commonly found in impregnation materials, coatings of papers and textiles, fire-fighting foams, pesticides, and cleaning agents. The potential for human exposure to PFASs is high because of their widespread distribution. The aim of this study was to investigate levels of PFASs in men and women from Sweden and to assess the influence of gender and parity among women. Levels of 13 PFASs were determined in plasma samples collected during 2001-2004 from 1016 (507 women) 70year-old participants from the population-based Prospective Study of the Vasculature in Uppsala Seniors (PIVUS). The PFASs studied were nine perfluorinated carboxylic acids (PFCAs), four perfluorinated sulfonic acids (PFSAs) and perfluorooctane sulfonamide (PFOSA). In addition, structural isomers of perfluorooctane sulfonic acid (PFOS) were determined in a subset of 398 individuals. The detection rates were high and the majority of the studied compounds were detected in more than 75% of the participants. Levels of the selected analytes were found to be similar to other studies of non-occupationally exposed populations. Gender differences were observed in levels of PFHpA which was higher in men, while PFHxS was higher in women. Parity among women was shown to have a minor effect on PFAS concentrations and we found primi- and multiparous women to have slightly lower levels of PFUnDAwhen compared to nulliparous women.				1						1												B	B	B-minor	2001-2004年にスウェーデンの70歳以上の男女について13種類のPFAS測定
368	バイオモニタリング	Schröter-Kermani, Christa; Müller, Josef; Jürling, Heinrich; Conrad, André; Schulte, Christoph	Retrospective monitoring of perfluorocarboxyla	2013	Int J Hyg Environ Health. 2013 Nov;216(6):633-40. doi: 10.1016/j.ijheh.2012.08.004. Epub 2012 Sep 21.	Due to the increased awareness of the ubiquitous contamination of all environmental compartments and of human beings with perfluoroalkyl substances (PFAS), voluntary withdrawals and shifts in products and manufacturing technologies, as well as in regulatory measures, have been made. To investigate whether these activities are reflected in the human exposure to PFASS, we examined human blood archived by the German Environmental Specimen Bank. Plasma samples (n=258, age range 20-29 years) covering the observation period 1982-2010 were analyzed for eleven perfluoroalkylcarboxylates (C4-C14) and five perfluoroalkylsulfonates (C4-C10) by HPLC-MS-MS. We detected perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), and perfluorohexanesulfonate (PFHxS) most often of all PFASs. Following a sharp increase from 1982 to 1986, median PFOS concentrations remained in the range of 20-24ng/mL until the end of the 1990s. Between 2001 and 2010, PFOS concentrations decreased steadily to 4ng/mL in plasma. Except for a similar strong increase from 1982 to 1986, we observed PFOA concentrations fluctuating between 4.8 and 6.3ng/mL in the following years. Since 2008, ESB data suggest a decreasing trend of PFOA. PFHxS concentrations increased continuously between 1982 and 2001 from about 1-2ng/mL. After nearly unchanged concentrations until 2005, a downward trend of PFHxS in plasma became apparent and in 2010 resulted in levels which were about 20% lower than those observed in the early 1980s. In the case of shorter and longer chained PFASs, quantification frequencies were between 0 and60% and we found no indication of any temporal trends in human plasma concentrations.				1						1							1			1		B	B		ドイツのバイオバンクの血漿を使って (n=258, age range 20-29 years) 1982-2010年までの16種類のPFAS濃度測定
369	バイオモニタリング	Wang, Bin; Chen, Qian; Shen, Lixiao; Zhao, Shasha; Pang, Weiyi; Zhang, Jun	Perfluoroalkyl and polyfluoroalkyl substances i	2016	Environ Int. 2016 Dec;97:7-14. doi: 10.1016/j.envint.2016.10.008. Epub 2016 Oct 19.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are commonly used in industrial applications and consumer products, and their potential health impacts are of concern, especially for vulnerable population like fetuses. However, in utero exposure to PFASs and health implications are far from fully characterized in China. To fill in the gap, we analyzed 10 PFASs in cord plasma samples (N=687) collected in Shanghai between 2011 and 2012, one of the regions widely polluted with PFASs in China. A questionnaire survey on maternal and diet-related factors was conducted. Except for perfluoroheptanoic acid (PFHpA) and perfluorooctane sulfonamide (PFOSA), all other PFASs were detected in >90% of the samples. Perfluorooctanoic acid (PFOA) was the most predominant PFAS (median value: 6.96ng/mL), followed by perfluorooctane sulfonate (PFOS) (2.48ng/mL). PFOA and PFOS combined contributed to 80% of the total PFASs. The final multiple regression models showed that maternal factors including maternal age, body mass index, gestational age, economic status and educational level as well as consumption of fish and wheat were significantly related with concentrations of PFASs in cord blood. The risk assessment using the hazard quotients (HQs) approach on the basis of plasma PFAS levels indicated no potential concern for developmental toxicity in the local newborns. The results demonstrate the unique profiles of local prenatal exposure to PFASs, suggesting that PFOA has been the primary human exposure due to its widespread use and pollution. Special attention to high PFOA exposure and confirmation of potential determinants should be takenas a priority in the future plan for risk management and actions in this area.				1						1												B	B		2011-12に上海の臍帯血587検体の10種類のPFAS測定
370	バイオモニタリング	Zhou, Zhen; Shi, Yali; Vestergren, Robin; Wang, Thanh; Liang, Yong; Cai, Yaqi	Highly elevated serum concentrations of perflu	2014	Environ Sci Technol. 2014 Apr 1;48(7):3864-74. doi: 10.1021/es4057467. Epub 2014 Mar 18.	Increasing production and use of per- and polyfluoroalkyl substances (PFASs) has been reported from China, and a few studies have shown there are subpopulations in China with high and increasing exposure to these chemicals. In this paper, we present a comprehensive exposure assessment of PFASs in fishery employees from Tangxun Lake, China. Exceptionally high serum concentrations of C4 to C12 PFASs were observed in fishery employees (n = 39, median perfluorooctanesulfonic acid (PFOS) 10 400 ng/mL) compared to a reference group from the same city (n = 9, median PFOS 18.7 ng/mL). On the basis of the comparison of different exposure pathways, it was concluded that contaminated fish from Tangxun Lake was the primary source of PFAS exposure to fishery employees, and there was a positive association between serum PFAS concentrations and time of employment in the fishery. PFOS isomer profiles in fishery employees showed a significantly higher proportion of linear PFOS (78.4%) compared to the background-exposed reference group (66.8%), reflecting the highly linear PFOS isomer profile (>90%) of lake fish. Median renal clearance rates (CLrenal) of C4 to C10 perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkanesulfonic acids (PFSAs) ranged from 0.020 to 16.5 mL/day/kg and 0.013 to 9.43 mL/day/kg, respectively. PFCAs with less than eight perfluoroalkyl carbons were primarily eliminated via urine, whereas other routes of excretion may have contributed to the elimination for long-chain PFCAs and PFSAs. Calculated daily PFOS exposures of fishery employees significantly exceeded tolerable daily intake limits, but clinical bloodchemistry parameters were mostly within normal reference ranges. However, additional epidemiological studies are needed to address potential associations between PFAS exposure and health effects in the Tangxun Lake area.				1						1												B	A	B-minor	中国のTangxun Lakeの漁業労働者の血清中に高濃度のPFASが検出された。
371	バイオモニタリング	Frisbee, Stephanie J; Brooks, A Paul Jr; Maher, Arthur; Flensborg, Patsy; Arnold, Susan; Fletcher, Tony; Steenland, Kyle; Shankar, Anoop; Knox, Sarah S; Pollard, Cecil; Halverson, Joel A; Vieira, Verónica M; Jin, Chuanfang; Leyden, Kevin M; Ducatman, Alan M	The C8 health project: design, methods, and p	2009	Environ Health Perspect. 2009 Dec;117(12):1873-82. doi: 10.1289/ehp.0800379. Epub 2009 Jul 13.	BACKGROUND: The C8 Health Project was created, authorized, and funded as part of the settlement agreement reached in the case of Jack W. Leach, et al. v. E.I. du Pont de Nemours & Company (no. 01-C-608 W.Va., Wood County Circuit Court, filed 10 April 2002). The settlement stemmed from the perfluorooctanoic acid (PFOA, or C8) contamination of drinking water in six water districts in two states near the DuPont Washington Works facility near Parkersburg, West Virginia. OBJECTIVES: This study reports on the methods and results from the C8 Health Project, a population study created to gather data that would allow class members to know their own PFOA levels and permit subsequent epidemiologic investigations. METHODS: Final study participation was 69,030, enrolled over a 13-month period in 2005-2006. Extensive data were collected, including demographic data, medical diagnoses (both self-report and medical records review), clinical laboratory testing, and determination of serum concentrations of 10 perfluorocarbons (PFCs). Here we describe the processes used to collect, validate, and store these health data. We also describe survey participants and their serum PFC levels. RESULTS: The population geometric mean for serum PFOA was 32.91 ng/mL, 500% higher than previously reported for a representative American population. Serum concentrations for perfluorohexane sulfonate and perfluorononanoic acid were elevated 39% and 73% respectively, whereas perfluorooctanesulfonate was present at levels similar to those in the U.S. population. CONCLUSIONS: This largest known population study of community PFC exposure permits new evaluations ofassociations between PFOA, in particular, and a range of health parameters. These will contribute to understanding of the biology of PFC exposure. The C8 Health Project also represents an unprecedented effort to gather basic data on an exposed population; its achievements and limitations can inform future legal settlements for populations exposed to environmental contaminants.		1							1			1		1	1			1		B	A	B-minor	2005-2006年のC8 studyで69,030名の10種類のPFAS濃度を測定したまとめ

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
372	バイオモニタリング	Lee, Jin Heon; Lee, Chae Kwan; Suh, Chun-Hui; Kang, Hee-Sook; Hong, Choon-Pyo; Choi, Suk-Nam	Serum concentrations of per- and poly-fluoroa	2017	Int J Hyg Environ Health. 2017 Aug;220(6):1046-1054. doi: 10.1016/j.ijheh.2017.06.005. Epub 2017 Jun 24.	Per- and polyfluoroalkyl substances (PFASs) are ubiquitous contaminants found worldwide, including in South Korea. As a result, they are frequently detected in Koreans. However, there is limited representative data and information on potential sources in Korea. Therefore, we measured the serum concentrations of ten PFASs in nationally representative samples of the Korean population (n=1874, 18-69 years) and evaluated the factors associated with their exposure. Serum PFOS, PFDA, PFOA, and PFNA were detected in nearly all participants (83.1-99.9%). However, serum PFPA, PFHxA, and PFHpA were almost undetected (<0.5% of participants). PFOS had the highest population-weighted geometric mean of 10.23ng/mL (95% CI: 9.99-10.47), which was followed by PFOA with 2.85ng/mL (95% CI: 2.73-2.97) and PFDA with 2.17ng/mL (95% CI: 2.12-2.23). PFNA, PFDA, PFHxS, PFOA, and PFOS concentrations were higher in males (p<0.001) and older adults (p<0.001). PFNA was higher in those who used wax, polish, and water-resistant materials (adjusted proportional change=1.14; 95% CI: 1.08-1.22), and those who ate cooked fish (1.16; 95% CI: 1.03-1.31) compared to those who ate nearly no fish. PFDA was higher in those who used herbicides and pesticides (1.05; 95% CI: 1.02-1.09), those who drank beverages in a plastic bag on a daily basis (1.10; 95% CI: 1.03-1.19), and those who ate raw fish (1.15; 95% CI: 1.03-1.29) or cooked fish (1.13; 95% CI: 1.05-1.23) compared to those who ate nearly no fish. PFHxS was higher in those who used traditional Korean health supplement foods (1.08; 95% CI: 1.01-1.15). PFOA was higher in those who used plastic wrap in amicrowave daily or weekly (1.08; 95% CI: 1.00-1.16), and those who used disposable paper cups (1.07; 95% CI: 1.01-1.13). PFOS was lower in underweight participants (0.84; 95%CI: 0.75-0.93) compared to those who were obese, and higher in those who exercised regularly (1.08; 95% CI: 1.03-1.14) or irregularly (1.06, 95% CI: 1.01-1.12) compared to those who did not exercise. Subjects who used severely damaged Teflon appliances had lower concentrations of PFOA (0.78, 95% CI: 0.65-0.95), while regular use of Gore-Tex goods was related to higher PFNA (1.15, 95% CI: 1.03-1.28) and PFDA (1.11; 95% CI: 1.02-1.20) levels. These findings suggest that most Koreans are frequently exposed to PFASs, and that serum concentrations of PFASs vary with age, sex, and exposure factors.			1									1												B	**B**	exposure source	韓国の1874名の10種類のPFAS濃度
373	バイオモニタリング	Loi, Eva I H; Yeung, Leo W Y; Mabury, Scott A; Lam, Paul K S	Detections of commercial fluorosurfactants in	2013	Environ Sci Technol. 2013 May 7;47(9):4677-85. doi: 10.1021/es303805k. Epub 2013 Apr 8.	Previously, much of the perfluoroalkyl and polyfluoroalkyl substance (PFAS) research has focused on perfluoroalkyl carboxylates (PFCAs) or perfluoroalkane sulfonates (PFSAs). Recent studies indicate that known PFCAs and PFSAs accounted for 5-95% of the organofluorine (OF) in human and wild rat blood samples suggesting that a relatively large proportion of OF remained unknown. Until recently, some studies reported commercially available compounds such as polyfluoroalkyl phosphate diesters (diPAPs) and fluorotelomer sulfonates (FTSAs) in human blood and sludge samples. The present investigation is a pilot study aiming at surveying some newly identified PFASs such as diPAPs, FTSAs, and perfluorinated phosphinates (PFPiAs) in different environmental samples including surface water, sediment, sewage treatment plant influent and effluent, sludge, benthic worm, and human blood from Hong Kong. DiPAPs (6:2, 6:2/8:2, and 8:2) were detected in some of the samples at part-per-billion (ppb) levels in sludge, sub ppb levels in influent and effluent, sediment, worm, and human blood samples, and sub part-per-trillion (ppt) levels in surface waters. Sub ppt to ppb levels of 6:2 and 8:2 FTSAs were observed in worm, surface water, and human blood samples. PFPiAs were only observed in worm samples. The detected "new PFASs" accounted for a minor proportion (less than 5%) of the total PFASs in benthic worm and human blood, but up to 95% in sewage sludge samples from Hong Kong. This is the first report of commercial fluorosurfactants (PFPiAs, diPAPs, and FTSAs) in the samples from the environment and human blood in Hong Kong; further information on thedistribution, fate, and transport of "new PFASs" in other Asian cities, as well as toxicity, is needed for further assessing the human exposure and risk.			1									1												B	**B**	B-minor	パイロットスタディ
374	バイオモニタリング	DHHS, N.	Questions and Answers Regarding North Carol	2017	DHHS, N. 2017. https://files.nc.gov/ncdeq/GenX/NC%20DHHS%20Risk%20Assessment%20FAQ%20Final%20Clean%20071417%20PM.pdf. March 28, 2024	1. Why is NC DHHS updating its GenX risk assessment? The goal of the North Carolina Department of Health and Human Services (NC DHHS) is to provide timely health information to residents and others who are concerned about potential health effects of GenX. When there is not a federal standard and sufficient scientific information available, the NC DHHS can develop and issue a health assessment. This assessment can include establishing a health goal, sometimes referred to as a health screening goal. A health goal is a non-regulatory, non-enforceable level of contamination below which no adverse health effects would be expected over a lifetime of exposure. The NC DHHS shared a preliminary assessment for GenX with local partners on June 8,2017 in an attempt to provide some context for understanding the health risks that could be associated with levels found in the Cape Fear River during 2013-2014. Since sharing the preliminary health assessment, NC DHHS has continued to review all available health information about GenX. Based on this review, continuing discussions, and consensus with EPA, NC DHHS has determined that sufficient data are available to make changes to the preliminary assessment. The updated health goal is 140 ng/L for the most vulnerable population- i.e. bottle-fed infants, the population that drinks the largest volume of water per body weight. This updated level is lower than the level in the preliminary assessment for several reasons, including the following: ☒ After consultation with EPA, a different set of animal studies was identified as an appropriate starting point for the assessment. This change lowered the health goal by 10-fold. ☒ Since the new starting point was based on intermediate (sub-chronic) rather than long-term (chronic) animal studies, an additional uncertainty factor was added, which lowered the level by another 10-fold. ☒ While the preliminary assessment assumed that drinking water was the only source of exposure, the updated value includes an assumption that only 20% of a person's GenX exposure comes from drinking water, lowering the level another 5-fold. EPA's practice is to use this 20% default factor as a generic assumption when information is lacking about other sources of exposure in 7/14/2017 3:09 PM the environment, as is currently the case with GenX. NC DHHS's use of the 20% factor was included based on additional review and consultation with EPA. Details of the specific updates and calculations for the updated health screening goal are presented in Appendix 3. As with the preliminary assessment, it is important to note that this updated risk assessment is not final and is likely to be updated as new information becomes available or when standards are made available by the EPA. 2. What does the updated assessment for GenX mean? For the most vulnerable population (bottle-fed infants) the updated health risk assessment means that there could be an increased risk of adverse health effects over a lifetime of consuming water with levels greater than 140 ng/L. Because this goal/level is calculated based on the most vulnerable population, it is the most conservative and is protective of other groups, including pregnant women, nursing mothers, children, as well as other adults. This updated health assessment is based on evolving toxicological data; therefore it is still considered provisional and is subject to further updates based on an ongoing review, consultation with federal agencies and other partners, and the introduction of new research and scientific information. Although the preliminary assessment was based upon a study with combined cancer and non-cancer endpoints, the updated health goal considers non-cancer endpoints only. There are no studies in humans on cancer related to GenX. Only one animal study is available for cancer analysis, and it has shown increases in certain cancers. Based on conversations with EPA, there is not enough information at this time to					1							1												C	**D**		
375	バイオモニタリング	Forsthuber, M.; Kaiser, A. M.; Granitzer, S.; Hassl, I.; Hengstschläger, M.; Stangl, H.; Gundacker, C.	Albumin is the major carrier protein for PFOS,	2020	Environ Int. 2020 Apr;137:105324. doi: 10.1016/j.envint.2019.105324. Epub 2020 Feb 25.	Perfluoroalkyl (PFAS) substances are widespread in the environment and in organisms. The fact that exposure to PFAS is associated with elevated cholesterol levels is a major concern for human health. Previous investigations, in which bovine serum albumin was frequently studied, indicate that PFOS, PFOA and PFNA bind to serum albumin. However, it is critical to know whether these and other PFAS have a preference for the protein or the lipid fraction in native human blood fractions. For this reason, blood samples from four young healthy volunteers (two women, two men, 23–31 years old) were used for protein size separation and fractionation by the Cohn method in combination with serial ultracentrifugation. The plasma fractions were analyzed for 11 PFAS using high-performance tandem mass spectrometry (HPLC-MS/MS). Although the data are based on a small sample, they clearly show that albumin is the most important carrier protein for PFOS, PFOA, PFHxS, PFNA and PFDA in native human plasma. These five compounds have very little or no affinity for lipoproteins. The confirmation of their transport through albumin is important for the epidemiology of PFAS. The present results must be verified by the examination of a larger number of persons.			1													1						B	**B**	PK	PFOS, PFOA, PFHxS, PFNA and PFDAは血清の脂質ではなくアルブミンに結合
376	バイオモニタリング	Apelberg, B. J.; Goldman, L. R.; Calafat, A. M.; Herbstman, J. B.; Kuklenyik, Z.; Heidler, J.; Needham, L. L.; Halden, R. U.; Witter, F. R.	Determinants of fetal exposure to polyfluoroalk	2007	Environ Sci Technol. 2007 Jun 1;41(11):3891-7. doi: 10.1021/es0700911.	Polyfluoroalkyl compounds (PFCs), such as perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA), are ubiquitous, man-made chemicals. Human data suggest that in utero exposures to these chemicals occur and some evidence of developmental toxicity in animals exists. To assess the distribution and determinants of fetal exposure to PFCs, we analyzed cord serum samples from 299 singleton newborns delivered between 2004 and 2005 in Baltimore, MD for 10 PFCs by employing on-line solid-phase extraction coupled with reversed-phase high-performance liquid chromatography-tandem mass spectrometry. PFOS and PFOA were detected in 99 and 1 of umbilical cord sera, with geometric mean concentrations of 4.9 and 1.6 ng/mL, respectively. PFOS and PFOA concentrations were highly correlated (Pearson's r = 0.64 after natural log transformation, p < 0.01). Eight other PFCs were detected less frequently and at lower concentrations than PFOS and PFOA. Geometric mean concentrations of PFOS for Asians (6.0 ng/mL) and Blacks (5.1 ng/mL) were higher than those for Whites (4.2 ng/mL), while PFOA levels were more evenly distributed by race. Other maternal demographic and socioeconomic characteristics, including age, education, marital status, and living in the city limits were not significantly associated with cord concentrations. Our findings suggest that in utero exposure to PFOS and PFOAis ubiquitous in a population of babies born in Baltimore, MD.				1												1	1					B	**B**		ボルチモアの新生児299名の臍帯血清で10種類のPFAS測定、2004-2005
377	バイオモニタリング	Brantsæter, A L; Whitworth, K W; Ydersbond, T A; Haug, L S; Haugen, M; Knutsen, H K; Thomsen, C; Meltzer, H M; Becher, G; Sabaredzovic, A; Hoppin, J A; Eggesbø, M; Longnecker, M P	Determinants of plasma concentrations of perf	2013	Environ Int. 2013 Apr;54:74-84. doi: 10.1016/j.envint.2012.12.014. Epub 2013 Feb 15.	BACKGROUND: Perfluoroalkyl substances (PFASs) are widespread pollutants that have been associated with adverse health effects although not on a consistent basis. Diet has been considered the main source of exposure. The aim of the present study was to identify determinants of four plasma PFASs in pregnant Norwegian women. METHODS: This study is based in the Norwegian Mother and Child Cohort Study (MoBa) conducted by the Norwegian Institute of Public Health. Our sample included 487 women who enrolled in MoBa from 2003 to 2004. A questionnaire regarding sociodemographic, medical, and reproductive history was completed at 17 weeks of gestation and a dietary questionnaire was completed at 22 weeks of gestation. Maternal plasma samples were obtained around 17 weeks of gestation. Plasma concentrations of four PFASs (perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA)) were examined in relation to demographic, lifestyle, dietary, and pregnancy-related covariates. Predictors were identified by optimizing multiple linear regression models using Akaike's information criterion (AIC). RESULTS: Parity was the determinant with the largest influence on plasma PFAS concentrations, with r(2) between 0.09 and 0.32 in simple regression models. In optimal multivariate models, when compared to nulliparous women, parous women had 46%, 70%, 19%, and 62% lower concentrations of PFOS, PFOA, PFHxS, and PFNA respectively (p<0.001 except for PFHxS, p<0.01). In all these models, duration of breastfeeding was associated with reduced PFAS levels. PFOA showed the largestreduction from breastfeeding, with a 2-3% reduction per month of breastfeeding in typical cases. Levels of PFOS, PFOA, and PFNA increased with time since most recent pregnancy. While pregnancy-related factors were the most important predictors, diet was a significant factor explaining up to 4% of the variance. One quartile increase in estimated dietary PFAS intake was associated with plasma PFOS, PFOA, PFHxS, and PFNA concentration increases of 7.2%, 3.3%, 5.8% and 9.8%, respectively, resulting in small, although non-trivial absolute changes in PFAS concentrations. CONCLUSION: Previous pregnancies and breastfeeding duration were the most important determinants of PFASs in this sample of pregnant women.				1												1	1					B	**B**		ノルウェーの妊婦の4種類のPFAS測定
378	バイオモニタリング	Calafat, Antonia M; Kuklenyik, Zsuzsanna; Reidy, John A; Caudill, Samuel P; Tully, Jason S; Needham, Larry L	Serum concentrations of 11 polyfluoroalkyl con	2007	Environ Sci Technol. 2007 Apr 1;41(7):2237-42. doi: 10.1021/es062686m.	We measured the concentrations of 11 polyfluoroalkyl compounds (PFCs), including perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexane sulfonic acid (PFHxS) in 1562 serum samples collected from a representative U.S. population 12 years of age and older in the 1999-2000 National Health and Nutrition Examination Survey. Participants represented both sexes, three race/ethnicities (non-Hispanic blacks, non-Hispanic whites, and Mexican-Americans), and four age categories (12-19 years, 20-39 years, 40-59 years, and 60 years and older). PFCs were extracted from 100 microL of serum using on-line solid-phase extraction coupled to isotope dilution-high performance liquid chromatography-tandem mass spectrometry; limits of detection ranged from 0.05 to 0.2 ng/ mL. PFOS, PFOA, PFHxS, and perfluorooctane sulfonamide were detected in all samples analyzed; 2-(N-ethyl-perfluorooctane sulfonamido) acetic acid, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid, and perfluorononanoic acid were detected in more than 90% of samples, which suggests prevalent exposures to several PFCs in the U.S. population. The concentrations of most PFCs were similar regardless of the participants' ages but were higher in males than in females. Mexican Americans had lower concentrations than non-Hispanic blacks and non-Hispanic whites, whose concentrations were similar. Higher education was associated with higher concentrations of PFOS and PFOA. These data will serve as a nationally representative baseline of the U.S. population's exposure to PFCs to which other populations can be compared, and will play an important role inpublic health by helping set research priorities, ranging from health effects studies to defining sources and pathways of exposure.	1	1	1	1											1	1					B	**B**		NHANES 1999-2000の11種類のPFAS

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
379	バイオモニタリング	Calafat, Antonia M; Needham, Larry L; Kuklenyik, Zsuzsanna; Reidy, John A; Tully, Jason S; Aguilar-Villalobos, Manuel; Naeher, Luke P	Perfluorinated chemicals in selected residents	2006	Chemosphere. 2006 Apr;63(3):490-6. doi: 10.1016/j.chemosphere.2005.08.028. Epub 2005 Oct 5.	Perfluorinated chemicals (PFCs) are used in multiple consumer products. Perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), the most widely studied PFCs, may be potential developmental, reproductive, and systemic toxicants. Although PFCs seem to be ubiquitous contaminants found both in humans and animals, geographic differences may exist in human exposure patterns to PFCs. We measured 11 PFCs in 23 pooled serum samples collected in the United States from 1990 through 2002, and in serum samples collected in 2003 from 44 residents from Trujillo, Peru. PFOS and PFOA were detected in all the pooled samples; perfluorohexane sulfonic acid (PFHxS) was detected in 21. Median concentrations were 31.1 micrograms per liter (mug/l, PFOS), 11.6 microg/l (PFOA), and 2 microg/l (PFHxS). The 90th percentile concentrations of PFCs in the 44 Peruvian residents were 0.7 microg/l (PFOS), 0.1 microg/l (PFOA), and <0.3 microg/l (PFHxS). The frequencies of detection were 20% (PFOS), 25% (PFOA), and 9% (PFHxS). The frequent detection of selected PFCs in the pooled samples from the United States and the lack of clear concentration trends based on a year of collection suggest a sustained widespread exposure to these compounds among US residents, at least since the 1990s. By contrast, the much lower frequency of detection and concentration ranges of PFCs in Peru suggest a lower exposure of Peruvians to PFCs compared with North Americans. Genetic variability, diet, lifestyle, or a combination of all these may contribute to the different patterns of human exposure to PFCs in the United States and Peru.	1																1					B	B		2000年ころのアメリカとペルーのPFAS濃度
380	バイオモニタリング	Calafat, Antonia M; Wong, Lee-Yang; Kuklenyik, Zsuzsanna; Reidy, John A; Needham, Larry L	Polyfluoroalkyl chemicals in the U.S. populatio	2007	Environ Health Perspect. 2007 Nov;115(11):1596-602. doi: 10.1289/ehp.10598.	BACKGROUND: Polyfluoroalkyl chemicals (PFCs) have been used since the 1950s in numerous commercial applications. Exposure of the general U.S. population to PFCs is widespread. Since 2002, the manufacturing practices for PFCs in the United States have changed considerably. OBJECTIVES: We aimed to assess exposure to perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), perfluorononanoic acid (PFNA), and eight other PFCs in a representative 2003-2004 sample of the general U.S. population >or= 12 years of age and to determine whether serum concentrations have changed since the 1999-2000 National Health and Nutrition Examination Survey (NHANES). METHODS: By using automated solid-phase extraction coupled to isotope dilution-high-performance liquid chromatography-tandem mass spectrometry, we analyzed 2,094 serum samples collected from NHANES 2003-2004 participants. RESULTS: We detected PFOS, PFOA, PFHxS, and PFNA in > 98% of the samples. Concentrations differed by race/ethnicity and sex. Geometric mean concentrations were significantly lower (approximately 32% for PFOS, 25% for PFOA, 10% for PFHxS) and higher (100%, PFNA) than the concentrations reported in NHANES 1999-2000 ($p < 0.001$). CONCLUSIONS: In the general U.S. population in 2003-2004, PFOS, PFOA, PFHxS, and PFNA serum concentrations were measurable in each demographic population group studied. Geometric mean concentrations of PFOS, PFOA, and PFHxS in 2003-2004 were lower than in 1999-2000. The apparent reductions in concentrations of PFOS, PFOA, and PFHxS most likely are related todiscontinuation in 2002 of industrial production by electrochemical fluorination of PFOS and related perfluorooctanesulfonyl fluoride compounds.	1	1	1	1											1					B	B		NHANES 2003-2004 と1999-2000の11種類のPFASの比較
381	バイオモニタリング	Croes, K; Colles, A; Koppen, G; Govarts, E; Bruckers, L; Van de Mieroop, E; Nelen, V; Covaci, A; Dirtu, A C; Thomsen, C; Haug, L S; Becher, G; Mampaey, M; Schoeters, G; Van Larebeke, N; Baeyens, W	Persistent organic pollutants (POPs) in human	2012	Chemosphere. 2012 Nov;89(8):988-94. doi: 10.1016/j.chemosphere.2012.06.058. Epub 2012 Jul 26.	To collect information on the concentrations of persistent organic pollutants (POPs) in the rural areas in Flanders (Belgium), 84 breastfeeding mothers were recruited in rural communities in East and West Flanders and Flemish Brabant in 2009-2010. Polychlorinated biphenyl (PCB) congeners, organochlorine pesticides, brominated flame retardants, perfluorinated compounds, polychlorinated dibenzodioxines and dibenzofurans, and dioxin-like PCBs were measured in individual milk samples and in a pooled milk sample, while some additional pollutants were only measured in the pooled sample. For most pollutants, the concentrations in this study were lower or comparable to the concentrations measured in the pooled Belgian sample of the WHO human milk study of 2006, except for the pesticides dichlorodiphenyltrichloroethane DDT (+25% for Σ DDT and metabolites) and trans-nonachlor (+94%), and for the brominated flame retardant hexachlorocyclododecane HBCD (+153%). Perfluorinated compounds were for the first time determined in human milk samples from Belgium and the concentrations were comparable to those from other European countries. Also, interesting associations were found between the concentrations of POPs measured in human milk and personal characteristics as well as dietary habits of the study population. PFOS en PFOA concentrations were significantly higher in milk of primiparous participants compared to mothers who gave birth to their second child. Lower brominated PBDE congeners increased with increasing BMI of the mothers ($p=0.01$ for BDE 47, $p=0.02$ for BDE 99 and $p=0.02$ for BDE 100). Participants consuming milk or dairy productsdaily had significant higher concentrations of Σ DDTs ($p=0.03$) and oxychlordane ($p=0.047$) in their human milk samples.			1											1					B	C	exposure source	ベルギーの2009-2010の有機物質全般の濃度
382	バイオモニタリング	De Silva, Amila O; Mabury, Scott A	Isomer distribution of perfluorocarboxylates in	2006	Environ Sci Technol. 2006 May 1;40(9):2903-9. doi: 10.1021/es0600330.	Detection of perfluorocarboxylate anions (PFCAs), such as perfluorooctanoate ($C_7F_{15}COO^-$, PFOA), at ng/g levels in human tissues has engendered public scrutiny of industrial fluorochemicals. Routes of PFCA exposure for the general human population are likely diverse given direct (industrially produced) and indirect (production from precursor organofluorines) sources. Major industrial production of organofluorines, including PFCAs, stems from either electrochemical fluorination (ECF) or telomerization. ECF products are a mixture of structural isomers (linear and branched perfluoroalkyls) and telomerization products are assumed to have one perfluorocarbon arrangement, typically linear. The objective of this research was to investigate structural isomer patterns of PFCAs in human blood. Volatile derivatives of PFCAs in human blood were analyzed by GC-(NCI)-MS for quantitation and isomers. PFOA was the dominant PFCA (mean 4.4 ng/g). Blood serum isomer profiles consisted of predominantly (mean approximately 98%) the linear isomer for each PFCA (C8-C11). There were similarities in branched isomer patterns of an ECF PFOA standard with both PFOA and PFNA in blood. Direct exposure to ECF PFOA, which has a legacy of production for uses in fluoropolymer industries, is postulated to be a source of the observed branched isomer pattern. Predominance of linear PFCA isomers and the [even PFCA] > [odd PFCA] concentration trend in blood is suggestive of additional input from a strictly linear perfluoroalkyl source.	1		1											1		1			B	B	B-minor	PFCAのisomerの分析
383	バイオモニタリング	Dobraca, Dina; Israel, Leslie; McNeel, Sandra; Voss, Robert; Wang, Miaomiao; Gajek, Ryszard; Park, June-Soo; Harwani, Suhash; Barley, Frank; She, Jianwen; Das, Rupali	Biomonitoring in California firefighters: metals	2015	J Occup Environ Med. 2015 Jan;57(1):88-97. doi: 10.1097/JOM.0000000000000307.	OBJECTIVE: To assess California firefighters' blood concentrations of selected chemicals and compare with a representative US population. METHODS: We report laboratory methods and analytic results for cadmium, lead, mercury, and manganese in whole blood and 12 serum perfluorinated chemicals in a sample of 101 Southern California firefighters. RESULTS: Firefighters' blood metal concentrations were all similar to or lower than the National Health and Nutrition Examination Survey (NHANES) values, except for six participants whose mercury concentrations (range: 9.79 to 13.42 μg/L) were close to or higher than the NHANES reporting threshold of 10 μg/L. Perfluorodecanoic acid concentrations were elevated compared with NHANES and other firefighter studies. CONCLUSIONS: Perfluorodecanoic acid concentrations were three times higher in this firefighter group than in NHANES adult males. Firefighters may have unidentified sources of occupational exposure to perfluorinated chemicals.				1										1		1			B	B		カルフォルニアの消防士の12種類のPFAS濃度は一般の3倍高かった
384	バイオモニタリング	Emmett, Edward Anthony; Shofer, Frances Susan; Zhang, Hong; Freeman, David; Desai, Chintan; Shaw, Leslie Michael	Community exposure to perfluorooctanoate: re	2006	J Occup Environ Med. 2006 Aug;48(8):759-70. doi: 10.1097/01.jom.0000232486.07658.74.	OBJECTIVE: The objective of this study was to determine serum (perfluorooctanoate [PFOA]) in residents near a fluoropolymer production facility: the contributions from air, water, and occupational exposures, personal and dietary habits, and relationships to age and gender. METHODS: The authors conducted questionnaire and serum PFOA measurements in a stratified random sample and volunteers residing in locations with the same residential water supply but with higher and lower potential air PFOA exposure. RESULTS: Serum (PFOA) greatly exceeded general population medians. Occupational exposure from production processes using PFOA and residential water had additive effects; no other occupations contributed. Serum (PFOA) depended on the source of residential drinking water, and not potential air exposure. For public water users, the best-fit model included age, tap water drinks per day, servings of home-grown fruit and vegetables, and carbon filter use. CONCLUSIONS: Residential water source was the primary determinant of serum (PFOA).	1														1				B	C		PFOAのみ
385	バイオモニタリング	Fromme, Hermann; Mosch, Christine; Morovitz, Maria; Alba-Alejandre, Irene; Boehmer, Sigrun; Kiranoglu, Mandy; Faber, Fabienne; Hannibal, Iris; Genzel-Boroviczény, Orsolya; Koletzko, Berthold; Völkel, Wolfgang	Pre- and postnatal exposure to perfluorinated	2010	Environ Sci Technol. 2010 Sep 15;44(18):7123-9. doi: 10.1021/es101184f.	Perfluorinated compounds (PFCs) are a group of chemicals widely used for many applications. In this study PFCs were investigated in maternal blood during pregnancy (at two time points) (n = 40 and 38) and 6 months after delivery (n = 47), in cord blood (n = 33) and in blood of infants six (n = 40) and nineteen months (n = 24) after birth, and monthly in breast milk samples in Germany. Concentrations in maternal serum ranged from 0.5 to 9.4 μg/L for perfluorooctane sulfonate (PFOS) and 0.7 to 8.7 μg/L for perfluorooctanoic acid (PFOA). In cord serum, the values ranged from 0.3 to 2.8 μg/L and from 0.5 to 4.2 μg/L for PFOS and PFOA, respectively. The median results from serum at six and nineteen months of age were 3.0 and 1.9 μg/L for PFOS and 6.9 and 4.6 μg/L for PFOA, respectively. In breast milk samples, PFOS ranged from <0.03 to 0.11 μg/L (median: 0.04 μg/L), while PFOA was detected only in some samples as were all other PFCs. Overall, we found low levels of PFCs in cord sera and an increase in concentrations through the first months of infant life. Although the concentrations in breast milk were low, this intake led to a body burden at the age of six months similar to (PFOS) or higher than (PFOA) that found in adults.			1											1	1				B	C		ドイツの母子のPFAS、PFOS, PFOAのみ
386	バイオモニタリング	Fromme, Hermann; Schlummer, Martin; Möller, Angela; Gruber, Ludwig; Wolz, Gerd; Ungewiss, Jan; Böhmer, Sigrun; Dekant, Wolfgang; Mayer, Richard; Liebl, Bernhard; Twardella, Dorothee	Exposure of an adult population to perfluorinat	2007	Environ Sci Technol. 2007 Nov 15;41(22):7928-33. doi: 10.1021/es071244n.	Because dietary intake is supposed to be an important route of human exposure we quantified the dietary intake of perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), perfluorohexanoate (PFHxA), and perfluorooctane sulfonamide (PFOSA) using 214 duplicate diet samples. The study was carried out with a study population of 15 female and 16 male healthy subjects aged 16-45 years. The participants collected daily duplicate diet samples over seven consecutive days in 2005. Duplicate samples were homogenized and their ultrasonic extracts were cleaned up by SPE and subjected to HPLC-ESI-MS/MS. In addition, individual intakes were estimated based on blood levels of PFOS and PFOA using a pharmacokinetic model. Blood samples were collected once during the sampling period. The median (90th percentile) daily dietary intake of PFOS and PFOA was 1.4 ng/kg b.w. (3.8 ng/kg b.w.) and 2.9 ng/kg b.w. (8.4 ng/kg b.w.), respectively. PFHxS and PFHxA could be detected only in some samples above detection limit with median (maximum) daily intakes of 2.0 ng/kg b.w. (4.0 ng/kg b.w.) and 4.3 ng/kg b.w. (9.2 ng/kg b.w.), respectively. Because PFOSA could not be detected above the limit of detection of 0.2 ng/g f.w. this indirect route of exposure seems to be of less significance. Overall, the results of this study demonstrate that the German population is exposed to PFOS and PFOA, but the median dietary intake did not reach the recommended tolerable daily intake by far. Biomonitoring data predict an exposure in a comparable range. We suppose that, normally, food intake is the main source of exposure ofthe general population to PFOS and PFOA.		1												1				B	B		ドイツの食事調査と血中濃度、5種類のPFAS
387	バイオモニタリング	Fu, Jianjie; Gao, Yan; Wang, Thanh; Liang, Yong; Zhang, Aiqian; Wang, Yawei; Jiang, Guibin	Elevated levels of perfluoroalkyl acids in family	2015	Sci Rep. 2015 Mar 20;5:9313. doi: 10.1038/srep09313.	The exposure pathways of perfluoroalkyl acids (PFAAs) to humans are still not clear because of the complex living environment, and few studies have simultaneously investigated the bioaccumulative behaviour of different PFAAs in humans. In this study, serum, dust, duplicate diet, and other matrices were collected around a manufacturing plant in China, and homologous series of PFAAs were analysed. PFAA levels in dust and serum of local residents in this area were considerably higher than those in non-polluted area. Although dietary intake was the major exposure pathway in the present study, dust ingestion played an important role in this case. Serum PFAAs in local residents was significantly correlated with dust PFAAs levels in their living or working microenvironment. Serum PFAAs and dust PFAAs were significantly higher in family members of occupational workers (FM) than in ordinary residents (OR) ($p < 0.01$). After a careful analysis of the PFAAs exposure pathway, a potential pathway in addition to direct dust ingestion was suggested: PFAAs might transferred from occupational worker's clothes to dinners via cooking processes. The bioaccumulative potential of PFHxS and PFOS were higher than other PFAAs, which suggested a substantial difference between the bioaccumulative ability of perfluorinated sulfonic acids and perfluorinated carboxylic acids.				1	1										1	1		1	B	A	exposure source	中国の工場作業者の家族ではPFASばく露量が高い。原因を色々調べた
388	バイオモニタリング	Fujii, Yukiko; Yan, Junxia; Harada, Kouji H; Hitomi, Toshiaki; Yang, Hyeran; Wang, Peiyu; Koizumi, Akio	Levels and profiles of long-chain perfluorinate	2012	Chemosphere. 2012 Jan;86(3):315-21. doi: 10.1016/j.chemosphere.2011.10.035. Epub 2011 Nov 21.	In this study, 90 human breast milk samples collected from Japan, Korea, and China were analyzed for perfluorooctanoic acid (PFOA) (C8), perfluorononanoic acid (PFNA) (C9), perfluorodecanoic acid (PFDA) (C10), perfluoroundecanoic acid (PFUnDA) (C11), perfluorododecanoic acid (PFDoDA) (C12), and perfluorotridecanoic acid (PFTrDA) (C13). In addition, infant formulas (n = 9) obtained from retail stores in China and Japan were analyzed. PFOA was the predominant compound and was detected in more than 60% of samples in all three countries. The PFOA, PFNA, PFDA, and PFUnDA levels in Japan were significantly higher than those in Korea and China ($p<0.05$). The PFTrDA level was highest in Korea ($p<0.05$). The median PFOA concentrations were 89 pg mL(-1) (48% of total perfluorinated carboxylic acids (PFCAs) (C8-C13)) in Japan, 62 pg mL(-1) (54%) in Korea, and 51 pg mL(-1) (61%) in China. The remaining ΣPFCAs (C9-C13) were 95 pg mL(-1) in Japan, 52 pg mL(-1) in Korea, and 33 pg mL(-1) in China. Among the long-chain PFCAs, odd-numbered PFCAs were more frequently detected than even-numbered PFCAs, except for PFDA in Japan. There were no evident correlations between the mother's demographic factors and the PFCA concentrations. PFOA, PFNA, and PFDA were frequently detected in both Japan and China, but there were no significant differences between the two countries. The total PFCA concentrations in the infant formulas were lower than those in the breast milk samples in Japan ($p<0.05$), but not in China ($p>0.05$). In conclusion, various PFCAs were detected in human breast milk samples from East Asian countries.				1											1				B	B		日本、韓国、中国の母乳中PFAS濃度を比較

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
389	バイオモニタリング	Han, Wenchao; Gao, Yu; Yao, Qian; Yuan, Tao; Wang, Yiwen; Zhao, Shasha; Shi, Rong; Bonefeld-Jorgensen, Eva Cecilie; Shen, Xiaoming; Tian, Ying	Perfluoroalkyl and polyfluoroalkyl substances i	2018	Environ Int. 2018 Jul;116:206-213. doi: 10.1016/j.envint.2018.04.025. Epub 2018 Apr 23.	BACKGROUND: Perfluoroalkyl and polyfluoroalkyl substances (PFASs) have been widely detected in different populations. However, limited data is available about exposure among family members. OBJECTIVES: To investigate the PFASs levels in parents and their newborns and to understand their correlation and health implications of in utero exposure to PFASs. METHODS: Ten PFASs were measured in matched parental and cord serum (N = 369 families) from a birth cohort in Shandong, one of the regions seriously polluted by PFASs in China. The correlation of PFASs levels within families was examined. A questionnaire survey on maternal factors and risk assessment using the hazard quotients (HQs) approach based on maternal PFASs levels was conducted. RESULTS: Within a family, the father had the highest levels of all PFASs. Among the 10 PFASs, perfluorooctanoic acid (PFOA) was the highest, with 103.38, 42.83, and 34.67 ng/ml in paternal, maternal and cord serum, respectively. PFASs levels were positively correlated among family members (r = 0.14-0.91, p < 0.01). Maternal age, body mass index (BMI); smoking history; and intake of fish, milk, poultry, vegetables and tap water were significantly related to PFASs concentrations in cord serum. Twenty-seven (7.3%) HQ values exceeded 1 for both PFOA and the sum of PFOA and perfluorooctane sulfonate (PFOS), indicating potential concern for developmental toxicity in the local newborns. CONCLUSIONS: PFASs, and especially PFOA levels were extremely high and positively correlated between parents, indicating heavy pollution in this region and common sources of exposure. In utero exposure toPFASs might pose potential concern for developmental toxicity in the local newborns.			1	1												1					B	B		中国の汚染のある地域の父、母、子供のPFAS10種類の濃度を比較
390	バイオモニタリング	Harris, Maria H; Rifas-Shiman, Sheryl L; Calafat, Antonia M; Ye, Xiaoyun; Mora, Ana Maria; Webster, Thomas F; Oken, Emily; Sagiv, Sharon K	Predictors of Per- and Polyfluoroalkyl Substan	2017	Environ Sci Technol. 2017 May 2;51(9):5193-5204. doi: 10.1021/acs.est.6b05811. Epub 2017 Apr 11.	Certain per- and polyfluoroalkyl substances (PFASs) are suspected developmental toxicants, but data on PFAS concentrations and exposure routes in children are limited. We measured plasma PFASs in children aged 6-10 years from the Boston-area Project Viva prebirth cohort, and used multivariable linear regression to estimate associations with sociodemographic, behavioral, and health-related factors, and maternal PFASs measured during pregnancy. PFAS concentrations in Project Viva children (sampled 2007-2010) were similar to concentrations among youth participants (aged 12-19 years) in the 2007-8 and 2009-10 National Health and Nutrition Examination Survey (NHANES); mean concentrations of most PFASs declined from 2007 to 2010 in Project Viva and NHANES. In mutually adjusted models, predictors of higher PFAS concentrations included older child age, lower adiposity, carpeting or a rug in the child's bedroom, higher maternal education, and higher neighborhood income. Concentrations of perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexanesulfonate (PFHxS), and 2-(N-methyl-perfluorooctane sulfonamido) acetate (Me-PFOSA-AcOH) were 26-36% lower in children of black mothers compared to children of white mothers and increased 12-21% per interquartile range increase in maternal pregnancy PFASs. Breastfeeding duration did not predict childhood PFAS concentrations in adjusted multivariable models. Together, the studied predictors explained the observed variability in PFAS concentrations to only a modest degree.			1													1					B	B	exposure source	Project VIVAの子供のPFAS濃度に影響を及ぼす要因検討
391	バイオモニタリング	Kang, Habyeong; Choi, Kyungho; Lee, Haeng-Shin; Kim, Do-Hee; Park, Na-Youn; Kim, Sunmi; Kho, Younglim	Elevated levels of short carbon-chain PFCAs ir	2016	Environ Res. 2016 Jul;148:351-359. doi: 10.1016/j.envres.2016.04.017. Epub 2016 Apr 23.	Breast milks can be contaminated with perfluoroalkyl substances (PFASs). Exposure to PFASs during early stages of life may lead to adverse health effects among breastfed infants. To date, perfluorootanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been most frequently measured PFASs in breast milks worldwide. Information on shorter carbon-chain PFASs in breast milk is scarce. In this study, breast milks were sampled from 264 Korean lactating women, and measured for seventeen PFASs, including ten perfluoroalkyl carboxylates (PFCAs), four perfluoroalkyl sulfonates, and three perfluoroalkyl sulfonamides. PFOA and PFOS were detected in 98.5% of the breast milk samples, with median concentrations of 0.072 and 0.050ng/mL, respectively. Perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA), and perfluoroheptanoic acid (PFHpA) were detected in higher frequencies, ranging between 67.4% and 81.8%. The concentrations of short carbon-chain PFCAs in breast milk such as PFPeA and PFHxA were the highest ever reported to date, and were comparable to that of PFOS. Concentrations of shorter chain PFCA in breast milk tended to be higher among the women with longer lactation period, while those of PFOA showed the opposite trend, suggesting a possibility that breastfeeding might be an important route of excretion for PFOA among lactating women. Fish consumption and the use of consumer products, e.g., skin care products, cosmetics and non-stick coated cooking utensils, were identified as significant predictors of PFAS concentrations in breast milk. Health risks associated with PFOA and PFOSexposure through breastfeeding were estimated negligible, however, risks of the short carbon-chain PFCAs could not be assessed because of lack of relevant toxicological information. Further efforts for source identification and exposure management measures for shorter chain PFCAs are necessary.		1													1					B	B		264名の韓国の母乳中の短鎖のPFAS濃度を測定
392	バイオモニタリング	Kärrman, A.; Ericson, I.; van Bavel, B.; Darnerud, P. O.; Aune, M.; Glynn, A.; Lignell, S.; Lindström, G.	Exposure of perfluorinated chemicals through l	2007	Environ Health Perspect. 2007 Feb;115(2):226-30. doi: 10.1289/ehp.9491. Epub 2006 Nov 28.	Background: Only limited data exist on lactation as an exposure source of persistent perfluorinated chemicals (PFCs) for children. Objectives: We studied occurrence and levels of PFCs in human milk in relation to maternal serum together with the temporal trend in milk levels between 1996 and 2004 in Sweden. Matched, individual human milk and serum samples from 12 primiparous women in Sweden were analyzed together with composite milk samples (25-90 women/year) from 1996 to 2004. Results: Eight PFCs were detected in the serum samples, and five of them were also above the detection limits in the milk samples. Perfluorooctanesulfonate (PFOS) and perfluorohexanesulfonate (PFHxS) were detected in all milk samples at mean concentrations of 0.201 ng/mL and 0.085 ng/mL, respectively. Perfluorooctanesulfonamide (PFOSA), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were detected less frequently. Discussion: The total PFC concentration in maternal serum was 32 ng/mL, and the corresponding milk concentration was 0.34 ng/mL. The PFOS milk level was on average 1% of the corresponding serum level. There was a strong association between increasing serum concentration and increasing milk concentration for PFOS (r(2) = 0.7) and PFHxS (r(2) = 0.8). PFOS and PFHxS levels in composite milk samples were relatively unchanged between 1996 and 2004, with a total variation of 20 and 32% coefficient of variation, respectively. Conclusion: The calculated total amount of PFCs transferred by lactation to a breast-fed infant in this study was approximately 200 ng/day. Lactation is a considerable source of exposure for infants, and reference concentrations for hazard assessments are needed.			1	1												1		1			B	C	exposure source	スウェーデンの母体血と母乳中のPFAS濃度、主にメインのPFASのみ
393	バイオモニタリング	Kato, K.; Wong, L. Y.; Chen, A.; Dunbar, C.; Webster, G. M.; Lanphear, B. P.; Calafat, A. M.	Changes in serum concentrations of maternal	2014	Environ Sci Technol. 2014 Aug 19;48(16):9600-8. doi: 10.1021/es501811k. Epub 2014 Jul 29.	Data on predictors of gestational exposure to poly- and perfluoroalkyl substances (PFASs) in the United States are limited. To fill in this gap, in a multiethnic cohort of Ohio pregnant women recruited in 2003-2006, we measured perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), and six additional PFASs in maternal serum at ~16 weeks gestation (N = 182) and delivery (N = 78), and in umbilical cord serum (N = 202). We used linear regression to examine associations between maternal serum PFASs concentrations and demographic, perinatal, and lifestyle factors. PFASs concentrations in maternal sera and in their infants' cord sera were highly correlated (Spearman rank correlation coefficients = 0.73-0.95). In 71 maternal-infant dyads, unadjusted geometric mean (GM) concentrations (95% confidence interval) (in μg/L) in maternal serum at delivery of PFOS [8.50 (7.01-9.58)] and PFOA [3.43 (3.01-3.90)] were significantly lower than at 16 weeks gestation [11.57 (9.90-13.53], 4.91 (4.32-5.59), respectively], but higher than in infants' cord serum [3.32 (2.84-3.89), 2.85 (2.51-3.24), respectively] (P <; 0.001). Women who were parous, with a history of previous breastfeeding, black, or in the lowest income category had significantly lower PFOS and PFOA GM concentrations than other women. These data suggest transplacental transfer of PFASs during pregnancy and nursing forthe first time in a U.S. birth cohort.				1												1		1			B	B		シンシナティの母体血、臍帯血について8種類のPFAS測定
394	バイオモニタリング	Kato, Kayoko; Wong, Lee-Yang; Jia, Lily T; Kuklenyik, Zsuzsanna; Calafat, Antonia M	Trends in exposure to polyfluoroalkyl chemical	2011	Environ Sci Technol. 2011 Oct 1;45(19):8037-45. doi: 10.1021/es1043613. Epub 2011 Apr 6.	Since 2002, practices in manufacturing polyfluoroalkyl chemicals (PFCs) in the United States have changed. Previous results from the National Health and Nutrition Examination Survey (NHANES) documented a significant decrease in serum concentrations of some PFCs during 1999-2004. To further assess concentration trends of perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA), we analyzed 7876 serum samples collected from a representative sample of the general U.S. population ≥12 years of age during NHANES 1999-2008. We detected PFOS, PFOA, PFNA, and PFHxS in more than 95% of participants. Concentrations differed by sex regardless of age and we observed some differences by race/ethnicity. Since 1999-2000, PFOS concentrations showed a significant downward trend, because of discontinuing industrial production of PFOS, but PFNA concentrations showed a significant upward trend. PFOA concentrations during 1999-2000 were significantly higher than during any other time period examined, but PFOA concentrations have remained essentially unchanged during 2003-2008. PFHxS concentrations showed a downward trend from 1999 to 2006, but concentrations increased during 2007-2008. Additional research is needed to identify the environmental sources contributing to human exposure to PFCs. Nonetheless, these NHANES data suggest that sociodemographic factors may influence exposure and also provide unique information on temporal trends of exposure.				1												1		1			B	B		NHANESの様々な年度での4種類のPFAS濃度を測定
395	バイオモニタリング	Landsteiner, Adrienne; Huset, Carin; Johnson, Jean; Williams, Allan	Biomonitoring for perfluorochemicals in a Minn	2014	J Environ Health. 2014 Dec;77(5):14-9.	Perfluorochemicals (PFCs) are pervasive and persistent environmental contaminants with uncertain public health implications. Following the discovery of PFC contamination in public and private drinking water supplies in Washington County, Minnesota, the authors conducted a pilot biomonitoring study. Serum samples from 196 residents of two communities were analyzed for seven PFCs. Perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorohexanesulfonate (PFHxS) were detected in all serum samples collected. Perfluorobutanoic acid (PFBA) and perfluorobutane sulfonate (PFBS) were found in 28% and 3% of the samples, respectively. The geometric mean for PFOA was 15.4 ng/mL (range: 1.6-177 ng/mL), PFOS was 35.9 ng/mL (range: 3.2-448 ng/mL), and PFHxS was 8.4 ng/mL (range 0.32-316 ng/mL). Mean levels for PFOA, PFOS, and PFHxS were higher in males and increased with age. Mean PFC serum levels for three PFCs were significantly elevated when compared to levels found in the U.S. population.	1														1					B	C		パイロットスタディ
396	バイオモニタリング	Lankova, Darina; Lacina, Ondrej; Pulkrabova, Jana; Hajslova, Jana	The determination of perfluoroalkyl substances	2013	Talanta. 2013 Dec 15;117:318-25. doi: 10.1016/j.talanta.2013.08.040. Epub 2013 Aug 30.	In the present study, a novel analytical approach for the simultaneous determination of 18 perfluoroalkyl substances (PFASs) and 11 brominated flame retardants (BFRs) including their hydroxylated metabolites and brominated phenols has been developed and validated for breast milk and infant formula. The sample preparation procedure based on extraction using acetonitrile and subsequent purification by dispersive solid-phase extraction (d-SPE) employing C18 sorbent is rapid, simple and high-throughput. Ultra-high performance liquid chromatography (UHPLC) interfaced with a tandem mass spectrometry (MS/MS) was employed for the identification/quantification of these compounds. The method recoveries of target compounds for both matrices ranged from 80% to 117% with relative standard deviations lower than 28% and quantification limits in the range of 3-200 pg/mL for milk and 5-450 pg/g for infant formula. Within the pilot study, the new method was used for the analysis of PFASs and BFRs in 50 human breast milks and six infant formulas. In the breast milk samples the total contents of PFASs and BFRs were in the range of 38-279 and 45-16,200 pg/mL, respectively. The most abundant PFASs detected in all tested breast milk samples were perfluorooctanoic acid (PFOA) and perfluorooctanesulfonate (PFOS), the latter contaminant was present not only as a linear form but also as a branched isomers. The incidence of BFRs was lower, the only representatives of this group, tetrabromobiphenol A (TBBPA) and α -hexabromocyclododecane (α -HBCD), were detected in less than 30% of breast milk samples. None of the infant formulas containedBFRs, traces of either PFOS, PFOA or PFNA were found in three samples.				1												1					B	B		18種類のPFASについて母乳と人工乳で測定

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
397	バイオモニタリング	Lien, Guang-Wen; Huang, Ching-Chun; Wu, Kuen-Yuh; Chen, Mei-Huei; Lin, Chien-Yu; Chen, Chia-Yang; Hsieh, Wu-Shiun; Chen, Pau-Chung	Neonatal-maternal factors and perfluoroalkyl s	2013	Chemosphere. 2013 Aug;92(7):843-50. doi: 10.1016/j.chemosphere.2013.04.038. Epub 2013 May 18.	Perfluoroalkyl substances (PFASs) can cross the placenta, enter fetal circulation, and were found to correlate with adverse fetal growth. However, determinants of cord blood PFASs are not fully characterized. The study aimed to explore the association between PFASs and neonatal-maternal factors within a Taiwanese birth cohort. We selected subjects from Taiwan Birth Panel Study, which enrolled 486 infant-mother pairs in 2004-2005. We collected cord blood and analyzed perfluorooctanoic acid (PFOA), perfluorooctanyl sulfonate (PFOS), perfluorononanoic acid (PFNA) and perfluoroundecanoic acid (PFUA) using a simple protein precipitation and an ultra-high performance liquid chromatography/tandem mass spectrometry. We retrieved information pertaining to maternal socio-demographics, lifestyle- and dietary-related factors through structured questionnaires during the postpartum hospital stay. A total of 439 subjects, with 90% response rate, have completed serum analysis and questionnaire survey. The median concentrations for PFOA, PFOS, PFNA, and PFUA in cord blood were 1.86, 5.67, 3.00, and 13.5ngmL(-1), respectively. After adjusting for potential confounders, multiple linear regression models revealed that log10-PFOA was positively associated with maternal age (β=0.011) and negatively associated with multiparity (β=-0.044). Log10-PFOS was negatively correlated with birth weight (β=-0.011) and higher maternal education (senior high school: β=-0.067; university: β=-0.088). Log10-PFUA tended to negatively associate with gender, male infants (β=-0.075), and using cosmetics during pregnancy (β=-0.065).Interestingly, presence of cockroaches in the home was positively associated with log10-PFOA (β=0.041) and 1og10-PFNA (β=0.123). In conclusion, this study demonstrated several factors to correlate with cord blood PFASs and further investigation are still needed for confirmation of exposure routes.			1										1								B	C		台湾で4種類のPFASの母子の濃度測定
398	バイオモニタリング	Liu, J.; Li, J.; Liu, Y.; Chan, H. M.; Zhao, Y.; Cai, Z.; Wu, Y.	Comparison on gestation and lactation exposu	2011	Environ Int. 2011 Oct;37(7):1206-12. doi: 10.1016/j.envint.2011.05.001. Epub 2011 May 26.	Perfluorinated compounds (PFCs) are worldwide present in the environment and the general population. Animal studies have shown developmental toxicity of these compounds. To investigate the PFCs exposure of neonates from mother during gestation and lactation, we analyzed twelve PFCs in matched maternal serum, cord serum and breast milk samples collected from 50 pairs of women and their newborns between June and July 2009 in Jinhu, China. Eight PFCs were detected in serum samples, and five of them were also detectable in breast milk. A significant intercorrelation between PFCs concentrations in matched maternal serum, cord serum and breast milk was observed (p<0.01, r=0.435-0.911). The median partition ratio was from 0.39:1 (PFDA) to 1.74:1 (PFTrDA) for seven PFCs through the placenta, and was from 0.02:1 (PFOS) to 0.09:1 (PFOA) for five PFCs through the lactation. A high transport efficiency of PFOA both through placental barrier and lactation was observed. The postnatal exposure of PFCs through lactation was higher compared to prenatal exposure, especially for PFOA.			1										1				1				B	B		中国の母体血、臍帯血、母乳について8種類のPFASを測定、サンプル数は50ペア
399	バイオモニタリング	Llorca, Marta; Farré, Marinella; Picó, Yolanda; Teijón, Marisa Lopez; Alvarez, Juan G; Barceló, Damià	Infant exposure of perfluorinated compounds:	2010	Environ Int. 2010 Aug;36(6):584-92. doi: 10.1016/j.envint.2010.04.016. Epub 2010 May 21.	In this study, an analytical method to determine six perfluorinated compounds (PFCs) based on alkaline digestion and solid phase extraction (SPE) followed by liquid chromatography-quadrupole-linear ion trap mass spectrometry (LC-QqLIT-MS) was validated for the analysis of human breast milk, milk infant formulas and cereals baby food. The average recoveries of the different matrices were in general higher than 70% with a relative standard deviation (RSD) lower than 21% and method limits of detection (MLOD) ranging from 1.2 to 362 ng/L for the different compounds and matrices. The method was applied to investigate the occurrence of PFCs in 20 samples of human breast milk, and 5 samples of infant formulas and cereal baby food (3 brands of commercial milk infant formulas and 2 brands of cereals baby food). Breast milk samples were collected in 2008 from donors living in Barcelona city (Spain) on the 40 days postpartum. Perfluorooctanesulfonate (PFOS) and perfluoro-7-methyloctanoic acid (i,p-PFNA) were predominant being present in the 95% of breast milk samples. Perfluorooctanoic acid (PFOA) was quantified in 8 of the 20 breast milk samples at concentrations in the range of 21-907 ng/L. Commercial formulas and food were purchased also in 2009 from a retail store. The six PFCs were detected in all brands of milk infant formulas and cereals baby food analyzed, being perfluorodecanoic acid (PFDA), PFOS, PFOA and i,p-PFNA the compounds detected in higher concentrations (up to 1289 ng/kg). PFCs presence can be associated to possible migration from packaging and containers during production processes.Finally, based on estimated body weight and newborn intake, PFOS and PFOA daily intakes and risk indexes (RI) were estimated for the firsts 6 month of life. We found that ingestion rates of PFOS and PFOA, with exception of one breast milk sample did not exceed the tolerable daily intake (TDI) recommended by the EFSA. However, more research is needed in order to assess possible risk associated to PFCs contamination during early stages of life.			1										1								B	B	exposure source	スペインの母乳、人工乳、離乳食のPFAS測定
400	バイオモニタリング	Makey, Colleen M; Webster, Thomas F; Martin, Jonathan W; Shoeib, Mahiba; Harner, Tom; Dix-Cooper, Linda; Webster, Glenys M	Airborne Precursors Predict Maternal Serum P	2017	Environ Sci Technol. 2017 Jul 5;51(13):7667-7675. doi: 10.1021/acs.est.7b00615. Epub 2017 Jun 13.	Human exposure to persistent perfluoroalkyl acids (PFAAs), including perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorooctanesulfonate (PFOS), can occur directly from contaminated food, water, air, and dust. However, precursors to PFAAs (PreFAAs), such as dipolyfluoroalkyl phosphates (diPAPs), fluorotelomer alcohols (FTOHs), perfluorooctyl sulfonamides (FOSAs), and sulfonamidoethanols (FOSEs), which can be biotransformed to PFAAs, may also be a source of exposure. PFAAs were analyzed in 50 maternal sera samples collected in 2007-2008 from participants in Vancouver, Canada, while PFAAs and PreFAAs were measured in matching samples of residential bedroom air collected by passive sampler and in sieved vacuum dust (<150 μm). Concentrations of PreFAAs were higher than for PFAAs in air and dust. Positive associations were discovered between airborne 10:2 FTOH and serum PFOA and PFNA and between airborne MeFOSE and serum PFOS. On average, serum PFOS concentrations were 2.3 ng/mL (95%CI: 0.40, 4.3) higher in participants with airborne MeFOSE concentrations in the highest tertile relative to the lowest tertile. Among all PFAAs, only PFNA in air and vacuum dust predicted serum PFNA. Results suggest that airborne PFAA precursors were a source of PFOA, PFNA, and PFOS exposure in this population.			1										1							1	B	A	B-minor	カナダで母体血と寝室のダストのPFAS前駆体濃度を測定
401	バイオモニタリング	Mogensen, U. B.; Grandjean, P.; Nielsen, F.; Weihe, P.; Budtz-Jørgensen, E.	Breastfeeding as an Exposure Pathway for Per	2015	Environ Sci Technol. 2015 Sep 1;49(17):10466-73. doi: 10.1021/acs.est.5b02237. Epub 2015 Aug 20.	Perfluorinated alkylate substances (PFASs) are widely used and have resulted in human exposures worldwide. PFASs occur in breast milk, and the duration of breastfeeding is associated with serum-PFAS concentrations in children. To determine the time-dependent impact of this exposure pathway, we examined the serum concentrations of five major PFASs in a Faroese birth cohort at birth, and at ages 11, 18, and 60 months. Information about the children's breastfeeding history was obtained from the mothers. The trajectory of serum-PFAS concentrations during months with and without breastfeeding was examined by linear mixed models that accounted for the correlations of the PFAS measurements for each child. The models were adjusted for confounders such as body size. The duration of exclusive breastfeeding was associated with increases of most PFAS concentrations by up to 0.3 per month, with lower increases during partial breast-feeding. In contrast to this main pattern, perfluorohexanesulfonate was not affected by breast-feeding. After cessation of breastfeeding, all serum concentrations decreased. This finding supports the evidence of breastfeeding being an important exposure pathway to some PFASs in infants.			1										1								B	B	exposure source	フェロー諸島の子供の血中5種類のPFAS濃度と母乳哺育との関係を調べて母乳由来の重要性を示した
402	バイオモニタリング	Mondal, D.; Weldon, R. H.; Armstrong, B. G.; Gibson, L. J.; Lopez-Espinosa, M. J.; Shin, H. M.; Fletcher, T.	Breastfeeding: a potential excretion route for n	2014	Environ Health Perspect. 2014 Feb;122(2):187-92. doi: 10.1289/ehp.1306613. Epub 2013 Nov 26.	Background: The presence of perfluoroalkyl acids (PFAAs) in breast milk has been documented, but their lactational transfer has been rarely studied. Determination of the elimination rates of these chemicals during breastfeeding is important and critical for assessing exposure in mothers and infants. Objectives: We aimed to investigate the association between breastfeeding and maternal serum concentrations of perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS). For a subset of the population, for whom we also have their infants' measurements, we investigated associations of breastfeeding with infant serum PFAA concentrations. Methods: The present analysis included 633 women from the C8 Science Panel Study who had a child < 3.5 years of age and who provided blood samples and reported detailed information on breastfeeding at the time of survey. PFAA serum concentrations were available for all mothers and 8% (n = 49) of the infants. Maternal and infant serum concentrations were regressed on duration of breastfeeding. Results: Each month of breastfeeding was associated with lower maternal serum concentrations of PFOA (-3%; 95% CI: -5, -2%), PFOS (-3%; 95% CI: -3, -2%), PFNA (-2%; 95% CI: -2, -1%), and PFHxS (-1%; 95% CI: -2, 0%). The infant PFOA and PFOS serum concentrations were 6% (95% CI: 1, 10%) and 4% (95% CI: 1, 7%) higher per month of breastfeeding. Conclusions: Breast milk is the optimal food for infants, but is also a PFAA excretion route for lactating mothers and exposure route for nursing infants.			1										1				1				B	C	exposure source	4種類のPFASについて母乳が母体からの排泄経路であることを示した
403	バイオモニタリング	Morello-Frosch, Rachel; Cushing, Lara J; Jesdale, Bill M; Schwartz, Jackie M; Guo, Weihong; Guo, Tan; Wang, Miaomiao; Harwani, Suhash; Petropoulou, Syrago-Styliani E; Duong, Wendy; Park, June-Soo; Petreas, Myrto; Gajek, Ryszard; Alvaran, Josephine; She, Jianwen; Dobraca, Dina; Das, Rupali; Woodruff, Tracey J	Environmental Chemicals in an Urban Populati	2016	Environ Sci Technol. 2016 Nov 15;50(22):12464-12472. doi: 10.1021/acs.est.6b03492. Epub 2016 Oct 26.	Exposures to environmental pollutants in utero may increase the risk of adverse health effects. We measured the concentrations of 59 potentially harmful chemicals in 77 maternal and 65 paired umbilical cord blood samples collected in San Francisco during 2010-2011, including polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), polybrominated diphenyl ethers (PBDEs), hydroxylated PBDEs (OH-PBDEs), and perfluorinated compounds (PFCs) in serum and metals in whole blood. Consistent with previous studies, we found evidence that concentrations of mercury (Hg) and lower-brominated PBDEs were often higher in umbilical cord blood or serum than in maternal samples (median cord:maternal ratio > 1), while for most PFCs and lead (Pb), concentrations in cord blood or serum were generally equal to or lower than their maternal pair (median cord:maternal ratio ≤ 1). In contrast to the conclusions of a recent review, we found evidence that several PCBs and OCPs were also often higher in cord than maternal serum (median cord:maternal ratio > 1) when concentrations are assessed on a lipid-adjusted basis. Our findings suggest that for many chemicals, fetuses may experience higher exposures than their mothers and highlight the need to characterize potential health risks and inform policies aimed at reducing sources of exposure.			1	1									1								B	B		サンフランシスコの母子についてPFASおよび有機化学物質の汚染レベルを調べた

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
404	バイオモニタリング	NH HHS.	Pease PFC blood testing program: April 2015-(	2016	State of New Hampshire, Department of Health and Human Services. https://www.dhhs.nh.gov/dphs/documents/pease-pfc-blood-testing.pdf. March 8, 2019.	In May 2014, perfluorochemicals (PFCs) were detected in concentrations near or above the U.S. Environmental Protection Agency's (EPA's) short-term Provisional Health Advisory levels in one of three wells that supplied drinking water to the Pease Tradeport in Portsmouth, New Hampshire. Perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were detected at concentrations of 2,500 parts per trillion (ppt) and 350 ppt, respectively, in the Haven well prompting the City of Portsmouth to shut down the well on May 12, 2014. Perfluorohexane sulfonic acid (PFHxS) was also found at concentrations of 830 ppt in the Haven well. Due to concern about exposure, the New Hampshire Department of Health and Human Services (NH DHHS) implemented a PFC blood testing program that began in April 2015 and ran through October 2015. The serum blood testing was for any person who had worked on, lived on, or attended childcare on the Pease Tradeport or Pease Air Force Base ("Pease") and was exposed to contaminated drinking water, or who consumed water from a contaminated private well adjacent to Pease that was tested as part of the Pease Superfund Assessment and found to have levels of PFOA or PFOS above the EPA Provisional Health Advisory levels. The purpose of the blood testing program was to provide individuals with a serum PFC level to inform them about levels of exposure from all sources. This testing program was not intended to be a health effects study and did not collect information pertaining to health outcomes. Brief questionnaires were distributed that collected basic information about PFC exposure at Pease but did not assess other potential sources of exposure. This report summarizes the findings of the NH DHHS PFC blood testing program. A total of 1,578 individuals submitted a blood sample for PFC testing. The majority of participants were adults 20 years of age or older, while almost one quarter of participants were children aged 11 years or younger. Due to the community's interest in PFC serum testing and limited testing capacity, serum samples were sent to three different laboratories. The majority of samples were sent to the Centers for Disease Control and Prevention (CDC) and AXYS Analytical Laboratories. The California State biomonitoring laboratory was also utilized. Three perfluorochemicals, PFOS, PFOA, and PFHxS, were detected in more than 94% of participants' serum samples; perfluorononanoic acid (PFNA) was also detected in the majority of participants' serum samples. The geometric mean levels in the Pease population for PFOS, PFOA, and PFHxS were significantly higher than the general U.S adult and adolescent population tested in 2011–2012 as part of the CDC's National Health and Nutrition Examination Survey (NHANES) and reported in the Fourth National Report on Human Exposure to Environmental Chemicals (updated tables, February 2015). The geometric mean level for PFNA was significantly lower in the Pease population. Geometric mean represents a type of average value of a set of numbers. Other PFCs were detected in a minority of serum samples and at much lower concentrations, preventing a valid summary analysis and comparison of results. Demographic and exposure characteristics of the Pease testing population were analyzed and showed that age, male sex, and the cumulative number of years spent on Pease were most strongly associated with serum PFC levels. Because serum levels of PFCs represent exposure from all sources, including other exposures on or off Pease and in the home environments, there are likely many factors unaccounted for in this analysis which have contributed to a person's serum PFC levels. Certain actions, especially in children, such as hand-to-mouth behavior, can be a significant source of exposure to PFCs and other chemicals and may account for some differences found among age groups. The			1										1								C	D		
405	バイオモニタリング	Ode, Amanda; Rylander, Lars; Lindh, Christian H; Källén, Karin; Jönsson, Bo AG; Gustafsson, Peik; Olofsson, Per; Ivarsson, Sten A; Rignell-Hydbom, Anna	Determinants of maternal and fetal exposure a	2013	Environ Sci Pollut Res Int. 2013 Nov;20(11):7970-8. doi: 10.1007/s11356-013-1573-5. Epub 2013 Feb 24.	In recent years, some perfluorinated compounds (PFCs) have been identified as potentially hazardous substances which are harmful to the environment and human health. According to limited data, PFC levels in humans could be influenced by several determinants. However, the findings are inconsistent. In the present study, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) were measured in paired maternal and cord serum samples (N=237) collected between 1978 and 2001 in Southern Sweden to study the relationship between these and to investigate several potential determinants of maternal and fetal exposure to PFCs. Time trends of PFCs in Swedish women were also evaluated. The study is a part of the Fetal Environment and Neurodevelopment Disorders in Epidemiological Research project. PFOS, PFOA, and PFNA levels (median) were higher in maternal serum (15, 2.1, and 0.24 ng/ml, respectively) than in cord serum (6.5, 1.7, and 0.20 ng/ml, respectively). PFC levels were among the highest in women originating from the Nordic countries and the lowest in women from the Middle East, North Africa, and sub-Saharan Africa. Multiparous women had lower serum PFOA levels (1.7 ng/ml) than primiparous women (2.4 ng/ml). Maternal age, body mass index, cotinine levels, and whether women carried male or female fetuses did not affect serum PFC concentrations. Umbilical cord serum PFC concentrations showed roughly similar patterns as the maternal except for the gestational age where PFC levels increased with advancing gestational age. PFOS levels increased during the study period in native Swedish women. In summary,PFOS levels tend to increase while PFOA and PFNA levels were unchanged between 1978 and 2001 in our study population. Our results demonstrate that maternal country of origin, parity, and gestational age might be associated with PFC exposure.			1										1		1						B	C		3種類のPFASについてスウェーデンの母子で調べた
406	バイオモニタリング	Olsen, Geary W; Church, Timothy R; Larson, Eric B; van Belle, Gerald; Lundberg, James K; Hansen, Kristen J; Burris, Jean M; Mandel, Jeffrey H; Zobel, Larry R	Serum concentrations of perfluorooctanesulfor	2004	Chemosphere. 2004 Mar;54(11):1599-611. doi: 10.1016/j.chemosphere.2003.09.025.	Perfluorooctanesulfonyl fluoride (POSF, C8F17SO2F) related-materials have been used as surfactants, paper and packaging treatments, and surface (e.g., carpet, textile, upholstery) protectants. A metabolite, perfluorooctanesulfonate (PFOS, C8F17SO3-), has been identified in the serum and liver of non-occupationally exposed humans and wildlife. Because of its persistence, an important question was whether elderly humans might have higher PFOS concentrations. From a prospective study designed to examine cognitive function in the Seattle (WA) metropolitan area, blood samples were collected from 238 dementia-free subjects (ages 65-96). High-pressure liquid chromatography-electrospray tandem mass spectrometry determined seven fluorochemicals: PFOS; N-ethyl perfluorooctanesulfonamidoacetate; N-methyl perfluorooctanesulfonamidoacetate; perfluorooctanesulfonamidoacetate; perfluorooctanesulfonamide; perfluorooctanoate; and perfluorohexanesulfonate. Serum PFOS concentrations ranged from less than the lower limit of quantitation (3.4 ppb) to 175.0 ppb (geometric mean 31.0 ppb; 95% CI 28.8-33.4). An estimate of the 95% tolerance limit was 84.1 ppb (upper 95% confidence limit 104.0 ppb). Serum PFOS concentrations were slightly lower among the most elderly. There were no significant differences by sex or years residence in Seattle. The distributions of the other fluorochemicals were approximately an order of magnitude lower. Similar to other reported findings of younger adults, the geometric mean serum PFOS concentration in non-occupational adult populations likely approximates30-40 ppb with 95% of the population's serum PFOS concentrations below 100 ppb.	1												1								B	C		シアトルの老人についてPFOS濃度について調べた
407	バイオモニタリング	Olsen, Geary W; Church, Timothy R; Miller, John P; Burris, Jean M; Hansen, Kristen J; Lundberg, James K; Armitage, John B; Herron, Ross M; Medhdizadehkashi, Zahra; Nobiletti, John B; O'Neill, E Mary; Mandel, Jeffrey H; Zobel, Larry R	Perfluorooctanesulfonate and other fluorochen	2003	Environ Health Perspect. 2003 Dec;111(16):1892-901. doi: 10.1289/ehp.6316.	Perfluorooctanesulfonyl fluoride-based products have included surfactants, paper and packaging treatments, and surface protectants (e.g., for carpet, upholstery, textile). Depending on the specific functional derivatization or degree of polymerization, such products may degrade or metabolize, to an undetermined degree, to perfluorooctanesulfonate (PFOS), a stable and persistent end product that has the potential to bioaccumulate. In this investigation, a total of 645 adult donor serum samples from six American Red Cross blood collection centers were analyzed for PFOS and six other fluorochemicals using HPLC-electrospray tandem mass spectrometry. PFOS concentrations ranged from the lower limit of quantitation of 4.1 ppb to 1656.0 ppb with a geometric mean of 34.9 ppb [95% confidence interval (CI), 33.3-36.5]. The geometric mean was higher among males (37.8 ppb; 95% CI, 35.5-40.3) than among females (31.3 ppb; 95% CI, 30.0-34.3). No substantial difference was observed with age. The estimate of the 95% tolerance limit of PFOS was 88.5 ppb (upper limit of 95% CI, 100.0 ppb). The measures of central tendency for the other fluorochemicals (N-ethyl perfluorooctanesulfonamidoacetate, N-methyl perfluorooctanesulfonamidoacetate, perfluorooctanesulfonamidoacetate, perfluorooctanesulfonamide, perfluorooctanoate, and perfluorohexanesulfonate) were approximately an order of magnitude lower than PFOS. Because serum PFOS concentrations correlate with cumulative human exposure, this information can be useful for risk characterization.	1		1										1								B	B		米国での献血血液中の7種類のPFAS濃度を調べた
408	バイオモニタリング	Olsen, Geary W; Huang, Han-Yao; Helzlsouer, Kathy J; Hansen, Kristen J; Butenhoff, John L; Mandel, Jeffrey H	Historical comparison of perfluorooctanesulfon	2005	Environ Health Perspect. 2005 May;113(5):539-45. doi: 10.1289/ehp.7544.	The purpose of this investigation was to determine whether there has been a change in the human blood concentration of perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), and five other fluorochemicals since 1974. Blood samples were collected in 1974 (serum) and 1989 (plasma) from volunteer participants of a large community health study. The study included a total of 356 samples (178 from each time period). These samples were analyzed by high-pressure liquid chromatography/tandem mass spectrometry methods. The median 1974 and 1989 fluorochemical concentrations, respectively, were as follows: PFOS, 29.5 ng/mL vs. 34.7 ng/mL; PFOA, 2.3 ng/mL vs. 5.6 ng/mL; perfluorohexanesulfonate (PFHS), 1.6 ng/mL vs. 2.4 ng/mL; and N-ethyl perfluorooctanesulfonamidoacetate (PFOSAA), less than the lower limit of quantitation (LLOQ; 1.6 ng/mL, vs. 3.4 ng/mL). For N-methyl perfluorooctanesulfonamidoacetate (M570), perfluorooctanesulfonamide, and perfluorooctanesulfonamidoacetate, median serum concentrations in both years were less than the LLOQ values (1.0, 1.0, and 2.5 ng/mL, respectively). Statistical analysis of 58 paired samples indicated that serum concentrations of PFOS, PFOSAA, PFOA, PFHS, and M570 were significantly ($p < 0.001$) higher in 1989 than in 1974. The data from 1989 were then compared with geometric mean fluorochemical concentrations of serum samples collected in 2001 from 108 American Red Cross adult blood donors from the same region. Except for M570, there were no statistically significant ($p < 0.05$) geometric mean fluorochemical concentration differences between the 1989 and 2001 samples. In conclusion, basedon this study population, PFOS and other serum fluorochemical concentrations have increased between 1974 and 1989. Comparison with other regional data collected in 2001 did not suggest a continued increase in concentrations since 1989.	1												1								B	B		1974年と1989年の健康調査時の7種類のPFAS濃度を比較
409	バイオモニタリング	Olsen, Geary W; Mair, David C; Church, Timothy R; Ellefson, Mark E; Reagen, William K; Boyd, Theresa M; Herron, Ross M; Medhdizadehkashi, Zahra; Nobiletti, John B; Rios, Jorge A; Butenhoff, John L; Zobel, Larry R	Decline in perfluorooctanesulfonate and other	2008	Environ Sci Technol. 2008 Jul 1;42(13):4989-95. doi: 10.1021/es800071x.	In 2000, 3M Company, the primary global manufacturer, announced a phase-out of perfluorooctanesulfonyl fluoride (POSF, C8F17SO2F)-based materials after perfluorooctanesulfonate (PFOS, C8F17SO3-) was reported in human populations and wildlife. The purpose of this study was to determine whether PFOS and other polyfluoroalkyl concentrations in plasma samples, collected in 2006 from six American Red Cross adult blood donor centers, have declined compared to nonpaired serum samples from the same locations in 2000-2001. For each location, 100 samples were obtained evenly distributed by age (20-69 years) and sex. Analytes measured, using tandem mass spectrometry, were PFOS, perfluorooctanoate (PFOA), perfluorohexanesulfonate (PFHxS), perfluorobutanesulfonate (PFBS), N-methyl perfluorooctanesulfonamidoacetate (Me-PFOSA-AcOH), and N-ethyl perfluorooctanesulfonamidoacetate (Et-PFOSA-AcOH). The geometric mean plasma concentrations were for PFOS 14.5 ng/mL (95% CI 13.9-15.2), PFOA 3.4 ng/ mL (95% CI 3.3-3.6), and PFHxS 1.5 ng/mL (95% CI 1.4-1.6). The majority of PFBS, Me-PFOSA-AcOH, and Et-PFOSA-AcOH concentrations were less than the lower limit of quantitation. Age- and sex-adjusted geometric means were lower in 2006 (approximately 60% for PFOS, 25% for PFOA, and 30% for PFHxS) than those in 2000-2001. The declines for PFOS and PFHxS are consistent with their serum elimination half-lives and the time since the phase-out of POSF-based materials. The shorter serum elimination half-life for PFOA and its smaller percentage decline than PFOS suggests PFOA concentrations measured in the general populationare unlikely to be solely attributed to POSF-based materials. Direct and indirect exposure sources of PFOA could include historic and ongoing electrochemical cell fluorination (ECF) of PFOA, telomer production of PFOA, fluorotelomer-based precursors, and other fluoropoly-mer production.			1	1									1								B	B		米国の献血血液の2000-2006年の6種類のPFAS濃度の低下を示した
410	バイオモニタリング	Olsen, G. W.	PFAS Biomonitoring in Higher Exposed Popula	2015	In: Dewitt JC, ed. Toxicological effects on perfluoroalkyl and polyfluoroalkyl substances. London: Humana Press, 77-125.	Perfluoroalkyl and polyfluoroalkyl substances (PFAS) have a wide range of applications as a result of their chemical and thermal stability of the C-F bond and their hydrophobic and lipophobic characteristics. Because of these unique physical and chemical properties there have been numerous industrial and consumer applications. These characteristics have also resulted in the widespread presence and persistence of PFAS in the environment and detection in biological tissue in humans. In general, biomonitoring trend studies of the PFAS, in particular PFOS and PFOA, within the general population have shown marked declines in PFOS since a May 2000 phase-out announcement by a major manufacturer. The trends, however, for PFOA are more inconclusive as multiple manufacturers of PFOA and its various precursors (e.g., fluorotelomer alcohols) remain. Higher exposed populations can be defined by identifiable exposures (e.g., environmental, occupational) that have resulted in serum, plasma, or whole blood concentrations of PFASs that are substantively larger than those reported in the general population. Although some investigators refer to these populations as 'highly exposed', this description does not sufficiently describe the magnitude of exposure that occurs within these populations and/or individuals. Thus, the term 'higher' is preferred. For the purpose of this chapter, higher exposed populations and their serum concentrations are described into three categories: (1) PFAS manufacturing and 'downstream' production workers; (2) communities affected by specific identifiable sources of PFAS exposure (above background levels) through municipal and/or private water sources; and (3) medical, occupational, and consumer PFAS-related exposures that were targeted to a well-defined group of individuals. Each of these three higher exposure populations are reviewed separately for their biomonitoring data and then compared jointly. PFAS manufacturing workers had serum concentrations 2-3 orders of magnitude higher than those reported in the general population. Depending upon the communities whose drinking water sources were affected with PFAS, these populations tended to have average serum concentrations ranging between 2x and <1 order of magnitude higher than the general population. Individuals, however, within these communities may have had comparable concentrations to those at the higher levels within the manufacturing sector. Likewise, depending on the specific medical, occupational, and/or consumer exposures, there may have been substantively higher exposures to PFOS and PFOA than reported in the general population.			1	1									1		1						B	D		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
411	バイオモニタリング	Pinney, Susan M; Biro, Frank M; Windham, Gayle C; Herrick, Robert L; Yaghjyan, Lusine; Calafat, Antonia M; Succop, Paul; Sucharew, Heidi; Ball, Kathleen M; Kato, Kayoko; Kushi, Lawrence H; Bornschein, Robert	Serum biomarkers of polyfluoroalkyl compounc	2014	Environ Pollut. 2014 Jan;184:327-34. doi: 10.1016/j.envpol.2013.09.008. Epub 2013 Oct 1.	PFC serum concentrations were measured in 6-8 year-old girls in Greater Cincinnati (GC) (N = 353) and the San Francisco Bay Area (SFBA) (N = 351). PFOA median concentration was lower in the SFBA than GC (5.8 vs. 7.3 ng/mL). In GC, 48/51 girls living in one area had PFOA concentrations above the NHANES 95th percentile for children 12-19 years (8.4 ng/mL), median 22.0 ng/mL. The duration of being breast fed was associated with higher serum PFOA at both sites and with higher PFOS, PFHxS and Me-PFOSA-AcOH concentrations in GC. Correlations of the PFC analytes with each other suggest that a source upriver from GC may have contributed to exposures through drinking water, and water treatment with granular activated carbon filtration resulted in less exposure for SWO girls compared to those in NKY. PFOA has been characterized as a drinking water contaminant, and water treatment systems effective in removing PFCs will reduce body burdens.			1												1						B	B		シンシナティとサンフランシスコの6-8歳のPFAS濃度を比較
412	バイオモニタリング	Spliethoff, H. M.; Tao, L.; Shaver, S. M.; Aldous, K. M.; Pass, K. A.; Kannan, K.; Eadon, G. A.	Use of newborn screening program blood spots	2008	Environ Sci Technol. 2008 Jul 15;42(14):5361-7. doi: 10.1021/es8006244.	Temporal biomonitoring studies can assess changes in population exposures to contaminants, but collection of biological specimens with adequate representation and sufficient temporal resolution can be resource-intensive. Newborn Screening Programs (NSPs) collect blood as dried spots on filter paper from nearly all infants born in the United States (U.S.). In this study, we investigated the use of NSP blood spots for temporal biomonitoring by analyzing perfluorooctane sulfonate (PFOS), perfluorooctane sulfonamide (PFOSA), perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) in 110 New York State (NYS) NSP blood spot composite specimens collected between 1997 and 2007, representing a total of 2640 infants. All analytes were detected in > or 0.9 of the specimens. Concentrations of PFOS, PFOSA, PFHxS, and PFOA exhibited significant exponential declines after the year 2000, coinciding with the phase-out in PFOS production in the U.S. Calculated disappearance half-lives for PFOS, PFHxS, and PFOA (4.4, 8.2, and 4.1 years, respectively) were similar to biological half-lives reported for retired fluorochemical workers. Our results suggest sharp decreases in perinatal exposure of NYS infants to PFOS, PFOSA, PFHxS, and PFOA and demonstrate, for the first time, the utility of NSP blood spots for assessment of temporal trends in exposure.			1												1						B	B		新生児の血液塗抹標本を用いてNY州のPFAS濃度を調べた
413	バイオモニタリング	Tao, Lin; Kannan, Kurunthachalam; Aldous, Kenneth M; Mauer, Matthew P; Eadon, George A	Biomonitoring of perfluorochemicals in plasma	2008	Environ Sci Technol. 2008 May 1;42(9):3472-8. doi: 10.1021/es8000079.	The collapse of the World Trade Center (WTC) on September 11, 2001 resulted in the release of several airborne pollutants in and around the site. Perfluorochemicals including perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA), which are used in soil- and stain-resistant coatings on upholstery, carpets, leather, floor waxes, polishes, and in fire-fighting foams were potentially released during the collapse of the WTC. In this pilot study, we analyzed 458 plasma samples of New York State (NYS) employees and National Guard personnel assigned to work in the vicinity of the WTC between September 11 and December 23, 2001, to assess exposure to perfluorochemicals released in dust and smoke. The plasma samples collected from NYS WTC responders were grouped based on estimated levels of exposure to dust and smoke, as follows: more dust exposure (MDE), less dust exposure (LDE), more smoke exposure (MSE), and less smoke exposure (LSE). Furthermore, samples were grouped, based on self-reported symptoms at the time of sampling, as symptomatic and asymptomatic. Eight perfluorochemicals were measured in 458 plasma samples. PFOS, PFOA, perfluorohexanesulfonate (PFHxS), and perfluorononanoic acid (PFNA), were consistently detected in almost all samples. PFOA and PFHxS concentrations were approximately 2-fold higher in WTC responders than the concentrations reported for the U.S. general population. No significant difference was observed in the concentrations of perfluorochemicals between symptomatic and asymptomatic groups. Concentrations of PFHxS were significantly ($p < or = 0.05$) higher in the MDEgroup than in the LDE group. Concentrations of PFNA were significantly higher in the MSE group than in the LSE group. Significantly higher concentrations of PFOA and PFHxS were found in individuals exposed to smoke than in individuals exposed to dust. A significant negative correlation existed between plasma lipid content and concentrations of certain perfluorochemicals. Our initial findings suggest that WTC responders were exposed to perfluorochemicals, especially PFOA, PFNA, and PFHxS, through inhalation of dust and smoke released during and after the collapse of the WTC. The potential health implications of these results are unknown at this time. Expansion of testing to include all archived samples will be critical to help confirm these findings. In doing so, it may be possible to identify biological markers of WTC exposure and to improve our understanding of the health impacts of these compounds.			1												1		1				B	B	B-minor	ニューヨークの住民の4種類のPFAS濃度
414	バイオモニタリング	Tittlemier S, Ryan JJ, Van Oostdam J.	Presence of anionic perfluorinated organic com	2004	Organohalogen Compounds 66:3959-3964. https://www.osti.gov/etdeweb/servlets/purl/20828466. March 28, 2024	Perfluorinated organic compounds are used in a wide variety of consumer and industrial products and applications, ranging from personal care products and cleaning solutions, to grease resistant coatings for fabric and paper and emulsifiers in the production of polymers. Perfluorinated compounds such as perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) are persistent and bioaccumulative. PFOS and PFOA have been detected in biota sampled from around the world2, including the Canadian Arctic. Evidence from various laboratory experiments suggest that these perfluorinated compounds can elicit negative effects, including peroxisome proliferation5 and possibly hepatocarcinogenesis. PFOA and PFOS also appear to biomagnify in marine food webs, in a similar fashion as traditional organohalogenated POPs like the recalcitrant PCB congeners. Indigenous northern Canadian populations such as the Inuit and Inuvialuit often hunt and consume marine mammals, including beluga, narwhal, and seal, as part of their traditional diet. Thus, segments of these populations are often exposed to higher levels of POPs than southern populations and other consumers of market foods. This higher exposure is reflected in plasma concentrations of traditional POPs such PCBs. There is a question of whether a similar situation occurs for PFOS, PFOA, and similar perfluorinated compounds. This preliminary survey analyzed a suite of perfluorinated sulfonates and carboxylates in 23 pooled archived samples of human plasma collected from various northern Canadian populations.														1						B	D		
415	バイオモニタリング	Toms, Leisa-Maree L; Calafat, Antonia M; Kato, Kayoko; Thompson, Jack; Harden, Fiona; Hobson, Peter; Sjödin, Andreas; Mueller, Jochen F	Polyfluoroalkyl chemicals in pooled blood serur	2009	Environ Sci Technol. 2009 Jun 1;43(11):4194-9. doi: 10.1021/es900272u.	Polyfluoroalkyl chemicals (PFCs) have been used worldwide for more than 50 years in a wide variety of industrial and consumer products. Limited data exist on human exposure to PFCs in the Southern Hemisphere. Human blood serum collected in southeast Queensland, Australia, in 2006-2007 from 2420 donors was pooled according to age (cord blood, 0-0.5, 0.6-1, 1.1-1.5, 1.6-2, 2.1-2.5, 2.6-3, 3.1-3.5, 3.6-4, 4.1-6, 6.1-9, 9.1-12, 12.1-15, 16-30, 31-45, 46-60, and > 60 years) and gender and was analyzed for eight PFCs. Across all pools, perfluorooctane sulfonate (PFOS) was detected at the highest mean concentration (15.2 ng/mL) followed by perfluorooctanoate (PFOA, 6.4 ng/mL), perfluorohexane sulfonate (PFHxS, 3.1 ng/mL), perfluorononanoate (PFNA, 0.8 ng/mL), 2-(N-methylperfluorooctane sulfonamido) acetate (Me-PFOSA-AcOH, 0.66 ng/mL), and perfluorodecanoate (PFDeA, 0.29 ng/mL). Perfluorooctane sulfonamide was detected in only 24% of the pools, and 2-(N-ethylperfluorooctane sulfonamido) acetate was detected in only one. PFOS concentrations were significantly higher in pools from adult males than from adult females ($p = 0.002$); no gender differences were apparent in the pools from children (< 12 years old). The highest mean concentrations of PFOA, PFHxS, PFNA, PFDeA, and Me-PFOSA-AcOH were found in children < 15 years, while PFOS was highest in adults > 60 years. Investigation into the sources and exposure pathways in Australia, in particular for children, is necessary as well as continued biomonitoring to determine the potential effects on human concentrations as a result of changes in the PFC manufacturingpractices, including the cessation of production of several PFCs.			1												1						B	B		オーストラリアで保存されたプール血清のPFAS濃度を測定
416	バイオモニタリング	Trasande, Leonardo; Koshy, Tony T; Gilbert, Joseph; Burdine, Lauren K; Attina, Teresa M; Ghassabian, Akhgar; Honda, Masato; Marmor, Michael; Chu, Dinh Binh; Han, Xiaoxia; Shao, Yongzhao; Kannan, Kurunthachalam	Serum perfluoroalkyl substances in children ex	2017	Environ Res. 2017 Apr;154:212-221. doi: 10.1016/j.envres.2017.01.008. Epub 2017 Jan 16.	The World Trade Center (WTC) disaster released large amounts of various chemical substances into the environment, including perfluoroalkyl substances (PFASs). Yet, no studies have examined exposures in children living or attending schools near the disaster site. We measured serum PFASs in WTC Health Registry (WTCHR) respondents who were ≤8 years of age on September 11, 2001 and a sociodemographically-matched comparison group. We also examined the relationship of PFASs levels with dust cloud exposure; home dust exposure, and with traumatic exposure, the latter to take into account differences related to possible mental health consequences and associated behavioral problems. Serum samples, collected between 2014 and 2016, were analyzed from 123 WTCHR participants and from 185 participants in the comparison group. In the WTCHR group, median perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) levels were 1.81ng/mL and 3.72ng/mL, respectively. Controlling for sex, caloric intake, race/ethnicity, and date of birth, significant increases among WTCHR participants compared with the matched comparison group were detected for perfluorohexanesulfonate (0.23ng/mL increase or 0.24log unit increase, p=0.006); PFOS (0.86ng/mL increase or 0.16log unit increase, p=0.011); PFOA (0.35ng/mL increase or 0.18log unit increase, p<0.001); perfluorononanoic acid (0.12ng/mL increase or 0.17log unit increase, p=0.003); perfluorodecanoic acid (0.06ng/mL increase or 0.42log unit increase, p<0.001); and perfluoroundecanoic acid (0.03ng/mL increase or 0.32log unit increase, p=0.019). Stronger associationswere identified for home dust exposures and traumatic exposures than dust cloud. These findings highlight the importance of conducting longitudinal studies in this population to assess possible cardiometabolic and renal consequences related to these exposures.			1												1						B	C	B-minor	ニューヨークで採取した血中PFAS濃度
417	バイオモニタリング	Wilhelm, Michael; Hölzer, Jürgen; Dobler, Lorenz; Rauchfuss, Knut; Midasch, Oliver; Kraft, Martin; Angerer, Jürgen; Wiesmüller, Gerhard	Preliminary observations on perfluorinated com	2009	Int J Hyg Environ Health. 2009 Mar;212(2):142-5. doi: 10.1016/j.ijheh.2008.04.008. Epub 2008 Jun 11.	In May 2006, a serious environmental contamination with perfluorinated compounds (PFCs) became evident in a rural area of North Rhine-Westphalia (NRW) (Region Sauerland), Germany. In autumn 2006, we performed a human biomonitoring study in which a 4-8-fold increase in perfluorooctanoate (PFOA)-plasma concentrations of children, their mothers and men living in Arnsberg (District Hochsauerlandkreis, NRW) was observed compared with a reference population. The exposure was clearly related to the consumption of PFOA-contaminated tap water. However, there is no clear information on the duration of this contamination. The current investigation involves the analysis of PFCs in 30 blood samples of young adults (age 20-31 years) who had ever lived in the affected area. The samples were taken between 1977 and 2004 and stored at the German Environmental Specimen Bank for Human Tissues. Analyses of PFOA, perfluorooctanesulfonate (PFOS), perfluorohexanoate (PFHxA), perfluorohexanesulfonate (PFHxS), perfluoropentanoate (PFPA) and perfluorobutanesulfonate (PFBS) in blood plasma were performed by solid-phase extraction, HPLC and MS/MS detection. PFOA values (median, range) were 6.1, 1.7-40.7 microg/l, PFOS values were 18.8, 8.1-150.7 microg/l and PFHxS values were 1.7, 0.5-4.6 microg/l. The concentrations of PFHxA, PFPA and PFBS in plasma were all below limit of detection. Time-trend analysis showed that between 1977 and 2004 PFOA and PFOS levels remained fairly stable. PFOS and PFOA levels were in the range of current background levels of the general population. In contrast, PFHxS plasma levels have steadily increased since 1977. There was aclose association between PFOS and PFOA-plasma levels. From this pilot study there are no indications for an increased exposure to PFCs of residents in Arnsberg in the years 1977-2004 prior to the contamination in 2006.		1		1										1		1				B	B		ドイツの水源汚染があった地域のPFAS濃度

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
418	バイオモニタリング	Worley, R. R.; Moore, S. M.; Tierney, B. C.; Ye, X.; Calafat, A. M.; Campbell, S.; Woudneh, M. B.; Fisher, J.	Per- and polyfluoroalkyl substances in human	2017	Environ Int. 2017 Sep;106:135-143. doi: 10.1016/j.envint.2017.06.007. Epub 2017 Jun 20.	Background: Per- and polyfluoroalkyl substances (PFAS) are considered chemicals of emerging concern, in part due to their environmental and biological persistence and the potential for widespread human exposure. In 2007, a PFAS manufacturer near Decatur, Alabama notified the United States Environmental Protection Agency (EPA) it had discharged PFAS into a wastewater treatment plant, resulting in environmental contamination and potential exposures to the local community. Objectives: To characterize PFAS exposure over time, the Agency for Toxic Substances and Disease Registry (ATSDR) collected blood and urine samples from local residents. Methods: Eight PFAS were measured in serum in 2010 (n=153). Eleven PFAS were measured in serum, and five PFAS were measured in urine (n=45) from some of the same residents in 2016. Serum concentrations were compared to nationally representative data and change in serum concentration over time was evaluated. Biological half-lives were estimated for perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and perfluorohexane sulfonic acid (PFHxS) using a one-compartment pharmacokinetic model. Results: In 2010 and 2016, geometric mean PFOA and PFOS serum concentrations were elevated in participants compared to the general U.S. Population: In 2016, the geometric mean PFHxS serum concentration was elevated compared to the general U.S. Population: Geometric mean serum concentrations of PFOA, PFOS, and perfluorononanoic acid (PFNA) were significantly (p≤0.0001) lower (49%, 53%, and 58%, respectively) in 2016 compared to 2010. Half-lives for PFOA, PFOS, and PFHxS were estimated to be 3.9, 3.3, and 15.5years, respectively. Concentrations of PFOA in serum and urine were highly correlated (r=0.75) in males. Conclusions: Serum concentrations of some PFAS are decreasing in this residentially exposed community, but remain elevated compared to the U.S. general population.			1											1		1			B	B		
419	バイオモニタリング	Yang, Lin; Wang, Zhen; Shi, Yu; Li, Jingguang; Wang, Yuxin; Zhao, Yunfeng; Wu, Yongning; Cai, Zongwei	Human placental transfer of perfluoroalkyl acid	2016	Chemosphere. 2016 Feb;144:1631-8. doi: 10.1016/j.chemosphere.2015.10.063. Epub 2015 Oct 28.	Perfluoroalkyl acids (PFAAs) precursors, the indirect source of PFAA exposure, have been observed in environmental and human samples. However, the maternal-fetal transfer of these chemicals has not been well examined. In this study, 50 paired maternal and cord serum samples collected in Jiangsu province of China were analyzed for fifteen PFAA precursors. Among the detected PFAAs, 6:2 fluorotelomer sulfonate (6:2 FTS), N-methyl- and N-ethyl-perfluorooctanesulfonamidoacetates had comparable detection rate in both maternal and cord sera, while the mean concentrations and detection rates of 8:2 FTS and perfluorooctane sulfonamide (PFOSA) were higher in maternal sera compared to cord sera (Mann-Whitney U test, P < 0.05). Analysis of variance and least significant difference tests showed that the youngest maternal age group (21-24 years old) had the highest concentration of 6:2 FTS in cord sera. Maternal serum PFOSA was found significantly correlated with the cord serum perfluorooctanesulfonate (PFOS) (Spearman test, r = 0.361, P = 0.010), indicating that maternal serum PFOSA might be an indirect source of PFOS in fetuses. The obtained results suggested the potential prenatal exposure and human placental transfer of perfluoroalkyl acid precursors.			1											1					1	B	A	B-minor	中国の母体血のPFAS前駆体と臍帯血のPFOSに相関有り
420	バイオモニタリング	Ye, Xiaoyun; Kato, Kayoko; Wong, Lee-Yang; Jia, Tao; Kalathil, Akil; Latremouille, John; Calafat, Antonia M	Per- and polyfluoroalkyl substances in sera fro	2018	Int J Hyg Environ Health. 2018 Jan;221(1):9-16. doi: 10.1016/j.ijheh.2017.09.011. Epub 2017 Sep 29.	Several per- and polyfluoroalkyl substances (PFAS) have been measured in U.S. National Health and Nutrition Examination Survey (NHANES) participants 12 years of age and older since 1999-2000, but PFAS data using NHANES individual samples among children younger than 12 years do not exist. To obtain the first nationally representative PFAS exposure data in U.S. children, we quantified serum concentrations of 14 PFAS including perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA), in a nationally representative subsample of 639 3-11year old participants in NHANES 2013-2014. We used on-line solid-phase extraction coupled to isotope dilution-high performance liquid chromatography-tandem mass spectrometry; limits of detection were 0.1ng/mL for all analytes. We calculated geometric mean concentrations, determined weighted Pearson correlations, and used linear regression to evaluate associations of sex, age (3-5 vs 6-11 years), race/ethnicity (Hispanic vs non-Hispanic), household income, and body mass index with concentrations of PFAS detected in more than 60% of participants. We detected PFOS, PFOA, PFHxS, and PFNA in all children at concentrations similar to those of NHANES 2013-2014 adolescents and adults, suggesting prevalent exposure to these PFAS or their precursors among U.S. 3-11year old children, most of whom were born after the phase out of PFOS in the United States in 2002. PFAS concentration differences by sex, race/ethnicity, and age suggest lifestyle differences that may impact exposure, and highlight theimportance of identifying exposure sources and of studying the environmental fate and transport of PFAS.			1	1										1					B	B		3-11歳児の14種類のPFASをNHANES 2013で調べた
421	バイオモニタリング	Averina, Maria; Brox, Jan; Huber, Sandra; Furberg, Anne-Sofie	Perfluoroalkyl substances in adolescents in no	2018	Environ Int. 2018 May;114:123-130. doi: 10.1016/j.envint.2018.02.031. Epub 2018 Feb 28.	Perfluoroalkyl substances (PFASs) are environmentally persistent chemicals widely used in many consumer products due to water and oil proofing and fire-resistant properties. Several PFASs are recognized as environmental pollutants. This study investigated serum concentrations of 18 different PFASs and their associations with diet and lifestyle variables in 940 adolescents (age 15-19 years) who participated in the Fit Futures 1 study in the Troms arctic district of Norway. Serum concentrations of PFASs were analyzed by ultrahigh pressure liquid chromatography coupled to a triple quadrupole mass spectrometer (UHPLC-MS/MS). The most abundant PFASs in this population were perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA) and perfluorodecanoate (PFDA) that were found in 99% of the participants. Perfluoroheptane sulfonate (PFHpS) was found in 98% of the participants. Median concentrations were: PFOS 6.20 ng/mL, PFOA 1.92 ng/mL, PFHxS 0.71 ng/mL, PFNA 0.50 ng/mL, PFDA 0.21 ng/mL and PFHpS 0.15 ng/mL. Median of PFASs sum concentration (∑PFAS) was 10.7 ng/mL, the concentration range was 2.6-200.8 ng/mL. Intake of fat fish, fish liver, seagull eggs, reindeer meat and drinks with sugar were the main dietary predictors of several PFASs. Intake of junk food (pizza, hamburger, sausages) was positively associated with PFNA, intake of canned food was positively associated with PFHxS. Intake of fruits and vegetables, milk products, snacks and candy was not associated with PFASs concentrations. Lean fish intake was positively associated with PFUnDA, but notwith other PFASs. There was a positive association of ∑PFAS, PFHxS, PFOA, PFNA and PFDA with chewed tobacco use.			1	1													1		B	B		15-19歳のノルウェーの若者の18種類のPFASと食生活
422	バイオモニタリング	Axmon, Anna; Axelsson, Jonatan; Jakobsson, Kristina; Lindh, Christian H; Jönsson, Bo A G	Time trends between 1987 and 2007 for perflu	2014	Chemosphere. 2014 May;102:61-7. doi: 10.1016/j.chemosphere.2013.12.021. Epub 2014 Jan 17.	Perfluoroalkyl acids (PFAAs) are a large group of chemicals which are highly persistent in both nature and humans. The use of the most prominent ones, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), was reduced in the early 21st century, and since then levels in human matrices have decreased. However, these two compounds have been exchanged by other PFAAs, for which time trends have not been as extensively investigated. By the use of 80 plasma samples collected between 1987 and 2007 from healthy women (n=1-9 yearly for 1987-2001, n=15 from 2006, and n=10 from 2007), possible time trends of six PFAAs were assessed. Time trends were evaluated for the entire study period, as well as for three sub-periods. As seen in previous studies, levels of perfluorohexane sulfonate (PFHxS), PFOS, and PFOA peaked during the middle time period (1990-2000), with medians of 0.98 ng mL(-1), 18.06 ng mL(-1), and 3.73 ng mL(-1), respectively. However, levels of perfluorononanic acid (PFNA), perfluorodecanic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) increased over the whole study period and most markedly so after year 2000, with medians of 0.73 ng mL(-1), 0.28 ng mL(-1), and 0.24 ng mL(-1), respectively, during the last study period.			1														1		B	B		1987-2007年のスウェーデンの６種類のPFAAの変化
423	バイオモニタリング	Bao, J.;ia; Karrman, A.; van Bavel, B.; Jin, Y.	Perfluoroalkyl substances in the blood samples	2014	Chin Sci Bull., 59, 388–395. doi: 10.1007/S11434-013-0008-5	Temporal trends of perfluoroalkyl substances (PFASs) have been determined in the blood samples from several countries globally including a female population in Sweden recently, yet little is known about the time trends in the blood levels of these compounds in Swedish male populations over recent years. In this study, the fourteen target PFASs consisted of four perfluorosulfonates (PFSAs) and ten perfluorocarboxylates (PFCAs) in the whole blood samples, collected from 153 Swedish elderly men during the period between 2008 and 2010, were analyzed via ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). As the dominant PFASs contaminants in the blood samples, perfluorooctane sulfonate (PFOS) showed the highest geometric mean (GM) at 8.5 ng/mL, ranging from 1.7 to 29 ng/mL, while blood perfluorooctanoic acid (PFOA) contained the GM of 1.8 ng/mL, ranging from 0.35 to 6.4 ng/mL. Both the levels of these two compounds were lower than those determined in the blood samples of Swedish elderly populations derived from the late 1990s. According to the temporal trend analysis, over the three years, the blood levels of PFOS in Swedish male populations declined 16 % per annum, while those of perfluoroundecanoic acid (PFUnDA) increased 6.1 % per annum, which were consistent with those reported previously for the populations from other countries.			1														1		B	D		
424	バイオモニタリング	Bartolomé, Mónica; Gallego-Picó, Alejandrina; Cutanda, Francisco; Huetos, Olga; Esteban, Marta; Pérez-Gómez, Beatriz; Castaño, Argelia	Perfluorinated alkyl substances in Spanish adu	2017	Sci Total Environ. 2017 Dec 15;603-604:352-360. doi: 10.1016/j.scitotenv.2017.06.031. Epub 2017 Jun 23.	Per- and polyfluoroalkyl substances (PFAS) are widely found in humans and the environment. Their persistence, bioaccumulation and toxicity make them a source of increasing public health concern. In this study, we analyzed the concentrations and geographical distribution of six PFAS in the serum of 755 Spanish adults aged 18-65. The geometric mean concentrations (and P95 values) for PFOS (perfluorooctane sulfonate), PFOA (perfluorooctanoic acid), PFHxS (perfluorohexane sulfonate), PFNA (perfluorononanoic acid) and PFDA (perfluorodecanoic acid) were 7.67 (19.3), 1.99 (5.48), 0.91 (2.84), 0.96 (2.44) and 0.42 (0.99) μg/L, respectively. N-Methylperfluorooctane sulfonamide (N-MeFOSAA) was detected in only 3.3% of samples. Residents in northeast (Catalonia) and northwest of Spain (Galicia) were found to have the highest serum values, whereas residents in the Canary Islands had the lowest values for almost all PFAS. Men presented higher levels than women, and we confirm that lactation (breastfeeding) contributes to a reduced body burden for all PFAS in women. Our data provide new information on exposure to PFAS in a national cross section sample of Spanish adults, thus providing a proxy for reference values for the Spanish population and forming the base for following temporal trends in the future.			1														1		B	B		スペインの地域別PFAA濃度
425	バイオモニタリング	Berg, Vivian; Nøst, Therese Haugdahl; Huber, Sandra; Rylander, Charlotta; Hansen, Solrunn; Veyhe, Anna Sofia; Fuskevåg, Ole Martin; Odland, Jon Øyvind; Sandanger, Torkjel Manning	Maternal serum concentrations of per- and pol	2014	Environ Int. 2014 Aug;69:58-66. doi: 10.1016/j.envint.2014.04.010. Epub 2014 May 7.	Determining maternal concentrations of per- and polyfluoroalkyl substances (PFASs) and the relative impact of various demographic and dietary predictors is important for assessing fetal exposure and for developing proper lifestyle advisories for pregnant women. This study was conducted to investigate maternal PFAS concentrations and their predictors in years when the production and use of several PFASs declined, and to assess the relative importance of significant predictors. Blood from 391 pregnant women participating in The Northern Norway Mother-and-Child Contaminant Cohort Study (MISA) was collected in the period 2007-2009 and serum analyses of 26 PFASs were conducted. Associations between PFAS concentrations, sampling date, and demographic and dietary variables were evaluated by multivariate analyses and linear models including relevant covariates. Parity was the strongest significant predictor for all the investigated PFASs, and nulliparous women had higher concentrations compared to multiparous women (10 ng/mL versus 4.5 ng/mL in median PFOS, respectively). Serum concentrations of PFOS and PFOA of women recruited day 1-100 were 25% and 26% higher, respectively, compared to those women recruited in the last 167 days of the study (day 601-867), and the concentrations of PFNA, PFDA and PFUnDA increased with age. Dietary predictors explained 0-17% of the variation in concentrations for the different PFASs. Significantly elevated concentrations of PFOS, PFNA, PFDA and PFUnDA were found among high consumers of marine food. The concentrations of PFHxS, PFHpS and PFNA were also increased in high consumers of game and elevated concentrations of PFHpS and PFOS were detected in high consumers of white meat. Study subjects with a high intake of salty snacks and beef had significantly higher concentrations of PFOA. The present study demonstrates that parity, sampling date and birth year are the most important predictors for maternal PFAS concentrations in years following a decrease in production and use of several PFASs. Further, dietary predictors of PFAS concentrations were identified and varied in importance according to compound.			1	1													1		B	B		2007-2009年のノルウェーの26種類のPFAS
426	バイオモニタリング	Dassuncao, C.; Hu, X. C.; Nielsen, F.; Weihe, P.; Grandjean, P.; Sunderland, E. M.	Shifting global exposures to poly- and perfluor	2018	Environ Sci Technol. 2018 Mar 20;52(6):3738-3747. doi: 10.1021/acs.est.7b06044. Epub 2018 Mar 12.	Rapid declines in legacy poly- and perfluoroalkyl substances (PFASs) have been reported in human populations globally following changes in production since 2000 However, changes in exposure sources are not well understood. Here, we report serum concentrations of 19 PFASs (∑19PFAS) measured in children between 1993 and 2012 from a North Atlantic fishing community (Faroe Islands). Median ∑19PFAS concentrations in children (ages 44694 years) peaked in 2000 (47.7 ng mL-1) and declined significantly by 0.144 year-1 until 2012 Principal component analysis (PCA) identified two groups of PFASs that likely reflect exposures from diverse consumer products and a third group that consisted of perfluorocarboxylic acids (PFCAs) with nine or more carbons (C ≥ 9). These C ≥ 9 PFASs are strongly associated with mercury in children's hair, a well-established proxy for seafood consumption, especially perfluoroundecanoic acid (PFUnDA, r = 0.72). Toxicokinetic modeling shows PFAS exposures from seafood have become increasingly important (53% of perfluorooctanesulfonate, PFOS, in 2012), despite a decline in whale consumption in recent years. We infer that even in a major seafood-consuming population, declines in legacy PFAS exposure after 2000 were achieved by the rapid phase out of PFOS and its precursors in consumer products. These results emphasize the importanceof better understanding exposures to replacement PFASs in these sources.	1	1	1	1											1		1	B	A		フェロー諸島の19種類のPFASの変遷と魚摂取量（毛髪中Hg濃度）との関係

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
427	バイオモニタリング	Denys, Sébastien; Fraize-Frontier, Sandrine; Moussa, Oumar; Le Bizec, Bruno; Veyrand, Bruno; Volatier, Jean-Luc	Is the fresh water fish consumption a significa	2014	Toxicol Lett. 2014 Dec 1;231(2):233-8. doi: 10.1016/j.toxlet.2014.07.028. Epub 2014 Aug 1.	PFAS are man-made compounds that are highly spread in the environment. Human dietary exposure to such contaminants is of high concern as they may accumulate in the food chain. Different studies already demonstrated the importance of the fish consumption in the dietary exposure of these molecules and the potential increase of internal doses of PFAS following the consumption of PFAS. However, so far few study aimed to study the link between the consumption of fresh water fishes and the internal exposure to PFAS. Objectives of this study were (i) to estimate the internal exposure of populations that are potentially high consumers of fresh water fishes and (ii) to determine whether the consumption of fish caught from fresh water is a significant determinant of the internal exposure of PFAS. In this work, a large sample of adult freshwater anglers from the French metropolitan population (478 individuals) was constituted randomly from participants lists of anglers associations. Questionnaires provided social and demographic information and diet information for each subject. In addition, analyses of blood serum samples provided the internal concentration of 14 PFAS. The survey design allowed to extrapolate the data obtained on the 478 individuals to the freshwater angler population. Descriptive data regarding internal levels of PFAS were discussed at the population level, whereas identification of the determinants were done at the 478 individuals level as sufficient contrast was required in terms of fresh water fish consumption. Only molecules for which the detection frequency were above 80% in blood were considered, i.e., PFOS, PFOA,PFHxS, PFNA, PFHpS, and PFDA. Distribution profiles showed log-normal distribution and PFOS and PFOA were the main contributors of the PFAS sum. For PFOS, the results obtained on the 478 individuals showed that upper percentiles were higher as compared to upper percentiles obtained on occidental general population. This confirmed an over-exposure of a fraction of the 478 individuals. Though, when the results were considered at the population level, the values were close. This was attributed to the low consumption frequency of fresh water fish in the general population. For PFOS, PFNA, PFHxS, PFHpS and PFDA, the fresh water fish consumption was identified as one of the contributors of internal PFAS concentrations. Gender, age, geographical location and consumption of home-grown products as other determinants were also discussed in this paper.			1															1		1	B	A	exposure source	フランスの釣り人教会で淡水魚の摂取量と14種類のPFASとの関係を調べ、PFOS, PFOA, PFHxS, PFNA, PFHpS, and PFDA濃度に注目
428	バイオモニタリング	Eriksson, Ulrika; Mueller, Jochen F; Toms, Leisa-Maree L; Hobson, Peter; Kärrman, Anna	Temporal trends of PFSAs, PFCAs and selecte	2017	Environ Pollut. 2017 Jan;220(Pt A):168-177. doi: 10.1016/j.envpol.2016.09.036. Epub 2016 Oct 7.	Per- and polyfluoroalkyl substances (PFASs) are a family of compounds that includes numerous compound classes. To date, only a subset of these PFASs have been studied thoroughly in the general population. In this study, pooled serum samples from Australia collected in 2002-2013 were analyzed for PFASs according to gender and age (age categories of 0-4 years, 5-15 years, 16-30 years, 31-45 years, 46-60 years, and >60 years), in total 54 pooled samples and 4920 individuals. Compound classes included were perfluorocarboxylic acids (PFCAs), perfluorosulfonic acids (PFSAs), and two groups of PFCA precursor compounds; polyfluoroalkyl phosphate diesters (diPAPs), and fluorotelomer sulfonic acids (FTSAs). Several PFASs that were not reported in previous studies of Australian serum samples were found in this sample set including; diPAPs, FTSAs, perfluoropentane sulfonic acid (PFPeS), perfluoroheptane sulfonic acid (PFHpS), perfluoroheptane carboxylic acid (PFHpA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA), and perfluorotridecanoic acid (PFTrDA). Various temporal trends were observed with a significant reduction ($p < 0.05$) between 2002 and 2013 for 8:2 FTSA, perfluorohexane sulfonic acid (PFHxS), PFHpS, PFOS, and perfluorooctanoic acid (PFOA). Levels of longer-chained PFDA and PFUnDA started to decrease more recently, between 2006 and 2013, while PFDoDA increased during the same time period. Higher levels in younger age groups (0-4 and 5-15 years) compared to adults (>15 years) were found for 8:2 FTSA and PFHpA, while levels of PFHpS, PFOS, PFUnDA, PFDoDA and PFTrDA were higher in adult age groupscompared to younger age groups. Gender-specific patterns were seen for PFOA, PFHxS, PFHpS and PFOS, where levels were lower in women. Changes in manufacturing processes were reflected in the temporal time trends, and differences in bioaccumulation potential between homologues could be associated with age trends. Our results emphasize the importance of including emerging classes of PFASs in biomonitoring studies.			1															1		B	B		2002-2013年のオーストラリアのPFASおよび前駆体の経年変化
429	バイオモニタリング	Freberg, Baard Ingegerdsson; Haug, Line Småstuen; Olsen, Raymond; Daae, Hanne Line; Hersson, Merete; Thomsen, Cathrine; Thorud, Syvert; Becher, Georg; Molander, Paal; Ellingsen, Dag G	Occupational exposure to airborne perfluorinat	2010	Environ Sci Technol. 2010 Oct 1;44(19):7723-8. doi: 10.1021/es102033k.	The concentration levels of 11 perfluorinated carboxylic (PFCA) and eight sulfonic (PFSA) acids were determined in the serum of 13 professional ski waxers. The same components were also determined in workroom aerosols and in fluoro containing solid ski waxes and ski wax powders. The highest median concentration (50 ng/mL) was detected for perfluorooctanoic acid (PFOA), which is around 25 times higher than the background level. For the first time perfluorotetradecanoic acid (PFTeDA) has been found in human serum. Positive statistically significant associations between years exposed as ski waxer and seven different PFCAs were observed. The serum concentrations of the PFCAs with carbon chain lengths from C(8) to C(11) were reduced by around five to 20% on average during the eight month exposure free interval, whereas the reduction was substantially larger when the carbon chain lengths were smaller than C(8) or larger than C(11). This study links for the first time PFCAs in the ski waxers serum to exposure from the work room aerosols. Not only professional ski waxers but also the significant larger group of amateur skiers and waxers are potentially exposed to these compounds.			1															1		B	A	exposure source	スキーワックス作業鎖における19種類のPFASへの曝露
430	バイオモニタリング	Graber, J. M.; Alexander, C.; Laumbach, R. J.; Black, K.; Strickland, P. O.; Georgopoulos, P. G.; Marshall, E. G.; Shendell, D. G.; Alderson, D.; Mi, Z.; Mascari, M.; Weisel, C. P.	Per and polyfluoroalkyl substances (PFAS) blo	2019	J Expo Sci Environ Epidemiol. 2019 Mar;29(2):172-182. doi: 10.1038/s41370-018-0096-z. Epub 2018 Nov 27.	Introduction: Per and polyfluoroalkyl substances (PFAS), including perfluorononanoic acid (PFNA) and perfluorooctanoic acid (PFOA), were detected in the community water supply of Paulsboro New Jersey in 2009. Methods: A cross-sectional study enrolled 192 claimants from a class-action lawsuit, not affiliated with this study, who had been awarded a blood test for 13 PFAS. Study participants provided their blood test results and completed a survey about demographics; 105 participants also completed a health survey. Geometric means, 25th, 50th, 75th, and 95th percentiles of exposure of PFNA blood serum concentrations were compared to that of the 2013-2014 NHANES, adjusted for reporting level. Associations between PFNA, PFOA, PFOS, and PFHxS and self-reported health outcomes were assessed using logistic regression. Results: PFNA serum levels were 285% higher in Paulsboro compared with U.S. residents. PFNA serum levels were higher among older compared with younger, and male compared to female, Paulsboro residents. After adjustment for potential confounding, there was a significant association between increased serum PFNA levels and self-reported high cholesterol (OR: 1.15, 95% CI: 1.02, 1.29). Discussion/conclusion: Further investigation into possible health effects of PFAS exposure in Paulsboro and other community settings is warranted. Since exposure has ceased, toxicokinetics of PFAS elimination should be explored.			1															1		B	B		ニュージャージー州の汚染があった地域でのPFNAばく露量
431	バイオモニタリング	Gyllenhammar I, Berger U, Sundstrom M, Lignell S, Aune M, Darnerud PO, Kotova N and Glynn A.	Perfluoroalkyl Acids in Serum from Nursing Wo	2013	Nationell miljöövervakning på uppdrag av naturvårdsverket. Report NV-02409-12.	Perfluoroalkyl acids (PFAAs) are a group of persistent organic substances that are surface active and water and fat/oil repellent. Due to the wide use and persistence of PFAAs they are present everywhere in the environment, and humans are exposed via food, drinking water and the use of products containing PFAAs and related compounds. We investigated blood serum levels of ten perfluoroalkyl carboxylic acids (PFCAs), four perfluoroalkane sulfonic acids (PFSAs), and perfluorooctane sulfonamide (FOSA) in 297 women from Uppsala County, Sweden, sampled three weeks after delivery during 1996-1999 and 2008-2011. The aim of the study was to determine if there were significant differences in PFAA serum levels between the women living in different districts in the City of Uppsala, in attempt to ascertain the impact of drinking water exposure on blood levels of PFAA. Earlier results on drinking water analyses suggested that the drinking water distributed mainly to the Southern district of Uppsala was contaminated with high levels of perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS), and lower levels of perfluorobutane sulfonic acid (PFBS). The contaminated water wells have now been taken out of production. Another aim was to evaluate associations between blood PFOS levels and fish consumption, suggested to be a significant source of PFOS exposure. When comparing serum levels of PFAA in women from different city districts, significantly higher concentrations PFBS and PFHxS were found in the Southern and/or the Western districts both in 1996-1999 and 2008-2011. Higher levels of PFHxS were observed in 2008-2011 than in 1996-1999 in all Uppsala districts, but not in women from areas outside of the City of Uppsala. These results suggest that drinking water exposure to PFHxS and PFBS gave a major contribution to the total exposure to the compounds mainly in the Southern district but also to some extent in other districts of Uppsala. Levels of PFOS in serum did not differ between districts, and the levels were lower in 2008-2011 than in 1996-1999 suggesting that the drinking water contamination of PFOS has not yet resulted in increased serum levels in women consuming the contaminated water. Total fish consumption and lean fish and shellfish consumption were positively associated with serum concentrations of lin-PFOS ($p< 0.05$) in the group of women from 2008-2011. Our results strongly suggest that drinking water exposure to perfluorohexane sulfonic acid (PFHxS) and perfluorobutane sulfonic acid (PFBS) is an important factor behind the increasing temporal trends of the levels of these compounds in blood serum from young women in Uppsala. Our results further suggested that the relative importance of fish consumption as human exposure pathway for PFOS has increased since the 1990s.	1	1	1														1			B	D		
432	バイオモニタリング	Hansen, Solrunn; Vestergren, Robin; Herzke, Dorte; Melhus, Marita; Evenset, Anita; Hanssen, Linda; Brustad, Magritt; Sandanger, Torkjel M	Exposure to per- and polyfluoroalkyl substance	2016	Environ Int. 2016 Sep;94:272-282. doi: 10.1016/j.envint.2016.05.030. Epub 2016 Jun 7.	Releases of aqueous film-forming foams (AFFFs) from airport firefighting activities have been identified as important local point sources of per- and polyfluoroalkyl substances (PFASs) in nearby waterways. PFASs can be taken up by fish, and in turn by the humans that consume them. Despite the global extent of AFFF emissions, few studies exist on related impacts on humans. We aimed to investigate the associations between the consumption of fish from AFFF-affected waters and serum PFAS concentrations in humans using a combination of statistical tools, empirical data, and toxicokinetic modeling. Participants of the SAMINOR 2 Clinical Study were the basis for this study sample, which comprised 74 persons. Fifty-nine participants who reported consuming fish from AFFF-affected waters and 15 nonconsumers completed a questionnaire and gave serum samples. Participants were classified based on their consumption of trout and char: high (n=16), moderate (n=16), low (n=27), and nonconsumers (n=15); and serum samples were tested for the presence of 15 PFASs. Perfluorooctane sulfonic acid (PFOS) was found in all participants, with the highest concentrations detected in the high consumption group (geometric means, 28ng/mL) compared to the low consumption group and nonconsumers (10 and 11ng/mL, respectively). In an analysis of variance contrast model, a significant, positive increasing trend was seen for fish consumption and PFOS, perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA). Toxicokinetic modeling allowed us to predict the median increases in serum concentrations of PFOS, PFHxS, and PFNA among highconsumers within a factor of 2.2. The combination of statistical evaluation and toxicokinetic modeling clearly demonstrated a positive relationship between consumption of fish from AFFF-affected waters and serum PFAS concentrations. Further studies on dietary exposure to other PFASs present in AFFF and its consequences on human health are warranted.			1															1		1	B	A		消火剤での汚染があったノルウェーの住民の魚由来とそれ以外の15種類のPFAS
433	バイオモニタリング	Haug, L. S.; Huber, S.; Becher, G.; Thomsen, C.	Characterisation of human exposure pathways	2011	Environ Int. 2011 May;37(4):687-93. doi: 10.1016/j.envint.2011.01.011. Epub 2011 Feb 18.	Commercially used per- and polyfluorinated compounds (PFCs) have been widely detected in humans, but the sources of human exposure are not fully characterized. The objectives of this study were to assess the relative importance of different exposure pathways of PFCs in a group of Norwegians and compare estimated intakes with internal doses obtained through biomonitoring. Individual PFC intakes from multiple exposure sources for a study group of 41 Norwegian women were estimated using measured PFC concentrations in indoor air and house dust as well as information from food frequency questionnaires and PFC concentrations in Norwegian food. Food was generally the major exposure source, representing 67-84% of the median total intake for PFOA and 88-99% for PFOS using different dust ingestion rates and biotransformation factors of precursor' compounds. However, on an individual basis, the indoor environment accounted for up to around 0.5 of the total intake for several women. Significant positive associations between concentrations of PFCs in house dust and the corresponding serum concentrations underline the importance of indoor environment as an exposure pathway for PFCs. For breast-fed infants, breast milk was calculated to be the single most important source to PFCs by far. The estimated intakes were confirmed by comparingserum concentrations of PFOA and PFOS calculated using PK models, with the corresponding concentrations measured in serum. Even though food in general is the major source of exposure for PFCs, the indoor environment may be an important contributor to human exposure. This study provides valuable knowledge for risk assessment of PFCs and control strategies.			1															1		1	B	A		食事だけでなく室内汚染がPFAS汚染源として重要であることを示した

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
434	バイオモニタリング	HBM	HBM-II values for perfluorooctanoic acid (PFO	2020	HBM, 2020.(Statement by the Human Biomonitoring Commission of the German Environment Agency). Translation of the German version in Bundesgesundheitsbl, 63, 356–360 Available on line: https://www.umweltbundesa mt.de/sites/default/files/medien/4031/dokumente/hbm-ii_values_for_pfoa_and_pfos_0.pdf	For the evaluation of internal exposure to harmful substances, the Human Biomonitoring Commission of the German Environment Agency (HBM Commission) develops toxicologically justified assessment values (HBM-I and HBM-II values). The HBM-I value corresponds to the concentration of a substance in human biological material below which, according to the current status of assessment, no adverse health effects are to be expected. Consequently, no action is required if the HBM-I value is not exceeded [HBM Commission 1996]. In 2016, the HBM Commission developed HBM-I values of 2 ng PFOA/ml and 5 ng PFOS/ml in blood serum or plasma, respectively. A detailed delineation of supporting arguments was published in April 2018 [HBM Commission 2018]. In contrast to the HBM-I value, the HBM-II value corresponds to the concentration of a substance in human biological material which, when exceeded, may lead to health impairment which is considered as relevant to affected individuals [HBM Commission 1996, 2014].														1			B	D	HBM value	
435	バイオモニタリング	Hu, Xindi C; Dassuncao, Clifton; Zhang, Xianming; Grandjean, Philippe; Weihe, Pál; Webster, Glenys M; Nielsen, Flemming; Sunderland, Elsie M	Can profiles of poly- and Perfluoroalkyl substar	2018	Environ Health. 2018 Feb 1;17(1):11. doi: 10.1186/s12940-018-0355-4.	BACKGROUND: Humans are exposed to poly- and perfluoroalkyl substances (PFASs) from diverse sources and this has been associated with negative health impacts. Advances in analytical methods have enabled routine detection of more than 15 PFASs in human sera, allowing better profiling of PFAS exposures. The composition of PFASs in human sera reflects the complexity of exposure sources but source identification can be confounded by differences in toxicokinetics affecting uptake, distribution, and elimination. Common PFASs, such as perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS) and their precursors are ubiquitous in multiple exposure sources. However, their composition varies among sources, which may impact associated adverse health effects. METHODS: We use available PFAS concentrations from several demographic groups in a North Atlantic seafood consuming population (Faroe Islands) to explore whether chemical fingerprints in human sera provide insights into predominant exposure sources. We compare serum PFAS profiles from Faroese individuals to other North American populations to investigate commonalities in potential exposure sources. We compare individuals with similar demographic and physiological characteristics and samples from the same years to reduce confounding by toxicokinetic differences and changing environmental releases. RESULTS: Using principal components analysis (PCA) confirmed by hierarchical clustering, we assess variability in serum PFAS concentrations across three Faroese groups. The first principal component (PC)/cluster consists of C9-C12 perfluoroalkyl carboxylates(PFCAs) and is consistent with measured PFAS profiles in consumed seafood. The second PC/cluster includes perfluorohexanesulfonic acid (PFHxS) and the PFOS precursor N-ethyl perfluorooctane sulfonamidoacetate (N-EtFOSAA), which are directly used or metabolized from fluorochemicals in consumer products such as carpet and food packaging. We find that the same compounds are associated with the same exposure sources in two North American populations, suggesting generalizability of results from the Faroese population. CONCLUSIONS: We conclude that PFAS homologue profiles in serum provide valuable information on major exposure sources. It is essential to compare samples collected at similar time periods and to correct for demographic groups that are highly affected by differences in physiological processes (e.g., pregnancy). Information on PFAS homologue profiles is crucial for attributing adverse health effects to the proper mixtures or individual PFASs.			1											1			B	B	B-minor	フェロー諸島の血清PFAS濃度を決める環境要因を主成分分析で解析し、第1主成分は魚、第2主成分は生活環境
436	バイオモニタリング	Kannan, Kurunthachalam; Corsolini, Simonetta; Falandysz, Jerzy; Fillmann, Gilberto; Kumar, Kurunthachalam Senthil; Loganathan, Bommanna G; Mohd, Mustafa Ali; Olivero, Jesus; Van Wouwe, Nathalie; Yang, Jae Ho; Aldoust, Kenneth M	Perfluorooctanesulfonate and related fluoroche	2004	Environ Sci Technol. 2004 Sep 1;38(17):4489-95. doi: 10.1021/es0493446.	Perfluorooctanesulfonyl fluoride based compounds have been used in a wide variety of consumer products, such as carpets, upholstery, and textiles. These compounds degrade to perfluorooctanesulfonate (PFOS), a persistent metabolite that accumulates in tissues of humans and wildlife. Previous studies have reported the occurrence of PFOS, perfluorohexanesulfonate (PFHxS), perfluorooctanoate (PFOA), and perfluorooctanesulfonamide (PFOSA) in human sera collected from the United States. In this study, concentrations of PFOS, PFHxS, PFOA, and PFOSA were measured in 473 human blood/serum/plasma samples collected from the United States, Colombia, Brazil, Belgium, Italy, Poland, India, Malaysia, and Korea. Among the four perfluorochemicals measured, PFOS was the predominant compound found in blood. Concentrations of PFOS were the highest in the samples collected from the United States and Poland (>30 ng/mL); moderate in Korea, Belgium, Malaysia, Brazil, Italy, and Colombia (3 to 29 ng/mL); and lowest in India (<3 ng/mL). PFOA was the next most abundant perfluorochemical in blood samples, although the frequency of occurrence of this compound was relatively low. No age- or gender-related differences in the concentrations of PFOS and PFOA were found in serum samples. The degree of association between the concentrations of four perfluorochemicals varied, depending on the origin of the samples. These results suggested the existence of sources with varying levels and compositions of perfluorochemicals, and differences in exposure patterns to these chemicals, in various countries. In addition to the four target fluorochemicals measured,qualitative analysis of selected blood samples showed the presence of other perfluorochemicals such as perfluorodecanesulfonate (PFDS), perfluoroheptanoic acid (PFHpA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluorododecanoic acid (PFDoA), and perfluoroundecanoic acid (PFUnDA) in serum samples, at concentrations approximately 5- to 10-fold lower than the concentration of PFOS. Further studies should focus on identifying sources and pathways of human exposure to perfluorochemicals.			1											1			B	B	9か国のメジャーPFAS濃度を比較。それ以外については定性的な比較	
437	バイオモニタリング	Long, Manhai; Knudsen, Ane-Kersti Skaarup; Pedersen, Henning Sloth; Bonefeld-Jørgensen, Eva Cecilie	Food intake and serum persistent organic pollu	2015	Sci Total Environ. 2015 Oct 1;529:198-212. doi: 10.1016/j.scitotenv.2015.05.022. Epub 2015 May 23.	The Greenlandic Inuit have high blood concentrations of environmental persistent organic pollutants (POPs). High POP concentrations have been associated with age, smoking and consumption of marine mammals. Studies have indicated that exposure to POPs during pregnancy may adversely affect fetal and child development. To assess geographical differences in diet, lifestyle and environmental contaminant exposure among pregnant women in Greenland, blood samples and questionnaire data were collected from 207 pregnant women in five Greenlandic regions (North, Disco Bay, West, South and East). Blood samples were analyzed for 11 organochlorine pesticides (OCPs), 14 polychlorinated biphenyls (PCBs), 5 polybrominated diphenyl ethers (PBDEs), 15 perfluoroalkylated substances (PFASs) and 63 metals. A trend of higher intake of marine mammals in the East and North regions was reflected by a higher n-3/n-6 fatty acid ratio. Participants in the East region tended also to have higher intake of terrestrial species. A significant higher seabird intake was seen for pregnant women in the West region. Significant regional differences were found for blood concentrations of PCBs, OCPs, PFASs and mercury, with higher levels in the North and East regions. PFASs were significantly associated with PCBs and OCPs in most of the regions. In the North region, PFASs were associated with both selenium and mercury. No significant regional difference was observed for PBDEs. The regional differences of blood levels of POPs and mercury were related to differences in intake of the traditional food. Compared to earlier reports, decreased levels of legacy POPs, Hg and Pb and perfluorooctane sulfonateand perfluorooctanoic acid were observed, but the levels of PFAS congeners perfluorohexane sulfonate and perfluorononanoic acid were sustained. The detection of POPs and heavy metals in maternal blood indicates fetal exposure to these compounds possibly influencing fetal development.			1											1			B	B	グリーンランドのPOPs汚染を調べ、PFASについては4種類を測定	
438	バイオモニタリング	Mørck, Thit A; Nielsen, Flemming; Nielsen, Jeanette K S; Siersma, Volkert D; Grandjean, Philippe; Knudsen, Lisbeth E	PFAS concentrations in plasma samples from t	2015	Chemosphere. 2015 Jun;129:203-9. doi: 10.1016/j.chemosphere.2014.07.018. Epub 2014 Aug 18.	Perfluoroalkyl substances (PFASs) are accumulating in our environment and human exposure to these potentially harmful chemicals are of growing concern. In the present study, 116 children aged 6-11 and 143 mothers in two locations in Denmark donated blood samples as a supplement to their participation in the large European human biomonitoring project, DEMOCOPHES (Demonstration of a study to COordinate and Perform Human Biomonitoring on a European Scale). The blood samples were analyzed by LC-MS/MS for the concentration of six PFASs: PFOA, PFHxS, PFNA, PFDA, br-PFOS and n-PFOS. All measured compounds were above the detection limit in both mothers and children except for PFHxS in one child. There was a significant correlation between the levels in children and their mothers, indicating a family-related exposure pattern. However, we also found that the levels of PFOA, PFNA, PFDA, br-PFOS and total-PFOS were significantly higher in children compared to their mothers. This may be due to higher exposure in children through for example dust and soil, and due to the fact that children are smaller in body size and blood volume and hence have a lower storage capacity. Furthermore, we found an association between plasma levels and the age of the mothers and higher levels of plasma PFASs in mothers with low parity. There were no associations between PFAS concentrations and residential area, dietary habits of the participants or with respect to the birth order of the children. The levels are comparable to concentrations found in other Western countries.			1											1			B	B		デンマークの母子について7種類のPFASを測定
439	バイオモニタリング	Nøst, Therese Haugdahl; Vestergren, Robin; Berg, Vivian; Nieboer, Evert; Odland, Jon Øyvind; Sandanger, Torkjel Manning	Repeated measurements of per- and polyfluor	2014	Environ Int. 2014 Jun;67:43-53. doi: 10.1016/j.envint.2014.02.011. Epub 2014 Mar 20.	BACKGROUND: Longitudinal biomonitoring studies can provide unique information on how human concentrations change over time, but have so far not been conducted for per- and polyfluoroalkyl substances (PFASs) in a background exposed population. OBJECTIVES: The objectives of this study were to determine: i) serum PFAS time trends on an individual level; ii) relative compositions and correlations between different PFASs; and iii) assess selected PFAS concentrations with respect to periodic (calendar year), age and birth cohort (APC) effects. METHODS: Serum was sampled from the same 53 men in 1979, 1986, 1994, 2001 and 2007 in Northern Norway and analysed for 10 PFASs. APC effects were assessed by graphical and mixed effect analyses. RESULTS: The median concentrations of perfluorooctane sulphonic acid (PFOS) and perfluorooctanoic acid (PFOA) increased five-fold from 1979 to 2001 and decreased by 26% and 23%, respectively, from 2001 to 2007. The concentrations of PFOS and PFOA peaked during 1994-2001 and 2001, respectively, whereas perfluorohexane sulphonic acid (PFHxS) increased to 2001, but did not demonstrate a decrease between 2001 and 2007. Perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) displayed increasing trends throughout the entire study period (1979-2007). Although PFOS comprised dominating and stable proportions of PFAS burdens during these years, the contributions from PFOA and PFHxS were considerable. The evaluation of APC effects demonstrated that calendar year was the dominating influence on concentrations of PFOA, PFUnDA, and PFOS, although time-variant and weakerassociations with age/birth cohort were indicated. CONCLUSIONS: The concentration changes of 10 PFASs in the repeated measurements from 1979 to 2007 demonstrated divergent time trends between the different PFASs. The temporal trends of PFASs in human serum during these 30years reflect the overall trends in historic production and use, although global transport mechanisms and bioaccumulation potential of the different PFASs together with a varying extent of consumer exposure influenced the observed trends. Sampling year was the strongest descriptor of PFOA, PFUnDA and PFOS concentrations, and the calendar-year trends were apparent for all birth year quartiles. Discrepancies between the trends in this current longitudinal study and previous cross-sectional studies were observed and presumably reflect the different study designs and population characteristics.			1											1			B	B		ノルウェーの1979 to 2007年の男性の10種類のPFAS濃度の変遷
440	バイオモニタリング	Okada, Emiko; Kashino, Ikuko; Matsuura, Hideyuki; Sasaki, Seiko; Miyashita, Chihiro; Yamamoto, Jun; Ikeno, Tamiko; Ito, Yoichi M; Matsumura, Toru; Tamakoshi, Akiko; Kishi, Reiko	Temporal trends of perfluoroalkyl acids in plas	2013	Environ Int. 2013 Oct;60:89-96. doi: 10.1016/j.envint.2013.07.013. Epub 2013 Sep 6.	Perfluoroalkyl acids (PFAAs) are persistent organic pollutants that are used in a wide range of consumer products. Recent epidemiological studies have shown that prenatal exposure to toxic levels of PFAAs in the environment may adversely affect fetal growth and humoral immune response in infants and children. Here we have characterized levels of prenatal exposure to PFAA between 2003 and 2011 in Hokkaido, Japan, by measuring PFAA concentrations in plasma samples from pregnant women. The study population comprised 150 women who enrolled in a prospective birth cohort study conducted in Hokkaido. Eleven PFAAs were measured in maternal plasma samples using simultaneous analysis by ultra-performance liquid chromatography coupled to triple quadrupole tandem mass spectrometry. At the end of the study, in 2011, age- and parity-adjusted mean concentrations of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorododecanoic acid (PFDoDA), perfluorotridecanoic acid (PFTrDA), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS) were 1.35ng/mL, 1.26ng/mL, 0.66ng/mL, 1.29ng/mL, 0.25ng/mL, 0.33ng/mL, 0.28ng/mL, and 3.86ng/mL, respectively. Whereas PFOS and PFOA concentrations declined 8.4%/y and 3.1%/y, respectively, PFNA and PFDA levels increased 4.7%/y and 2.4%/y, respectively, between 2003 and 2011. PFUnDA, PFDoDA, and PFTrDA were detected in the vast majority of maternal samples, but no significant temporal trend was apparent. Future studies must involve a larger population of pregnant women and their children to determine theeffects of prenatal exposure to PFAA on health outcomes in infants and children.			1	1										1		1	B	A	北海道スタディでの2003-2011のPFAS濃度変化	
441	バイオモニタリング	Papadopoulou, Eleni; Sabaredzovic, Azemira; Namork, Ellen; Nygaard, Unni C; Granum, Berit; Haug, Line S	Exposure of Norwegian toddlers to perfluoroalk	2016	Environ Int. 2016 Sep;94:687-694. doi: 10.1016/j.envint.2016.07.006. Epub 2016 Jul 21.	High exposure to perfluoroalkyl substances (PFASs) has been associated with adverse health effects in children. PFASs exposure pathways of toddlers might differ from those of infants and adults, and the investigations on determinants of PFASs exposure in early childhood are scarce. Our aims were to examine the PFAS blood concentrations in Norwegian toddlers and to assess their relationship with maternal PFAS concentrations in pregnancy and breastfeeding duration. We determined PFAS concentrations in 112 plasma samples of 3-year-old children collected at 2010-2011 and 99 maternal serum samples collected around delivery at 2007-2008. PFAS concentrations in children were regressed on duration of breastfeeding, and the effect modification by maternal prenatal PFAS concentrations was examined in 55 mother-child pairs. Six PFASs were quantifiable in >50% of both maternal and children samples. Positive and significant correlations ranging between 0.50 and 0.66 were found between maternal and child concentrations of the same PFAS congeners. Nevertheless, toddlers had higher total PFAS blood concentrations than their mothers, due to higher concentrations of PFOA, PFNA and PFHxS. Every month of breastfeeding was associated with an increase of 3.3% (95% Confidence Intervals (CI): 0.8-5.8) for PFOS, 4.7% (95%CI: 2.8-6.6) for PFOA and 6.1% (95% CI: 2.6-9.7) for PFHpS in toddlers' plasma and a dose-response association was found, after adjustment for confounders. However, PFNA and PFUnDA concentrations in children were not associated with either maternal concentrations or breastfeeding duration. Our findings suggest thattransplacental transfer, prenatally, and breastfeeding, postanatally, are among the main determinants of PFOS, PFOA, PFHxS and PFHpS concentrations in toddlers, while that was not the case for PFNA and PFUnDA. Nevertheless, due to the small number of mother child-pairs in our study, our results should be interpreted with caution.			1											1			B	B		ノルウェーの幼児のPFAS濃度と母体血、母乳中PFAS濃度の比較

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
442	バイオモニタリング	Poothong, Somrutai; Papadopoulou, Eleni; Padilla-Sánchez, Juan Antonio; Thomsen, Cathrine; Haug, Line Små stuen	Multiple pathways of human exposure to poly-	2020	Environ Int. 2020 Jan;134:105244. doi: 10.1016/j.envint.2019.105244. Epub 2019 Nov 8.	Exposure to PFASs may result in adverse health effects. This study aimed to characterise the exposure to PFASs from diet, house dust, indoor air, and dermal contact and the relative contribution from different external exposure pathways to human serum concentrations. Daily intakes of 18 perfluoroalkyl acids (PFAAs) and 12 PFAA precursors from diet, dust ingestion, inhalation of indoor air and dermal absorption were estimated using a comprehensive dataset comprising 61 adults from the Oslo area, Norway. Concentrations of PFAAs and PFAA precursors in house dust, indoor air, hand wipes, foods and drinks were utilised to estimate the daily intakes. Perfluorooctanesulfonate (PFOS) was the predominant PFAS in serum for this study group. On a median level, perfluorooctanoate (PFOA) contributed most to the total estimated daily intake of PFAAs, with a median intake of 280 (range: 72-1810) pg-kg bw(-1)-day(-1), covering both direct and indirect (precursors) exposure. Out of this, only 3% (range: <1-48%) of the total PFOA intake came from indirect exposure. Dietary exposure from ingestion of food and drinks was in general the predominant exposure pathway, followed by exposure from ingestion of house dust, inhalation of indoor air, and dermal absorption, but considerable variations were observed among individuals. House dust ingestion and indoor air inhalation contributed most to the total intakes for some participants, for which most of them were among the 20% participants with the highest total estimated intakes. Some statistical significant associations between concentrations of PFASs measured in serum and estimated intakes wereobserved. Measured serum concentrations and modelled serum concentrations based on external exposure estimates were in the same order of magnitude for PFOS, PFHxS, PFOA, and PFNA, but only PFOA concentrations were comparable, 1.9 and 2.0 ng mL(-1) for observed and modelled serum concentrations, respectively. The estimated daily intakes of PFASs in this study were lower than the health-based guidance values, e.g. the tolerable weekly intakes derived by EFSA. This study underlines the importance of performing studies considering multiple exposure pathways on an individual basis.			1													1		1	B	A		30種類のPFASについて室内ダストなどの生活環境由来の寄与を調べた
443	バイオモニタリング	Rush, Elise L; Singer, Alison B; Longnecker, Matthew P; Haug, Line S; Sabaredzovic, Azemira; Symanski, Elaine; Whitworth, Kristina W	Oral contraceptive use as a determinant of pla	2018	Environ Int. 2018 Mar;112:156-164. doi: 10.1016/j.envint.2017.12.015. Epub 2017 Dec 20.	OBJECTIVE: Because oral contraceptives (OC) tends to lessen menstrual fluid loss - a route of excretion for perfluoroalkyl substances (PFASs) - we hypothesized that such use would be positively associated with PFAS concentrations. METHODS: This analysis was based on the Norwegian Mother and Child Cohort (MoBa) study. We included 1090 women from two previous substudies of women enrolled from 2003 to 2007. Characteristics of OC use were obtained at baseline: use in the past 12months, duration and recency of use, age at first use. We examined log-transformed plasma concentrations of seven PFASs (perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorohexane sulfonate (PFHxS), perfluoroheptane sulfonate (PFHpS), and perfluorooctane sulfonate (PFOS)). Linear regression analyses, adjusted for maternal age, menstrual cycle length, parity, and education, were used to examine whether OC use characteristics were determinants of PFAS concentrations. RESULTS: Except for PFDA and PFUnDA, women who used OCs in the 12months preceding the baseline interview had 12.9-35.7% higher PFAS concentrations than never OC users. To a lesser extent, past OC use was positively associated with PFASs (estimates ranged from 7.2-32.1%). Compared with never users, using OCs for 10 or more years was associated with increased PFAS concentrations, except for PFDA and PFUnDA (estimates for other PFASs ranged from 18.9-46.2%). We observed little effect of age at first OC use. CONCLUSIONS: This analysis shows that characteristics of OC use, and duration of use inparticular, may be important considerations when investigating relationships between women's reproductive outcomes and PFASs.			1													1			B	B	exposure source	ノルウェーの女性の経口避妊薬使用による７種類のPFAS濃度の上昇
444	バイオモニタリング	Sagiv, Sharon K; Rifas-Shiman, Sheryl L; Webster, Thomas F; Mora, Ana Maria; Harris, Maria H; Calafat, Antonia M; Ye, Xiaoyun; Gillman, Matthew W; Oken, Emily	Sociodemographic and Perinatal Predictors of	2015	Environ Sci Technol. 2015 Oct 6;49(19):11849-58. doi: 10.1021/acs.est.5b02489. Epub 2015 Sep 11.	Per- and polyfluoroalkyl substances (PFASs), used in food packaging and stain-resistant coatings, are suspected developmental toxicants that are ubiquitous and persistent in the environment. We measured plasma PFAS concentrations during early pregnancy (median = 9.7 weeks gestation) among 1645 women in the Boston-area Project Viva cohort, recruited during 1999-2002. We used multivariable linear regression to estimate associations of sociodemographic and perinatal predictors, including measures of pregnancy physiology (albumin, glomerular filtration rate (GFR)), with log-transformed plasma PFAS concentrations. Geometric mean concentrations for the four main PFASs, perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexanesulfonate (PFHxS) and perfluorononanoate (PFNA) were 25.4, 5.7, 2.5, and 0.6 ng/mL, respectively, comparable with general U.S. population concentrations during those years. Higher early pregnancy PFAS concentrations were associated with younger age (except PFNA), less educational attainment, nulliparity, no history of breastfeeding and higher prepregnancy body mass index in adjusted models. In addition, lower GFR was associated with 3-4% higher PFAS concentrations and higher albumin was associated with 4-6% higher PFAS concentrations. Our results show associations consistent (parity and breastfeeding) and less consistent (age and education) with previous studies. We also report associations with GFR and albumin, which were strongly related to PFAS concentrations and thus could confound estimates of PFAS-outcomeassociations in epidemiologic studies.			1													1			B	B	exposure source	VIVA cohortの妊婦の４種類のPFAS濃度と社会経済指標
445	バイオモニタリング	Salihovic S, Nilsson H, Hagberg J and Lindstrom G.	Trends in the analysis of persistent organic pol	2013	TrAC Trends in Analytical Chemistry, 46, 129–138. doi: 10.1016/j.trac.2012. 06.009	The general demands on analytical practices in laboratories involved in monitoring concentrations of persistent organic pollutants (POPs) in human blood in the context of the Stockholm Convention are met by the validated analytical procedures applied in most laboratories today. At the same time, as the concentrations of many of the legacy POPs are decreasing in the general populations, more specific, sensitive, and accurate analytical techniques are required. Thus, a challenge for the Stockholm Convention is the analytical capacity, in terms of quality and availability worldwide, to monitor declining concentrations of POPs in human blood. However, other POP issues (e.g., those targeted by epidemiological studies) might require different information and therefore more specialized analytical procedures having greater instrumental sensitivity. We review current and emerging analytical procedures used for analysis of the chlorinated, brominated, and fluorinated classes of POPs in human blood with a focus on the compounds included in the Stockholm Convention. In general, analytical trends in sample clean-up, separation, detection techniques and quality protocols provide a tool for POP laboratories to measure POPs in human blood. Techniques based on established mass-selective instruments are most commonly employed but declining concentrations in humans in the future might require more selective, more sensitive techniques.															1			C	D	Review	
446	バイオモニタリング	Salihović, Samira; Dickens, Alex M; Schoultz, Ida; Fart, Frida; Sinisalu, Lisanna; Lindeman, Tuomas; Halfvarson, Jonas; Orešič, Matej; Hyötyläinen, Tuulia	Simultaneous determination of perfluoroalkyl s	2020	Anal Bioanal Chem. 2020 Apr;412(10):2251-2259. doi: 10.1007/s00216-019-02263-6. Epub 2019 Nov 23.	There is evidence of a positive association between per- and polyfluoroalkyl substances (PFASs) and cholesterol levels in human plasma, which may be due to common reabsorption of PFASs and bile acids (BAs) in the gut. Here we report development and validation of a method that allows simultaneous, quantitative determination of PFASs and BAs in plasma, using 150 μL or 20 μL of sample. The method involves protein precipitation using 96-well plates. The instrumental analysis was performed with ultra-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS), using reverse-phase chromatography, with the ion source operated in negative electrospray mode. The mass spectrometry analysis was carried out using multiple reaction monitoring mode. The method proved to be sensitive, robust, and with sufficient linear range to allow reliable determination of both PFASs and BAs. The method detection limits were between 0.01 and 0.06 ng mL(-1) for PFASs and between 0.002 and 0.152 ng mL(-1) for BAs, with the exception of glycochenodeoxycholic acid (0.56 ng mL(-1)). The PFAS measured showed excellent agreement with certified plasma PFAS concentrations in NIST SRM 1957 reference serum. The method was tested on serum samples from 20 healthy individuals. In this proof-of-concept study, we identified significant associations between plasma PFAS and BA levels, which suggests that PFAS may alter the synthesis and/or uptake of BAs. Graphical Abstract.			1													1			B	B		ヒト血漿中のPFASと胆汁酸の高感度測定法の確立。コレステロール値が高くなる原因に近づける可能性
447	バイオモニタリング	Shaw, Susan D; Berger, Michelle L; Harris, Jennifer H; Yun, Se Hun; Wu, Qian; Liao, Chunyang; Blum, Arlene; Stefani, Anthony; Kannan, Kurunthachalam	Persistent organic pollutants including polychl	2013	Chemosphere. 2013 Jun;91(10):1386-94. doi: 10.1016/j.chemosphere.2012.12.070. Epub 2013 Feb 8.	Polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs and PBDD/Fs) were measured in serum of twelve firefighters sampled after a fire event in San Francisco, California, along with polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), p,p'-DDE, hexachlorobenzene (HCB), perfluorinated chemicals (PFCs), bisphenol-A (BPA) and tetrabromobisphenol-A (TBBPA). TEQPCDD/F concentrations were relatively low (mean 5pgg(-1) (lipid weight), lw, range 1-11pgg(-1)lw), but concentrations of 1,2,3,4,6,7,8-HpCDD, a congener indicative of exposure during firefighting, were elevated. Tentative WHO2005-TEQs calculated for PBDD/Fs in our samples (mean 104pgg(-1)lw, range 0.2-734pgg(-1)lw) suggested that PBDD/Fs may contribute substantially to dioxin-like toxicity in individual firefighters. PBDE concentrations were elevated in firefighter serum (mean 135ngg(-1)lw, range 48-442ngg(-1)lw). PBDE-209, PBDE-47 and PBDE-153 were prevalent congeners; PBDE-209 contributed >50% of the total PBDE concentration in four individuals, implying continuous occupational exposure to deca-BDE. Perfluorooctanesulfonate (PFOS) was the dominant PFC in serum (mean 12ngml(-1) (wet weight), ww, range 3ngml(-1)ww to 59ngml(-1)ww), followed by perfluorooctanoic acid (PFOA) (mean 7ngml(-1)ww, range 2ngml(-1)ww to 12ngml(-1)ww). Concentrations of perfluorononanoic acid (PFNA) (mean 2ngml(-1)ww, range 1-4ngml(-1)ww) were higher than those reported in the high-smoke exposure group of World Trade Center fire responders, suggesting that the California firefighters were exposed to PFNA in smoke during firefighting.Given their elevated rates of cancers, these results illustrate the importance of monitoring halogenated contaminants including PBDD/Fs in firefighters.			1													1			B	B		カルフォルニアの消防士の有機汚染物質濃度、および4種類のPFAS。火事場での煙とPFNAが関係？
448	バイオモニタリング	Sochorová, Lenka; Hanzlíková, Lenka; Černá, Milena; Drgáčová, Anna; Fialová, Alena; Švarcová, Andrea; Gramblička, Tomáš; Pulkrabová, Jana	Perfluorinated alkylated substances and bromi	2017	Int J Hyg Environ Health. 2017 Mar;220(2 Pt A):235-243. doi: 10.1016/j.ijheh.2016.09.003. Epub 2016 Sep 28.	Persistent organic pollutants, such as perfluorinated alkylated substances (PFASs) and brominated flame retardants (BFRs) are widespread in the environment and most of them are bioaccumulated in wildlife and humans. The present study is the first investigation to reveal the PFAS and BFR levels of serum samples in the adult population of the Czech Republic. Altogether, 300 serum samples from blood donors in four cities were examined. In all samples 19 PFASs and 33 BFRs, including some of their metabolites, were targeted. The analyses were performed using ultra high performance liquid chromatography coupled with tandem mass spectrometry or gas chromatography with mass spectrometry (according to the type of analyte). PFASs, with the carbon chain length C6 and higher, dominated in all samples. Perfluorooctanesulfonate (PFOS; median: 2.43ng/mL), perfluorooctanoic acid (PFOA; median: 0.756ng/mL), perfluorodecanoic acid (PFDA; median: 0.145ng/mL) and perfluorohexanesulfonate (PFHxS; median: 0.184ng/mL) were detected in 100% of samples. Perfluorononanoic acid (PFNA; median: 0.325ng/mL) and perfluoroundecanoic acid (PFUdA; median: 0.058ng/mL) in 99.7% and 96.0% of samples, respectively. We observed statistically significant associations ($p<0.05$) between selected PFAS concentrations and the locality, gender, age of donors and education level. None of the BFRs was detected above the LOQ in more than 9% of the samples. The most frequently detected representatives of this group were congeners of polybrominated diphenyl ethers, namely BDE-47 (in 8.7%; range: 0.496-5.44ng/g lipid weight (l.w.)), BDE-99 (in 6.0%; range:0.706-9.46ng/g l.w.), BDE-153 (in 7.3%; range: 0.736-6.44ng/g l.w.) and BDE-209 (in 7.0%; range: 13.7-2693ng/g l.w.).	1		1	1											1			B	B		チェコの人々の19種類のPFASを初めて測定
449	バイオモニタリング	Stubleski, Jordan; Salihovic, Samira; Lind, Lars; Lind, P Monica; van Bavel, Bert; Kärrman, Anna	Changes in serum levels of perfluoroalkyl subs	2016	Environ Int. 2016 Oct;95:86-92. doi: 10.1016/j.envint.2016.08.002. Epub 2016 Aug 16.	Poly- and perfluoroalkyl substances (PFASs) are a group of man-made fluorinated chemicals which have, at background levels, been associated with negative health effects in humans. Thus far, most human biomonitoring studies have evaluated the general change in PFAS concentration over time by continuously testing various individuals. This is one of the few studies to report the longitudinal trend of a range of PFAS concentrations in humans. In addition, this is the first known longitudinal study to include a large background level exposed cohort of both men and women with the same age and location who were repeatedly sampled from 2001 to 2014. The longitudinal change in concentration of eight PFASs detected in serum collected from the Prospective Investigation of the Vasculature in Uppsala Seniors (PIVUS) cohort were determined and compared to results from general population studies. The sex-dependent changes in PFAS concentrations over time were also assessed. Serum was sampled from the same individuals at ages 70 (collection period 2001-2004), 75 (2006-2009) and 80 (2011-2014,). Eight (C6-11) of fourteen (C4-13) analyzed PFASs were usually detected in over 75% of individuals and assessed using a random effects (mixed) model. In the 579 individuals attending all three examinations, PFOSA and PFOS concentrations significantly decreased, while the remaining six PFASs significantly increased between ages 70 and 75. However, between ages 75 and 80 all PFAS concentrations significantly decreased. Overall from age 70 to 80, concentrations of PFHxS, PFUnDA, PFNA, and PFDA showed a significant increase (7% to 34%), whereasconcentrations of PFOSA, PFHpA, PFOS, and PFOA (-75% to -27%) significantly decreased. Over time PFHxS concentrations increased more among women, while PFHpA concentrations showed a greater decrease among men. From age 70 to age 80, spanning from 2001-2004 to 2011-2014, the PIVUS cohort showed decreases in circulating levels of some PFASs phased out of production with the exception of PFHxS and C>8 PFASs. Contrary to other studies, PFHxS concentrations showed the greatest overall increase, which is likely attributed to a local drinking water contamination incident.			1													1			B	B		2001-2014年にかけてのウプサラの人々の8種類のPFAS濃度の経年変化

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
450	バイオモニタリング	Toms, L-M L; Thompson, J; Rotander, A; Hobson, P; Calafat, A M; Kato, K; Ye, X; Broomhall, S; Harden, F; Mueller, J F	Decline in perfluorooctane sulfonate and perflu	2014	Environ Int. 2014 Oct;71:74-80. doi: 10.1016/j.envint.2014.05.019. Epub 2014 Jun 27.	Some perfluoroalkyl and polyfluoroalkyl substances (PFASs) have become widespread pollutants detected in human and wildlife samples worldwide. The main objective of this study was to assess temporal trends of PFAS concentrations in human blood in Australia over the last decade (2002-2011), taking into consideration age and sex trends. Pooled human sera from 2002/03 (n=26); 2008/09 (n=24) and 2010/11 (n=24) from South East Queensland, Australia were obtained from de-identified surplus pathology samples and compared with samples collected previously from 2006/07 (n=84). A total of 9775 samples in 158 pools were available for an assessment of PFASs. Stratification criteria included sex and age: <16 years (2002/03 only); 0-4 (2006/07, 2008/09, 2010/11); 5-15 (2006/07, 2008/09, 2010/11); 16-30; 31-45; 46-60; and >60 years (all collection periods). Sera were analyzed using on-line solid-phase extraction coupled to high-performance liquid chromatography-isotope dilution-tandem mass spectrometry. Perfluorooctane sulfonate (PFOS) was detected in the highest concentrations ranging from 5.3-19.2 ng/ml (2008/09) to 4.4-17.4 ng/ml (2010/11). Perfluorooctanoate (PFOA) was detected in the next highest concentration ranging from 2.8-7.3 ng/ml (2008/09) to 3.1-6.5 ng/ml (2010/11). All other measured PFASs were detected at concentrations <1 ng/ml with the exception of perfluorohexane sulfonate which ranged from 1.2-5.7 ng/ml (08/09) and 1.4-5.4 ng/ml (10/11). The mean concentrations of both PFOS and PFOA in the 2010/11 period compared to 2002/03 were lower for all adult age groups by 56%. For 5-15 year olds, the decrease was66% (PFOS) and 63% (PFOA) from 2002/03 to 2010/11. For 0-4 year olds the decrease from 2006/07 (when data were first available for this age group) was 50% (PFOS) and 22% (PFOA). This study provides strong evidence for decreasing serum PFOS and PFOA concentrations in an Australian population from 2002 through 2011. Age trends were variable and concentrations were higher in males than in females. Global use has been in decline since around 2002 and hence primary exposure levels are expected to be decreasing. Further biomonitoring will allow assessment of PFAS exposures to confirm trends in exposure as primary and eventually secondary sources are depleted.			1															1			B	B		2002-2011年のオーストラリアのPFAS濃度の変化。結果ははぼPFOS, PFOA
451	バイオモニタリング	Vorkamp, Katrin; Nielsen, Flemming; Kyhl, Henriette Boye; Husby, Steffen; Nielsen, Lars Bo; Barington, Torben; Andersson, Anna-Maria; Jensen, Tina Kold	Polybrominated diphenyl ethers and perfluoroa	2014	Arch Environ Contam Toxicol. 2014 Jul;67(1):9-20. doi: 10.1007/s00244-013-9988-z. Epub 2014 Jan 17.	Polybrominated diphenyl ethers (PBDEs), a group of flame retardants, and perfluoroalkyl substances (PFASs) were analysed in serum samples of pregnant women from Denmark to provide information about their exposure and to study indications of common exposure pathways. The main BDE congener was the fully brominated BDE-209 with a median value of 7.5 ng/g lipid (46 pg/mL; 9.8 pmol/g lipid). Other BDE congeners decreased in the order BDE-47 > BDE-99 > BDE-153. The summed concentration of tri- to hepta-BDEs was 7.7 ng/g lipid, i.e. in the higher end of previously reported concentrations from Europe, including plasma samples of pregnant Danish women. Total lipid contents were relatively low, on average 5.9 g/L (9.0 mmol/L). The main PFAS compound was perfluorooctane sulfonate with a median concentration of 8.4 ng/mL. Other PFASs decreased in the order perfluorooctanoic acid > perfluorononanoic acid > perfluorodecanoic acid > perfluorohexane sulfonate and resulted in a ΣPFAS of 12 ng/mL. Within each group, compounds were highly intercorrelated with the exception of BDE-209, which was not correlated with any of the other compounds. No correlations were found either between PFASs and PBDEs suggesting different sources of exposure and/or pharmacokinetic and metabolisation processes. PBDE and PFAS concentrations were in the range associated with adverse effects in some epidemiological studies.			1															1			B	B		デンマークのPBDE、PFAS濃度
452	バイオモニタリング	Wang, Yuan; Shi, Yali; Vestergren, Robin; Zhou, Zhen; Liang, Yong; Cai, Yaqi	Using hair, nail and urine samples for human e	2018	Sci Total Environ. 2018 Sep 15;636:383-391. doi: 10.1016/j.scitotenv.2018.04.279. Epub 2018 Apr 27.	Non-invasive samples present ethical and practical benefits for investigating human exposure to hazardous contaminants, but analytical challenges and difficulties to interpret the results limit their application in biomonitoring. Here we investigated the potential for using hair, nail and urine samples as a measure of internal exposure to an array of legacy and emerging per- and polyfluoroalkyl substances (PFASs) in two populations with different exposure conditions. Paired urine-serum measurements of PFASs from a group of highly exposed fishery employees displayed strong correlations for PFASs with three to eight perfluorinated carbons ($\rho > 0.653$; $p < 0.01$). Consistent statistical correlations and transfer ratios in nails and hair from both populations demonstrated that these non-invasive samples can be used as a measure of internal exposure to perfluorooctane sulfonic acid and C8 chlorinated polyfluoroalkyl ether sulfonic acid (C8 Cl-PFESA). Contrastingly, the infrequent detections and/or lack of consistent transfer ratios for perfluorooctanoic acid, perfluorononanoic acid and short-chain PFASs in hair and nail samples indicate passive uptake from the external environment rather than uptake and internal distribution. Collectively, the study supports the use of urine samples as a valid measure of internal exposure for a range of short- and medium-chain PFASs, while the validity of nail and hair samples as a measure of internal exposure may vary for different PFASs and populations. The ubiquitous detection of C8 Cl-PFESA in all sample matrices from both populations indicates widespread exposure to this contaminant ofemerging concern in China.	1			1													1			B	B	B-minor	中国の毛髪、爪、尿中の多種類のPFAS濃度
453	バイオモニタリング	Wilhelm, Michael; Wittsiepe, Jürgen; Völkel, Wolfgang; Fromme, Hermann; Kasper-Sonnenberg, Monika	Perfluoroalkyl acids in children and their mothe	2015	Int J Hyg Environ Health. 2015 Oct;218(7):645-55. doi: 10.1016/j.ijheh.2015.07.001. Epub 2015 Jul 9.	BACKGROUND: Perfluoroalkyl acids (PFAAs) are widely distributed in the environment and humans are globally exposed with them. Contaminated drinking water can considerably contribute to the inner exposure levels. OBJECTIVES: We report the results of a human biomonitoring study with mother-child pairs living in two German cities, one city with PFAA contaminated drinking water in the sub μg/l-range (Bochum) and the other one without contamination (Duisburg). Furthermore, we studied time trends of exposure levels within the Duisburg cohort study. METHODS: We measured seven PFAAs (PFOS, PFOA, PFHxS, PFNA, PFBS, PFDeA, PFDoA) in blood samples by high performance liquid chromatography and tandem mass spectrometry. Samples were taken during pregnancy, from umbilical cord blood (2000-2002), 6-7 years (5th follow-up) and 8-10 years after birth (7th follow-up). The consumption of drinking water was recorded by a standardized questionnaire. Statistical analyses were calculated with multiple linear regression models. RESULTS: Children and mothers from Bochum showed higher PFOS and PFOA plasma concentrations than from Duisburg. The median concentrations (μg/l) for children were: PFOS 4.7 vs. 3.3; PFOA 6.0 vs. 3.6 μg/l ($p \leq 0.05$). Consumption of >0.7 l (children) and >0.9 l (mothers) drinking water/day was associated with 13-18% higher PFOS, PFOA and PFHxS concentrations in children ($p \leq 0.01$), and 22% higher PFOA in mothers ($p \leq 0.05$). Within the Duisburg cohort, PFAA levels in children peaked in the 5th follow-up study (medians (μg/l): cord plasma: 2.7 (PFOS); 1.9 (PFOA); 5th follow-up: 3.6 (PFOS); 4.6 (PFOA); 7thfollow-up: 3.3 (PFOS); 3.6 (PFOA)). PFOS concentrations in mothers declined from pregnancy to the 5th follow-up (medians: 8.7 vs. 4.0 μg/l). CONCLUSION: Residents exposed to PFOS and PFOA through drinking water showed significantly higher PFOS and PFOA concentrations in blood plasma. Although PFAA concentrations in the children slightly decreased from the 5th to the 7th follow-up, we detected increasing exposure trends with increasing age in the 7th follow-up.				1													1			1	B	A		ドイツの汚染があった地域と非汚染地域の母親、臍帯血、子供のPFAS濃度を追跡。水の濃度との関連がわかる重要論文
454	バイオモニタリング	Yeung, Leo W Y; Robinson, Shona J; Koschorreck, Jan; Mabury, Scott A	Part I. A temporal study of PFCAs and their pre	2013	Environ Sci Technol. 2013 Apr 16;47(8):3865-74. doi: 10.1021/es303716k. Epub 2013 Apr 2.	A total of 420 human plasma samples from two cities (Halle and Münster, Germany), collected between 1982 and 2009, were analyzed for a suite of PFCAs (C6-C12) and selected PFCA precursors (4:2-, 4:2/6:2-, 6:2-, 6:2/8:2-, 8:2-, 8:2/10:2-, and 10:2-diPAPs). PFCAs (C7-C11 and C13) were detected in over 80% of the samples (<0.005-39.4 ng/mL), while C12 PFCA was detected in fewer than 10% of the samples. In a range of 10-46% of the samples, 4:2-, 4:2/6:2-, 6:2, and 8:2-diPAPs were identified at concentrations of <0.0002-0.687 ng/mL; fewer than 10% of the samples had detectable 10:2-diPAP. Temporal trends (2000-2009) showed increasing concentrations of PFNA, PFDA, and PFUnDA, whereas PFOA concentrations were decreasing. Calculated population halving time for PFOA varied between 8.2-14.5 years, which contrasts to the generally accepted value of 3.8 years. This suggests an ongoing or additional exposure to PFOA or one of its precursor compounds. DiPAPs, known to metabolize rapidly to PFCAs, were detected in a significant number of samples and at concentrations that have not declined significantly over the past half-decade. The evidence suggests they have contributed to the continued presence of the longer chain PFCAs and perhaps contribute to the slow decline of PFOA.			1	1													1			1	B	A		ドイツのPFAS及び前駆体の経年変化。前駆体からPFCAが生じている可能性を示した重要論文
455	バイオモニタリング	Zhang, Yifeng; Jiang, Weiwei; Fang, Shuhong; Zhu, Lingyan; Deng, Jimin	Perfluoroalkyl acids and the isomers of perfluo	2014	Environ Int. 2014 Jul;68:185-91. doi: 10.1016/j.envint.2014.03.022. Epub 2014 Apr 16.	A total of 100 serum samples from 50 new couples (none of the females in this study has ever been pregnant) in Tianjin, North China, were analyzed for eleven perfluoroalkyl acids (PFAAs) with isomer-specific method. Among all samples, total perfluorooctanesulfonate (ΣPFOS, mean 11.3 ng/mL) was predominant followed by total perfluorooctanoate (ΣPFOA, 2.95 ng/mL), perfluorodecanoate (PFDA, 1.17 ng/mL), perfluorononanoate (PFNA, 0.93 ng/mL) and perfluorohexanesulfonate (PFHxS, 0.67 ng/mL). The mean concentrations of ΣPFOS and PFHxS in males (14.2 and 0.89 ng/mL) were significantly higher ($p=0.001$) than in females (8.36 and 0.45 ng/mL). No statistical difference between genders was observed for the other PFAAs. This suggests that menstruation is one important elimination pathway for ΣPFOS and PFHxS in females. Linear PFOA was the dominant isomer with mean proportion of 99.7%, suggesting that telomeric PFOA (and its precursors), which contains almost pure linear isomer, might be the dominant exposure source of PFOA in Tianjin. On average, the proportion of linear PFOS (n-PFOS) was 59.2% of ΣPFOS, which was lower than that in technical PFOS products (ca. 70% linear). Except perfluoroisopropyl PFOS, all the other monomethyl branched PFOS isomers were enriched in human serum compared to the commercial products, suggesting the monomethyl branched PFOS precursors were preferentially biotransformed in humans.				1													1			1	B	A		50ペア100人のPFAS測定し、前駆体との関係を議論。重要
456	ADME	Olsen, G. W.; Hansen, K. J.; Stevenson, L. A.; Burris, J. M.; Mandel, J. H.	Human donor liver and serum concentrations o	2003	Environ Sci Technol. 2003 Mar 1;37(5):888-91. doi: 10.1021/es020955c.	Perfluorooctanesulfonate (PFOS, CaF17SO3-) has been identified in the serum of nonoccupationally exposed humans and in serum and liver tissue in wildlife. The purpose of this investigation was to determine whether PFOS liver concentrations in humans are comparable to the approximate 30 ng/mL average serum concentrations reported in nonoccupationally exposed subjects. Thirty-one donors (16 male and 15 female, age range 5-74) provided serum and/or liver samples for analysis of PFOS and three other fluorochemicals: perfluorosulfonamide (PFOSA, C8F17SO2NH2), perfluorooctanoate (PFOA, C7F15CO2-), and perfluorohexanesulfonate (PFHxS, C6F13SO3-). Both sera and liver samples were extracted by ion-pair extraction and quantitatively assayed using high-performance liquid chromatography electrospray tandem mass spectrometry. Liver PFOS concentrations ranged from <;4.5 ng/g (limit of quantitation, LOQ)to 57 ng/g. Serum PFOS concentrations ranged from <;6.1 ng/mL (LOQ) to 58.3 ng/mL. Among the 23 paired samples, the mean liver to serum ratio was 1.3:1 (95% confidence interval 0.9:1-1.7:1). This liver to serum ratio is comparable to that reported in a toxicological study of cynomolgus monkeys, which had liver and serum concentrations 44595 orders of magnitude higher than observed in these human donors. This information may be useful in human risk characterization for PFOS. Liver to serum ratios were not estimated for PFOA, PFHxS,and PFOSA as 0.9 of the human donor liver samples were determined to be less than the LOQ.		1													1				B	B		肝臓と血清中の4種類のPFAS濃度を比較
457	ADME	Macmanus-Spencer, L. A.; Tse, M. L.; Hebert, P. C.; Bischel, H. N.; Luthy, R. G.	Binding of perfluorocarboxylates to serum albu	2010	Anal Chem. 2010 Feb 1;82(3):974-81. doi: 10.1021/ac902238u.	Perfluorochemicals are globally pervasive contaminants that are persistent, bioaccumulative, and toxic. Perfluorocarboxylic acids (PFCAs) with 8-13 carbons accumulate in the liver and blood of aquatic organisms; PFCA-protein interactions may explain this accumulation pattern. Here, the interactions between PFCAs with 8-11 carbons and serum albumin are examined using three experimental approaches: surface tension titrations, (19)F NMR spectroscopy, and fluorescence spectroscopy. Surface tension titrations indicate complex formation at high (mM) PFCA concentrations. Secondary association constants ranging from 10(2) to 10(4) M(-1) were determined from (19)F NMR titrations at high PFCA:albumin mole ratios. Fluorescence measurements indicate that PFCA-albumin interactions alter the protein conformation at low PFCA:albumin mole ratios (up to 5:1) and suggest two binding classes with association constants around 10(5) and 10(2) M(-1). While (19)F NMR and fluorescence provide both qualitative and quantitative information about PFCA-albumin interactions, surface tension provides only qualitative information. Limitations associated with instrumentation and methods require high PFCA concentrations in both surface tension and (19)F NMR experiments; in contrast, fluorescence allows for analysis of a wider range of PFCA concentrations and PFCA:albumin mole ratios. Results from this study indicate that fluorescence, though an indirect method, offers a more comprehensive picture of the nature of PFCA-albumin interactions.				1													1				B	C		
458	ADME	Abraham, Klaus; El-Khatib, Ahmed H; Schwerdtle, Tanja; Monien, Bernhard H	Perfluorobutanoic acid (PFBA): No high-level a	2021	Int J Hyg Environ Health. 2021 Aug;237:113830. doi: 10.1016/j.ijheh.2021.113830. Epub 2021 Aug 24.	Perfluorobutanoic acid (PFBA) belongs to the complex group of synthetic perfluoroalkyl substances (PFAS) which have led to ubiquitous environmental contamination. While some of the long-chain compounds accumulate in the human body, the short-chain compound PFBA was found to have a relatively short half-life in blood of a few days, in agreement with relatively low PFBA serum/plasma levels of roughly 0.01 ng/ml in European studies. Surprisingly, very high median levels of PFBA of 807 and 263 ng/g tissue for human lung and kidney autopsy samples, respectively, were reported in a paper of Pérez et al. (2013). This would question the concept of PFAS blood analysis reflecting the body burden of these compounds. To verify the results of high PFBA tissue accumulation in humans, we have analyzed PFBA in a set of 7 lung and 9 kidney samples from tumor patients with a different method of quantification, using high-resolution mass spectrometry with the accurate mass as analytical parameter. The only human sample with a quantifiable amount of PFBA (peak area more than twice above the analytical background signals) contained approximately 0.17 ng/g lung tissue. In the light of our results and considering the analytical problems with the short-chain compound PFBA exhibiting only one mass fragmentation, it appears to be likely that PFBA is not accumulating on a high level in human lung and kidney tissue. In general, the analysis of short-chain PFAS in complex matrices like food or tissue is very challenging with respect to instrumental quantification and possible sample contamination.	1						1												1		A	A	ヒトにおけるPFBAの肺、腎臓中蓄積濃度に関する知見	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
459	ADME	Burkemper, J. L.; Aweda, T. A.; Rosenberg, A. J.; Lunderberg, D. M.; Peaslee, G. F.; Lapi, S. E.	Radiosynthesis and biological distribution of F-	2017	Environ Sci Technol Lett. 4: 211-215. doi: 10.1021/acs.estlett.7b00042.	A novel method for radiolabeling perfluorinated alkyl substances (PFAS) with fluorine 18 has been developed, and after purification, the stability and biological distribution in healthy mice were evaluated. Three PFAS, [F-18]PFOA (C8), [F-18]PFHxA (C6), and [F-18]PFBA (C4), were readily labeled and isolated in average yields between 12 and 31%. The stability of each compound was monitored in 0.001 ammonium hydroxide (NH4OH) in methanol, in saline, and in human, mouse, and rat sera. The amount of intact, radiolabeled PFAS was determined by radiometric instant thin layer chromatography and was calculated by the amount of free fluorine 18 observed over time. All compounds were highly stable in 0.001 NH4OH in methanol and saline, with <10% defluorination observed after 4 h. Interestingly, each compound had differing affinities for the serum proteins. In vivo biodistribution studies in mice showed uptake in all organs examined, with the highest uptake being exhibited in the liver for both [F-18]PFOA and [F-18]PFHxA and the stomach for [F-18]PFBA. The results of this initial study suggest that this method could be valuable in helping to determine the biological uptake of any PFAS in mammals.	1	1				1	1												1	A	B	マウスにおけるPFBA、PFHxAの組織分布の違いに関する知見	
460	ADME	Cerrutti, Jorgelina A; Brandoni, Anabel; Quaglia, Nora B; Torres, Adriana M	Sex differences in p-aminohippuric acid transp	2002	Mol Cell Biochem. 2002 Apr;233(1-2):175-9. doi: 10.1023/a:1015563021602.	Sex differences in the kinetic parameters of p-aminohippuric acid (PAH) transport in brush border (BBMV) and basolateral (BLMV) membrane vesicles from kidney cortex have been observed. Membrane fluidity of BBMV was higher in females as compared with male rats as indicated by anisotropy values (0.1897 +/- 0.0010 vs. 0.2003 +/- 0.0014, p < 0.05, for females and males respectively). Membrane fluidity of BLMV were similar in both sexes. Western blot studies revealed that OAT1 protein in female BLMV was present at only 40% of level found in BLMV from male rats. The lower expression of OAT1 in BLMV in association with the higher BBMV fluidity (which may affect the affinity of PAH transporter in this membrane domain) observed in females may be responsible, at least in part, for the gender difference described in renal PAH secretion.	1					1														C	C		
461	ADME	Chang, Shu-Ching; Das, Kaberi; Ehresman, David J; Ellefson, Mark E; Gorman, Gregory S; Hart, Jill A; Noker, Patricia E; Tan, Yu-Mei; Lieder, Paul H; Lau, Christopher; Olsen, Geary W; Butenhoff, John L	Comparative pharmacokinetics of perfluorobut	2008	Toxicol Sci. 2008 Jul;104(1):40-53. doi: 10.1093/toxsci/kfn057. Epub 2008 Mar 18.	Perfluorobutyrate (PFBA) has been detected in precipitation, surface waters, water treatment effluent, and in public and private wells in Minnesota at up to low microg/l concentrations. We evaluated the pharmacokinetics of PFBA in rats, mice, monkeys, and humans to provide a rational basis for dose selection in toxicological studies and to aid in human-health-risk assessment. Studies included (1) rats--iv and oral; (2) mice--oral; (3) monkeys--iv; and (4) humans--occupationally exposed volunteers. PFBA was determined in serum (all species), liver (rats and mice), urine (rats, mice, and monkeys), and feces (rats and mice). In addition, we characterized serum PFBA concentrations in 177 individuals with potential exposure to PFBA through drinking water. Mean terminal serum PFBA elimination half-lives for males (M) and females (F), respectively, in h were (1) for rats given 30 mg/kg, 9.22 and 1.76 (oral), and 6.38 and 1.03 (iv); (2) for mice given oral doses of 10, 30, or 100 mg/kg ammonium PFBA, 13.34 and 2.87 at 10 mg/kg, 16.25 and 3.08 at 30 mg/kg; and 5.22 and 2.79 at 100 mg/kg; (3) for monkeys given 10 mg/kg iv, 40.32 and 41.04; and (4) for humans, 72.16 and 87.00 (74.63 combined). Volume of distribution estimates indicated primarily extracellular distribution. Among individuals with plausible exposure via drinking water, 96% of serum PFBA concentrations were < 2 ng/ml (maximum 6 ng/ml). These findings demonstrate that PFBA is eliminated efficiently from serum with a low potential for accumulation from repeated exposure.	1					1	1								1	1				1	A	A	ラット、マウス、サル、ヒトにおけるPFBAのPK評価	
462	ADME	Chen, Y. M.; Guo, L. H.	Fluorescence study on site-specific binding of	2009	Arch Toxicol. 83: 255-261. doi: 10.1007/s00204-0080359-x.	Binding of five perfluorooalkyl acids with human serum albumin (HSA) was investigated by site-specific fluorescence. Intrinsic fluorescence of tryptophan-214 in HSA was monitored upon addition of the chemicals. Although perfluorobutyl acid (PFBA) and perfluorobutane sulfonate (PFBS) did not cause fluorescence change, perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorododecanoic acid (PFDoA) induced fluorescence quenching, from which binding constant of 2.7 x 10(5) M(-1) for PFOA and 2.2 x 10(4) M(-1) for PFOS was calculated. Two fluorescent probes, dansylamide (DA) and dansyl-L: -proline (DP), were employed in fluorescence displacement measurements to study the interaction at two Sudlow's binding sites. At Site I, both PFBA and PFBS displaced DA with binding constants of 1 x 10(6) M(-1) and 2.2 x 10(6) M(-1). At Site II, PFBS and PFDoA displaced DP with binding constants of 6.5 x 10(6) M(-1) and 1.2 x 10(6) M(-1), whereas PFBA did not bind. The data were compared with fatty acids to evaluate the potential toxicological effect of these environmental chemicals.	1			1		1					1				1				1	B	A		
463	ADME	Gebbink, Wouter A; Berger, Urs; Cousins, Ian T	Estimating human exposure to PFOS isomers a	2015	Environ Int. 2015 Jan;74:160-9. doi: 10.1016/j.envint.2014.10.013. Epub 2014 Oct 28.	Contributions of direct and indirect (via precursors) pathways of human exposure to perfluorooctane sulfonic acid (PFOS) isomers and perfluoroalkyl carboxylic acids (PFCAs) are estimated using a Scenario-Based Risk Assessment (SceBRA) modelling approach. Monitoring data published since 2008 (including samples from 2007) are used. The estimated daily exposures (resulting from both direct and precursor intake) for the general adult population are highest for PFOS and perfluorooctanoic acid (PFOA), followed by perfluorohexanoic acid (PFHxA) and perfluorodecanoic acid (PFDA), while lower daily exposures are estimated for perfluorobutanoic acid (PFBA) and perfluorododecanoic acid (PFDoDA). The precursor contributions to the individual perfluoroalkyl acid (PFAA) daily exposures are estimated to be 11-33% for PFOS, 0.1-2.5% for PFBA, 3.7-34% for PFHxA, 13-64% for PFOA, 5.2-66% for PFDA, and 0.7-25% for PFDoDA (ranges represent estimated precursor contributions in a low- and high-exposure scenario). For PFOS, direct intake via diet is the major exposure pathway regardless of exposure scenario. For PFCAs, the dominant exposure pathway is dependent on perfluoroalkyl chain length and exposure scenario. Modelled PFOS and PFOA concentrations in human serum using the estimated intakes from an intermediate-exposure scenario are in agreement with measured concentrations in different populations. The isomer pattern of PFOS resulting from total intakes (direct and via precursors) is estimated to be enriched with linear PFOS (84%) relative to technical PFOS (70% linear). This finding appears to be contradictoryto the observed enrichment of branched PFOS isomers in recent human serum monitoring studies and suggests that either external exposure is not fully understood (e.g. there are unknown precursors, missing or poorly quantified exposure pathways) and/or that there is an incomplete understanding of the isomer-specific human pharmacokinetic processes of PFOS, its precursors and intermediates.	1			1		1													1	B	A		
464	PBPK	Gomis, Melissa I; Vestergren, Robin; Borg, Daniel; Cousins, Ian T	Comparing the toxic potency in vivo of long-ch	2018	Environ Int. 2018 Apr;113:1-9. doi: 10.1016/j.envint.2018.01.011. Epub 2018 Jan 28.	Since 2000, long-chain perfluoroalkyl acids (PFAAs) and their respective precursors have been replaced by numerous fluorinated alternatives. The main rationale for this industrial transition was that these alternatives were considered less bioaccumulative and toxic than their predecessors. In this study, we evaluated to what extent differences in toxicological effect thresholds for PFAAs and fluorinated alternatives, expressed as administered dose, were confounded by differences in their distribution and elimination kinetics. A dynamic one-compartment toxicokinetic (TK) model for male rats was constructed and evaluated using test data from toxicity studies for perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluorobutane sulfonic acid (PFBS), perfluorooctanoic acid (PFOA), perfluoroctanesulfonic acid (PFOS) and ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate (GenX). Dose-response curves of liver enlargement from sub-chronic oral toxicity studies in male rats were converted to internal dose in serum and in liver to examine the toxicity ranking of PFAAs and fluorinated alternatives. Converting administered doses into equivalent serum and liver concentrations reduced the variability in the dose-response curves for PFBA, PFHxA, PFOA and GenX. The toxicity ranking using modeled serum (GenX>PFOA>PFHxA>PFBA) and liver (GenX>PFOA ≈PFHxA ≈PFBA) concentrations indicated that some fluorinated alternatives have similar or higher toxic potency than their predecessors when correcting for differences in toxicokinetics. For PFOS and perfluorobutane sulfonic acid (PFBS) the conversionfrom administered dose to serum concentration equivalents did not change the toxicity ranking. In conclusion, hazard assessment based on internal exposure allows evaluation of toxic potency and bioaccumulation potential independent of kinetics and should be considered when comparing fluorinated alternatives with their predecessors.	1	1		1	1	1	1		1		1		1			1		1		1	A	A	雄ラットにおけるPFBA、PFHxA、PFBS、GenXのTKモデルの構築に関する知見	
465	ADME	Kato, Yukio; Kuge, Kiyoka; Kusuhara, Hiroyuki; Meier, Peter J; Sugiyama, Yuichi	Gender difference in the urinary excretion of o	2002	J Pharmacol Exp Ther. 2002 Aug;302(2):483-9. doi: 10.1124/jpet.102.033878.	This study was aimed at clarifying the gender differences in the urinary excretion of organic anions and the gene expression of organic anion transporters in rats. The renal clearance with regard to the plasma concentration (CL(urine,p)) of taurocholate, dibromosulfophthalein (DBSP), and zenarestat, all substrates and/or inhibitors of organic anion transporting polypeptide 1 (Oatp1), was much higher in female than in male rats. The following results imply that the transport system(s) for the reabsorption of zenarestat across the luminal side exhibits a gender difference: 1) the renal uptake clearance assessed by an in vivo integration plot analysis of zenarestat from the blood side does not show any clear gender differences; 2) the renal clearance with regard to the kidney concentration (CL(urine,k)) of zenarestat in female rats was approximately 30 times higher than in male rats; and 3) both CL(urine,p) and CL(urine,k) were increased in male rats by the coinfusion of DBSP, which is an inhibitor of organic anion transporters. Northern and Western blot analyses confirmed a previous finding that the gene expression of Oatp1, which is localized at the apical plasma membrane of the kidney, was much higher in the kidneys of male rats. Overall, a gender difference in urinary excretion is commonly observed for several organic anions, including Oatp1 substrates and inhibitors, and Oatp1 and/or transporters that have a similar substrate specificity to Oatp1 could be involved in such a phenomenon involving its substrates.	1					1														C	C		
466	ADME	Li, J.; Cai, D.; Chu, C.; Li, Q. Q.; Zhou, Y.; Hu, L. W.; Yang, B. Y.; Dong, G. H.; Zeng, X. W.; Chen, D.	Transplacental Transfer of Per- and Polyfluoro	2020	Environ Sci Technol 54: 5062-5070. doi: 10.1021/acs.est.0c00829.	Previous studies demonstrated that per- and polyfluoroalkyl substances (PFASs) can cross the human placental barrier. However, their transplacental transfer efficiencies (TTEs) have not been investigated in preterm delivery, and the role of placental transport proteins has rarely been explored. Our study hypothesized that the TTEs of PFASs could differ between preterm and full-term deliveries, and some placental transporters could be involved in active maternofetal PFAS transfer. In the present study, the median TTEs of 16 individual PFAS chemicals or isomers were determined to be 0.23 to 1.72 in matched maternal-cord serum pairs with preterm delivery (N = 86), which were significantly lower than those (0.35 to 2.26) determined in full-term delivery (N = 187). Significant associations were determined between the TTEs of several PFASs and the mRNA expression levels of selected transporters located on the brush border membrane. The association patterns also significantly differed between preterm and full-term deliveries and exhibited a chemical-specific manner. For example, the expression of MRP2 exhibited significantly positive associations with the TTEs of linear and branched perfluorooctanesulfonic acid (PFOS) isomers in full-term delivery, but negative, nonsignificant associations were observed in preterm delivery. This is the first study to compare the transplacental transfer of PFASs betweenpreterm and full-term deliveries and indicate that some placental transport proteins could be involved in active transmission. The mechanisms underlying the cross-placental transfer of PFASs require further investigations to better elucidate their risks to fetal health and birth outcomes.	1					1									1					B	B		
467	ADME	Ljubojević, Marija; Balen, Daniela; Breljak, Davorka; Kusan, Marija; Anzai, Naohiko; Bahn, Andrew; Burckhardt, Gerhard; Sabolić, Ivan	Renal expression of organic anion transporter (	2007	Am J Physiol Renal Physiol. 2007 Jan;292(1):F361-72. doi: 10.1152/ajprenal.00207.2006. Epub 2006 Aug 1.	The renal reabsorption and/or excretion of various organic anions is mediated by specific organic anion transporters (OATs). OAT2 (Slc22a7) has been identified in rat kidney, where its mRNA expression exhibits gender differences [females (F) > males (M)]. The exact localization of OAT2 protein in the mammalian kidney has not been reported. Here we studied the expression of OAT2 mRNA by RT-PCR and its protein by Western blotting (WB) and immunocytochemistry (IC) in kidneys of adult intact and gonadectomized M and F, sex hormone-treated castrated M, and prepubertal M and F rats, and the protein in adult M and F mice. In adult rats, the expression of OAT2 mRNA was predominant in the outer stripe (OS) tissue, exhibiting 1) gender dependency (F > M), 2) upregulation by castration and downregulation by ovariectomy, and 3) strong downregulation by testosterone and weak upregulation by estradiol and progesterone treatment. A polyclonal antibody against rat OAT2 on WB of isolated renal membranes labeled a approximately 66-kDa protein band that was stronger in F. By IC, the antibody exclusively stained brush border (BB) of the proximal tubule S3 segment (S3) in the OS and medullary rays (F > M). In variously treated rats, the pattern of 66-kDa band density in the OS membranes and the staining intensity of BB in S3 matched the mRNA expression. The expression of OAT2 protein in prepubertal rats was low and gender independent. In mice, the expression pattern largely resembled that in rats. Therefore, OAT2 in rat (and mouse) kidney is localized to the BB of S3, exhibiting gender differences (F > M) that appear in puberty and are caused bystrong androgen inhibition and weak estrogen and progesterone stimulation.	1					1														C	C		
468	ADME	Ljubojevic, Marija; Herak-Kramberger, Carol M; Hagos, Yohannes; Bahn, Andrew; Endou, Hitoshi; Burckhardt, Gerhard; Sabolic, Ivan	Rat renal cortical OAT1 and OAT3 exhibit gend	2004	Am J Physiol Renal Physiol. 2004 Jul;287(1):F124-38. doi: 10.1152/ajprenal.00029.2004. Epub 2004 Mar 9.	In rats, the secretion of p-aminohippurate (PAH) by the kidney is higher in males (M) than in females (F). The role of the major renal PAH transporters, OAT1 and OAT3, in the generation of these gender differences, as well as the responsible hormones and mechanisms, has not been clarified. Here we used various immunocytochemical methods to study effects of gender, gonadectomy, and treatment with sex hormones on localization and abundance of OAT1 and OAT3 along the rat nephron. Both transporters were localized to the basolateral membrane: OAT1 was strong in proximal tubule S2 and weak in the S3 segments, whereas OAT3 was stained in proximal tubule S1 and S2 segments, thick ascending limb, distal tubule, and in principal cells along the collecting duct. Gender differences in the expression of both transporters in adult rats (M > F) were observed only in the cortical tubules. OAT1 in the cortex was strongly reduced by castration in adult M, whereas the treatment of castrated M with testosterone, estradiol, or progesterone resulted in its complete restitution, further depression, or partial restitution, respectively. In adult F, ovariectomy weakly increased, whereas estradiol treatment of ovariectomized F strongly decreased, the expression of OAT1. The expression of OAT3 in the M and F cortex largely followed a similar pattern, except that ovariectomy and progesterone treatment showed no effect, whereas in other tissue zones gender differences were not observed. In prepubertal rats, the expression of OAT1 and OAT3 in the kidney cortex was low and showed no gender differences. Our data indicate that gender differences inthe rat renal cortical OAT1 and OAT3 (M > F) appear after puberty and are determined by both a stimulatory effect of androgens (and progesterone in the case of OAT1) and an inhibitory effect of estrogens.	1					1										1				C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
469	PBPK	Loccisano, Anne E; Campbell, Jerry L Jr; Andersen, Melvin E; Clewell, Harvey J 3rd	Evaluation and prediction of pharmacokinetics	2011	Regul Toxicol Pharmacol. 2011 Feb;59(1):157-75. doi: 10.1016/j.yrtph.2010.12.004.	Perfluoroalkyl acid carboxylates and sulfonates (PFAAs) have many consumer and industrial applications. The persistence and widespread distribution of these compounds in humans have brought them under intense scrutiny. Limited pharmacokinetic data is available in humans; however, human data exists for two communities with drinking water contaminated by PFAAs. Also, there is toxicological and pharmacokinetic data for monkeys, which can be quite useful for cross-species extrapolation to humans. The goal of this research was to develop a physiologically-based pharmacokinetic (PBPK) model for PFOA and PFOS for monkeys and then scale this model to humans in order to describe available human drinking water data. The monkey model simulations were consistent with available PK data for monkeys. The monkey model was then extrapolated to the human and then used to successfully simulate the data collected from residents of two communities exposed to PFOA in drinking water. Human PFOS data is minimal; however, using the half-life estimated from occupational exposure, our model exhibits reasonable agreement with the available human serum PFOS data. It is envisioned that our PBPK model will be useful in supporting human health risk assessments for PFOA and PFOS by aiding in understanding of human pharmacokinetics.	1					1									1		1				D	C	PFOA、PFOSのサルのデータを用いたPBPKモデルの開発に関する知見（PFBAに関する知見は不明）	
470	ADME	Matsuzaki, Hiroshi; Katsumata, Shin-ichi; Masuyama, Ritsuko; Uehara, Mariko; Nakamura, Kahoru; Suzuki, Kazuharu	Sex differences in kidney mineral concentratio	2002	Biosci Biotechnol Biochem. 2002 Aug;66(8):1737-9. doi: 10.1271/bbb.66.1737.	We examined sex differences in kidney mineral concentrations and urinary albumin excretion in rats given feed containing various phosphorus (P) levels. With feed that was 0.6%, 0.9%, 1.2%, and 1.5% P, kidney calcium and P concentrations were higher in female rats than in male rats. With 1.2% or 1.5% P, urinary albumin excretion was higher in the female rats. The sex of the animal affected the kidney mineral concentrations and urinary albumin excretion in rats with a high P intake.	1					1														C	C		
471	ADME	Russell, Mark H; Himmelstein, Matthew W; Buck, Robert C	Inhalation and oral toxicokinetics of 6:2 FTOH	2015	Chemosphere. 2015 Feb;120:328-35. doi: 10.1016/j.chemosphere.2014.07.092. Epub 2014 Aug 31.	The toxicokinetics of 6:2 fluorotelomer alcohol (6:2 FTOH) and its terminal perfluorinated and polyfluorinated metabolites (PFBA, PFHxA, PFHpA and 5:3 Acid) have been calculated from laboratory studies of rats and from a biomonitoring study of humans. In vitro studies with mouse, rat and human hepatocytes indicate qualitatively similar metabolic pathways of 6:2 FTOH. In a one-day inhalation study of 6:2 FTOH in rats, PFBA, PFHxA, PFHpA and 5:3 Acid were determined to be the major metabolites in plasma with calculated elimination half-lives of 1.3-15.4h and metabolic yields up to 2.7 mol%. In five-day and 23-day inhalation studies and a 90-day oral study of 6:2 FTOH, the plasma or serum concentration profile of 5:3 Acid was several-fold higher than concentrations observed in the single day study, resulting in an estimated elimination half-life of 20-30 d. In contrast, the concentrations of PFBA, PFHxA and PFHpA showed little or no concentration increase with repeated exposure. Elimination half-lives of PFHxA, PFHpA and 5:3 Acid in humans were estimated from a study of professional ski wax technicians who were occupationally exposed to aerosolized and volatilized components of fluorinated glide wax. The resulting human elimination half-life values of PFHxA, PFHpA and 5:3 Acid were 32, 70 and 43 d, respectively. Based on a one compartment toxicokinetic model, current environmental air concentrations of 6:2 FTOH are estimated to result in plasma concentrations of PFHxA, PFHpA and 5:3 Acid that are less than or equal to typical LOQ values, in agreement with extant biomonitoring results.	1	1				1	1							1					1	A	B	ラットにおけるPFBA、PFHxAの消失半減期、ヒトにおける推定半減期に関する知見	
472	ADME	Weaver, Y. M.; Ehresman, D. J.; Butenhoff, J. L.; Hagenbuch, B.	Roles of rat renal organic anion transporters in	2010	Toxicol Sci 113: 305-314. doi: 10.1093/toxsci/kfp275.	Perfluorinated carboxylates (PFCAs) are generally stable to metabolic and environmental degradation and have been found at low concentrations in environmental and biological samples. Renal clearance of PFCAs depends on chain length, species, and, in some cases, gender within species. While perfluoroheptanoate (C7) is almost completely eliminated renally in both male and female rats, renal clearance of perfluorooctanoate (C8) and perfluorononanoate (C9) is much higher in female rats. Perfluorodecanoate (C10) mainly accumulates in the liver for both genders. Therefore, we tested whether PFCAs with different chain lengths are substrates of rat renal transporters with gender-specific expression patterns. Inhibition of uptake of model substrates was measured for the basolateral organic anion transporter (Oat)1 and Oat3 and the apical Oat2, organic anion transporting polypeptide (Oatp)1a1, and Urat1 with 10microM PFCAs with chain lengths from 2 to 18 (C2-C18) carbons. Perfluorohexanoate (C6), C7, and C8 inhibited Oat1-mediated p-aminohippurate transport, with C7 being the strongest inhibitor. C8 and C9 were the strongest inhibitors for Oat3-mediated estrone-3-sulfate transport, while Oatp1a1-mediated estradiol-17beta-glucuronide uptake was inhibited by C9, C10, and perfluoroundecanoate (C11), with C10 giving the strongest inhibition. No strong inhibitors were found for Oat2 or Urat1. Kinetic analysis was performed for the strongest inhibitors. Oat1 transported C7and C8 with K(m) values of 50.5 and 43.2microM, respectively. Oat3 transported C8 and C9 with K(m) values of 65.7 and 174.5microM, respectively. Oatp1a1-mediated transport yielded K(m) values of 126.4 (C8), 20.5 (C9), and 28.5microM (C10). These results suggest that Oat1 and Oat3 are involved in renal secretion of C7-C9, while Oatp1a1 can contribute to the reabsorption of C8 through C10, with highest affinities for C9 and C10.	1					1	1	1				1			1				1	B	B		
473	ADME	Yang, C. H.; Glover, K. P.; Han, X.	Organic anion transporting polypeptide (Oatp)	2009	Toxicol Lett 190: 163-171. doi: 10.1016/j.toxlet.2009.07.011	Organic anion transporting polypeptide (Oatp) 1a1 has been hypothesized to play a key role in rat renal reabsorption of perfluorooctanoate (PFO). We have investigated PFO uptake kinetics in Chinese Hamster Ovary (CHO) cells that have been stably transfected with the cDNA encoding Oatp1a1. The Oatp1a1-expressing CHO cells have been validated by their Oatp1a1 gene expression, estrone-3-sulfate (E3S) uptake kinetics, and the correlation between Oatp1a1 gene expression and E3S uptake activity that were both induced by the treatment of sodium butyrate. Oatp1a1-mediated PFO uptake underwent a saturable process with a K(m) value of 162.2+/-20.2microM, which was effectively inhibited by known Oatp1a1 substrates sulfobromophthalein and taurocholate, and a major flavonoid in grapefruit juice, naringin. The inhibition of Oatp1a1-mediated E3S uptake has been compared for linear perfluorocarboxylates with carbon chain lengths ranged from 4 to 12 There was no apparent inhibition by perfluorobutanoate and perfluoropentanoate at 1mM. Inhibition was observed for perfluorohexanoate at 1mM and the level of inhibition increased as the increase of the chain length up to perfluorodecanoate. The values of apparent inhibition constant (K(i,app)) were determined for perfluorocarboxylates with chain lengths between 6 and 10 The log values of K(i,app) exhibited a negative linear relationship to the chain lengths anda positive linear relationship to the log values of the total clearance of perfluorocarboxylates in male rats. This in vitro-to-in vivo correlation strongly supports a tubular reabsorptive role of Oatp1a1 in rat renal elimination of perfluorocarboxylates. Due to the sex-dependent expression of Oatp1a1 in rat kidney, Oatp1a1-mediated tubular reabsorption is suggested to be the mechanism for the sex-dependent renal elimination of PFO in rats.	1					1	1													B	B		
474	ADME	Benskin, J. P.; De Silva, A. O.; Martin, L. J.; Arsenault, G.; Mccrindle, R.; Riddell, N.; Mabury, S. A.; Martin, J. W.	Disposition of perfluorinated acid isomers in Sa	2009	Environ Toxicol Chem. 28: 542-554. doi: org/10.1897/08-239.1	Perfluorinated acids (PFAs) and their precursors (PFA-precursors) exist in the environment as linear and multiple branched isomers. These isomers are hypothesized to have different biological properties, but no isomer-specific data are currently available. The present study is the first in a two-part project examining PFA isomer-specific uptake, tissue distribution, and elimination in a rodent model. Seven male Sprague-Dawley rats were administered a single gavage dose of approximately 500 microg/kg body weight perfluorooctane sulfonate (C(8)F(17)SO(3)(-), PFOS), perfluorooctanoic acid (C(7)F(15)CO(2)H, PFOA), and perfluorononanoic acid (C(8)F(17)CO(2)H, PFNA) and 30 microg/kg body weight perfluorohexane sulfonate (C(6)F(13)SO(3)(-), PFHxS). Over the subsequent 38 d, urine, feces, and tail-vein blood samples were collected intermittently, while larger blood volumes and tissues were collected on days 3 and 38 for isomer analysis by high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS). For all PFAs, branched isomers generally had lower blood depuration half-lives than the corresponding linear isomer. The most remarkable exception was for the PFOS isomer containing an alpha-perfluoromethyl branch (1m-PFOS), which was threefold more persistent than linear PFOS, possibly due to steric shielding of the hydrophilic sulfonate moiety. For perfluoromonomethyl-branched isomers of PFOS, a structure-property relationship was observed whereby branching toward the sulfonate end of the perfluoroalkyl chain resulted inincreased half-lives. For PFHxS, PFOA, and PFOS, preferential elimination of branched isomers occurred primarily via urine, whereas for PFNA preferential elimination of the isopropyl isomer occurred via both urine and feces. Changes in the blood isomer profiles over time and their inverse correlation to isomer elimination patterns in urine, feces, or both provided unequivocal evidence of significant isomer-specific biological handling. Source assignment based on PFA isomer profiles in biota must therefore be conducted with caution, because isomer profiles are unlikely to be conserved in biological samples.			1			1				1				1	1			1		1	A	B	ラットにおけるPFNAの組織分布、排泄に関する知見	
475	ADME	Bischel, Heather N; Macmanus-Spencer, Laura A; Zhang, Chaojie; Luthy, Richard G	Strong associations of short-chain perfluoroalk	2011	Environ Toxicol Chem. 2011 Nov;30(11):2423-30. doi: 10.1002/etc.647. Epub 2011 Sep 14.	Interactions of perfluoroalkyl acids (PFAAs) with tissue and serum proteins likely contribute to their tissue distribution and bioaccumulation patterns. Protein-water distribution coefficients (K(PW)) based on ligand associations with bovine serum albumin (BSA) as a model protein were recently proposed as biologically relevant parameters to describe the environmental behavior of PFAAs, yet empirical data on such protein binding behavior are limited. In the present study, associations of perfluoroalkyl carboxylates (PFCAs) with two to 12 carbons (C_4-C_{12}) and perfluoroalkyl sulfonates with four to eight carbons (C_4, C_6, and C_8) with BSA are evaluated at low PFAA:albumin mole ratios and various solution conditions using equilibrium dialysis, nanoelectrospray ionization mass spectrometry, and fluorescence spectroscopy. Log K(PW) values for C_4 to C_{12} PFAAs range from 3.3 to 4.3. Affinity for BSA increases with PFAA hydrophobicity but decreases from the C_8 to C_{12} PFCAs, likely due to steric hindrances associated with longer and more rigid perfluoroalkyl chains. The C_4-sulfonate exhibits increased affinity relative to the equivalent chain-length PFCA. Fluorescence titrations support evidence that an observed dependence of PFAA-BSA binding on pH is attributable to conformational changes in the protein. Association constants determined for perfluorobutanesulfonate and perfluoropentanoate with BSA are on the order of those for long-chain PFAAs (K(a) ~10^6/M), suggesting that physiological implications of strong binding to albumin may be important for short-chain PFAAs.	1					1			1	1				1	1					B	B		
476	ADME	Buck, R.; Gannon, S.	Perfluorohexanoic acid pharmacokinetics in ma	2017	In Abstracts of Papers of the 253rd National meeting of the American Chemical Society. Washington, DC: American Chemical Society.	Perfluorohexanoic acid (PFHxA) is a perfluorocarboxylic acid (PFCA) that has been widely identified in the aqueous environment. In order to conduct a human health risk characterization, it is necessary to understand both its toxicology and phamacokinetics in mammals. The elimination kinetics of PFHxA have been determined from published data for multiple mammalian species: mouse, rat, microminipig, pig, monkey and human. For each species, the data was compiled and modeled to identify the kinetic profile of elimination from blood including calculation of elimination rate (hr-1) and elimination half-life (hr). The study shows that PFHxA elimination kinetics in mammals is consistent with a rapid initial (alpha) phase followed by a slower terminal (beta) phase. Further, the PFHxA alpha phase elimination has a first-order half-life range of 44928 hours in mouse, rat, microminipig, pig, monkey and human. The alpha phase elimination in mammals accounts for over 0.997 of the total PFHxA elimination in mammals. PFHx- elimination is extensive in the rapid alpha phase and there are no significant pharmacokinetic differences across mammals: mice, rats, monkeys, pigs and humans. The overall conclusion of this kinetic assessment is that PFHxA does not appear to exhibit significantly different elimination kinetics across a wide range of mammalianspecies. The results suggest that for human health risk assessment, the interspecies pharmacokinetics adjustment factor applied to a hazard assessment benchmark should be small. Details of the assessment for each species will be presented.	1					1													入手不可	A	A	マウス、ラット、マイクロミニブタ、ブタ、サルおよびヒトにおけるPFHxAの体内動態(半減期)に関する知見	
477	ADME	Chengelis, Christopher P; Kirkpatrick, Jeannie B; Myers, Nichole R; Shinohara, Motoki; Stetson, Philip L; Sved, Daniel W	Comparison of the toxicokinetic behavior of pe	2009	Reprod Toxicol. 2009 Jun;27(3-4):400-406. doi: 10.1016/j.reprotox.2009.01.013. Epub 2009 Feb 11.	The toxicokinetics of perfluorohexanoic acid (PFHxA) and nonafluoro-1-butanesulfonic acid (PFBS) were evaluated in Sprague-Dawley rats and cynomolgus monkeys. Systemic exposure to PFHxA was lower than for PFBS following single equivalent intravenous or oral (rat only) doses. Serum clearance was more rapid for PFHxA than for PFBS. In rats, exposure to PFHxA and PFBS was up to 8-fold (intravenous) and 4-fold (oral) higher for males than females and serum clearance of PFHxA and PFBS was more rapid in females than males; however, there was no appreciable difference in the extent or rate of urinary elimination between compounds or genders. There were no apparent differences between genders in the serum half-life for PFHxA following 26 days of repeated oral dosing in rats; exposure decreased upon repeated dosing.	1		1			1	1		1	1				1					1	A	A	ラット、カニクイザルにおけるPFBS、PFHxAの血清クリアランス、半減期に関する知見	
478	ADME	D'eon, Jessica C; Simpson, André J; Kumar, Rajeev; Baer, Andrew J; Mabury, Scott A	Determining the molecular interactions of perfl	2010	Environ Toxicol Chem. 2010 Aug;29(8):1678-88. doi: 10.1002/etc.204.	Perfluorooctanoate (PFOA) is ubiquitous in North American human sera and has a serum half-life of 3.5 years in humans. The molecular interactions that lead to the bioaccumulation of these hydrophobic and lipophobic molecules in human blood are not well understood. Perfluorohexanoic acid (PFHxA) and PFOA were used as model perfluorinated carboxylic acids (PFCAs) to characterize the major site of PFCA interaction in human sera. Using novel heteronuclear saturation transfer difference nuclear magnetic resonance spectroscopy experiments, human serum albumin (HSA) was identified as the major site of interaction for both PFHxA and PFOA in human sera. Heteronuclear single quantum coherence nuclear magnetic resonance experiments were then performed to interrogate site-specific interactions of PFHxA and PFOA with isolated HSA. Perfluorohexanoic acid was found to bind specifically to Sudlow's drug-binding site II, whereas PFOA interacted preferentially with Sudlow's drug-binding site I at the lower concentration, with additional interactions developing at the higher concentration. These experiments highlight the utility of nuclear magnetic resonance spectrometry as a tool to observe the in situ interactions of chemical contaminants with biological systems. Both PFCAs displaced the endogenous HSA ligand oleic acid at concentrations lower than observed for the drugs ibuprofen and phenylbutazone, which are established HSA ligands. Interactions between PFCAs and HSA may affect the pharmacokinetics and distribution of fatty acids and certain drugs in the human body and warrant further investigation.	1					1		1												B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
479	ADME	De Silva, Amila O; Benskin, Jonathan P; Martin, Leah J; Arsenault, Gilles; McCrindle, Robert; Riddell, Nicole; Martin, Jonathan W; Mabury, Scott A	Disposition of perfluorinated acid isomers in Sp	2009	Environ Toxicol Chem. 2009 Mar;28(3):555-67. doi: 10.1897/08-254.1. Epub 2008 Oct 21.	Two major industrial synthetic pathways have been used to produce perfluorinated acids (PFAs) or their precursors: Telomerization and electrochemical fluorination (ECF). Products of telomer and ECF origin can be distinguished by structural isomer profiles. A mixture of linear and branched perfluoroalkyl isomers is associated with ECF. Telomer products characteristically consist of a single perfluoroalkyl geometry, typically linear. In biota, it is unclear if the isomer profile is conserved relative to the exposure medium and hence whether PFA isomer profiles in organisms are useful for distinguishing environmental PFA sources. A companion study suggested isomer-specific disposition following a single oral gavage exposure to rats. To confirm these findings under a more realistic subchronic feeding scenario, male and female rats were administered PFA isomers by diet for 12 weeks, followed by a 12-week depuration period. The diet contained 500 ng/g each of ECF perfluorooctanoate (PFOA, approximately 80% n-PFOA), ECF perfluorooctane sulfonate (PFOS, approximately 70% n-PFOS), and linear and isopropyl perfluorononanoate (n- and iso-PFNA). Blood sampling during the exposure phase revealed preferential accumulation of n-PFOA and n-PFNA compared to most branched isomers. Female rats depurated all isomers faster than males. Both sexes eliminated most branched perfluorocarboxylate isomers more rapidly than the n-isomer. Elimination rates of the major branched PFOS isomers were not statistically different from n-PFOS. Two minor isomers of ECF PFOA and one branched PFOS isomer had longer elimination half-lives than the n-isomers.Although extrapolation of these pharmacokinetics trends in rats to humans and wildlife requires careful consideration of dosage level and species-specific physiology, cumulative evidence suggests that perfluorocarboxylate isomer profiles in biota may not be suitable for quantifying the relative contributions of telomer and ECF sources.			1			1					1			1		1						B	B		
480	ADME	Dzierlenga, A. L.; Robinson, V. G.; Waidyanatha, S.; Devito, M. J.; Eifrid, M. A.; Gibbs, S. T.; Granville, C. A.; Blystone, C. R.	Toxicokinetics of perfluorohexanoic acid (PFHx	2019	Xenobiotica. 50: 1-11. doi: 10.1080/00498254.2019.1683776	Poly- and perfluorinated alkyl substances (PFAS) are environmentally persistent chemicals associated with many adverse health outcomes. The National Toxicology Program evaluated the toxicokinetics (TK) of several PFAS to provide context for toxicologic findings.Plasma TK parameters and tissue (liver, kidney, brain) concentrations are reported for perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA) or perfluorodecanoic acid (PFDA) after single-dose administration in male and female Hsd:Sprague-Dawley® (SD) rats.Generally, longer Tmax and elimination half-lives, and slower clearance f, were correlated with longer chain length. Male rats administered PFOA had a prolonged half-life compared to females (215 h vs. 2.75), while females had faster clearance and smaller plasma area under the curve (AUC). Females administered PFHxA had a shorter half-life (2 h vs. 9) than males and faster clearance with a smaller plasma AUC, although this was less pronounced than PFOA. There was no sex difference in PFDA half-life. Female rats administered PFDA had a higher plasma AUC/dose than males, and a slower clearance. PFDA had the highest levels in the liver of the PFAS evaluated.Profiling the toxicokinetics of these PFAS allows for comparison among subclasses, and more direct translation of rodent toxicity to human populations.			1			1												1			1	A	B	ラットにおけるPFHxAのTK試験（組織濃度、半減期）に関する知見	
481	ADME	Ericson, I.; Gómez, M.; Nadal, M.; van Bavel, B.; Lindström, G.; Domingo, J. L.	Perfluorinated chemicals in blood of residents	2007	Environ Int 33: 616-623. doi: 10.1016/j.envint.2007.01.003	Fluorinated organic compounds (FOCs) are a group of chemicals widely used as surfactants, lubricants, polymers, and fire-fighting foams. Recent studies have shown the ubiquitous distribution of FOCs in the environment, wildlife, and humans. We here report the results of a pilot study conducted to provide preliminary data on the levels of 13 FOCs in the blood of 48 residents in Catalonia, Spain, in relation to gender and age (25+/-5 and 55+/-5 years). The highest mean concentration was obtained for perfluorooctane sulfonate (PFOS, 7.64 ng/ml), followed by perfluorohexane sulfonate (PFHxS, 3.56 ng/ml) and perfluorooctanoic acid (PFOA, 1.80 ng/ml). Four other FOCs showed mean levels between 0.30 and 0.44 ng/ml, whereas those of the remaining 6 compounds were below the detection limit. Regarding gender, the blood levels of PFHxS and PFOA were significantly higher ($p<0.05$) in men than in women, while differences according to age were only noted for PFHxS ($p<0.05$) and perfluorooctane sulfonamide (PFOSA) ($p<0.001$), for which the levels were higher in the younger (25+/-5 years) group of subjects. A significant correlation between PFOS levels and those of the remaining detected FOCs (except PFDA) was found. In general terms, the current FOC concentrations were lower than those found in recent studies concerning levels of these chemicals in human blood and serum of subjects from different countries.			1			1												1				D	D	スペイン住民におけるフッ素有機化合物の血液濃度に関する知見（PFHxAに関する知見は不明）	
482	PBPK	eerl, U. S. E.,PA; Vasani, N.; Thomas, R. S.; Applegate, D.; Gonzalez, F. J.; Aleksunes, L. M.; Klaassen, C. D.; Corton, J.; Laboratory of Toxicology and Environmental Health, S. Y. M.; Kumar, V.; Benfenati, E.; Schuhmacher, M.; Domingo, J. L.; Nadal, M.	Physiologically based pharmacokinetic modelir	2015	Toxicol Environ Chem. 97: 814-827. doi: 10.1080/02772248.2015.1060976	Currently, there are limited data on the levels of perfluoroalkyl substances other than perfluorooctane sulfonic acid and perfluorooctanoic acid in the human body. Most of this information has been extracted from biological monitoring of plasma while the occurrence of perfluoroalkyl substances in other human tissues is rarely studied. The objective of the present study was to develop a physiologically based pharmacokinetic model to assess the concentration of perfluoroalkyl substances in human tissues, based on an existing model previously validated for perfluorooctane sulfonic acid and perfluorooctanoic acid. Experimental data on concentrations of perfluoroalkyl substances in human tissues from individuals in Tarragona County (Catalonia, Spain) were used to estimate the values of some distribution and elimination parameters needed for the simulation. No significant correlations were found between these parameters and the chain lengths. The model was finally validated for five perfluoroalkyl substances.			1			1	1														D	B	パーフルオロアルキル化合物のヒトPBPKモデルに関する知見（PFHxAに関して不明）	
483	ADME	Gannon, Shawn A; Johnson, Terry; Nabb, Diane L; Serex, Tessa L; Buck, Robert C; Loveless, Scott E	Absorption, distribution, metabolism, and excre	2011	Toxicology. 2011 Apr 28;283(1):55-62. doi: 10.1016/j.tox.2011.02.004. Epub 2011 Feb 22.	The absorption, tissue distribution, elimination, and metabolism of [1-^{14}C]-PFHx in rats and mice dosed orally at 2 or 100 mg/kg was evaluated following a single dose or after 14 consecutive doses. Absorption was rapid in rats as evidenced by a short time to maximum concentration (C(max)) of 30 min in male rats and 15 min in female rats at both the 2 and 100mg/kg dose level. The plasma elimination half-life was somewhat longer in males (1.5-1.7 h) than in females (0.5-0.7 h). Absorption in the mouse was also rapid with the maximum plasma concentration occurring between 15 and 30 min after dosing. The maximum concentration was not appreciably different between male and female mice (8 μg equiv./g at 2 mg/kg; ~350 μg equiv./g at 100 mg/kg). The primary route of elimination was via the urine. PFHx was not metabolized in rat or mouse hepatocytes, nor were any metabolites observed after oral dosing in either rodent species. Essentially 100% of the dose was eliminated in urine within 24 h demonstrating that PFHx is readily absorbed and bioavailability approaches 100%, even at a dose as high as 100 mg/kg. The route and extent of elimination was unchanged after 14 days of daily dosing. Tissues were collected at three time points (rat: 0.5, 2, and 24 h; mice: 0.25, 1, and 24 h) after dosing to investigate the tissue clearance kinetics of PFHx following a single dose at 2 or 100 mg/kg. In all tissues except skin, PFHx was not quantifiable 24 h after dosing in both sexes of the two species.		1				1					1			1					1	A	A	ラット、マウスにおけるPFHxAのPK試験に関する知見	
484	PBPK	Han, Xing; Nabb, Diane L; Russell, Mark H; Kennedy, Gerald L; Rickard, Robert W	Renal elimination of perfluorocarboxylates (PF	2012	Chem Res Toxicol. 2012 Jan 13;25(1):35-46. doi: 10.1021/tx200363w. Epub 2011 Oct 25.	Sex-, species-, and chain length-dependent renal elimination is the hallmark of mammalian elimination of perfluorocarboxylates (PFCAs) and has been extensively studied for almost 30 years. In this review, toxicokinetic data of PFCAs (chain lengths ranging from 4 to 10) in different species are compared with an emphasis on their relevance to renal elimination. PFCAs vary in their affinities to bind to serum albumins in plasma, which is an important factor in determining the renal clearance of PFCAs. PFCA-albumin binding has been well characterized and is summarized in this review. The mechanism of the sex-, species-, and chain length-dependent renal PFCA elimination is a research area that has gained continuous interest since the beginning of toxicological studies of PFCAs. It is now recognized that organic anion transport proteins play a key role in PFCA renal tubular reabsorption, a process that is sex-, species-, and chain length-dependent. Recent studies on the identification of PFCA renal transport proteins and characterization of their transport kinetics have greatly improved our understanding of the PFCA renal transport mechanism at the molecular level. A mathematical representation of this renal tubular reabsorption mechanism has been incorporated in physiologically based pharmacokinetic (PBPK) modeling of perfluorooctanoate (PFOA). Improvement of PBPK models in the future will require more accurate and quantitative characterization of renal transport pathways of PFCAs. To that end, a basolateral membrane efflux pathway for the reabsorption of PFCAs in the kidney is discussed in this review, which could provide a futureresearch direction toward a better understanding of the mechanisms of PFCA renal elimination.			1			1												1			B	B		
485	ADME	Iwabuchi, K.; Senzaki, N.; Mazawa, D.; Sato, I.; Hara, M.; Ueda, F.; Liu, W.; Tsuda, S.	Tissue toxicokinetics of perfluoro compounds v	2017	J Toxicol Sci 42: 301-317. doi: 10.2131/jts.42.301	To examine the kinetics of low doses of perfluoro compounds (PFCs), we administered perfluorohexanoic acid (C6A), perfluorooctanoic acid (C8A), perfluorononanoic acid (C9A) and perfluorooctane sulfonate (C8S) with a single oral dose (50-100 μg/kg BW), and in drinking water at 1, 5, and 25 μg/L for one and three months to male rats; and examined the distribution in the brain, heart, liver, spleen, kidney, whole blood and serum. C6A was very rapidly absorbed, distributed and eliminated from the tissues with nearly the same tissue t1/2 of 2-3 hr. Considering serum Vd, and the tissue delivery, C6A was mainly in the serum with the lowest delivery to the brain; and no tissue accumulation was observed in the chronic studies as estimated from the single dose study. For the other PFCs, the body seemed to be an assortment of independent one-compartments with a longer elimination t1/2 for the liver than the serum. The concentration ratio of liver/serum increased gradually from C0 to a steady state. The high binding capacity of plasma protein may be the reason for the unusual kinetics, with only a very small fraction of free PFCs moving gradually to the liver. Although the tissue specific distribution was time dependent and different among the PFCs, the Vd and ke of each tissue were constant throughout the study. The possibility of extremely high C6A accumulation in the human brain and liver was suggested, by comparing the steady state tissue concentration of this study with the human data reported by Pérez et al. (2013).			1			1												1	1		1	A	A	ラットにおけるPFHxAの血中動態、組織分布に関する知見	
486	ADME	Hiroyuki Iwai	Toxicokinetics of ammonium perfluorohexanoa	2011	Drug Chem Toxicol. 34: 341-346. doi: 10.3109/01480545.2011.585162	Excretion patterns and rates of ammonium perfluorohexanoate (APFHx) after administration of a single and multiple (14 days) oral dose(s) at 50 mg/kg to male and female mice and rats were examined. The test substance was [(14)C]-labeled APFHx. After a single oral administration, total excretion was rapid, with mean recoveries of over 90% of the dose at 24 hours after administration, irrespective of gender or species. The major route of elimination was via the urine (means of percentage recovery between 73.0 and 90.2% of the dose), followed by the feces (means of percentage recovery between 7.0 and 15.5% of the dose). Elimination via expired air was negligible. For the multiple dose tests, multiple (13 daily doses) oral administration of APFHx was followed by a single oral administration of [(14)C]-APFHx. Excretion was rapid, with mean recoveries of over 90% of the administered dose (mean values >95% of the ultimately recovered material) at 24 hours after dosing, irrespective of gender or species. The major route of elimination was via the urine (means of percentage recovery between 77.8 and 83.4% of the dose), followed by the feces (means of percentage recovery between 9.6 and 12.9% of the dose).			1			1												1				A	B	マウス、ラットにおけるPFHxAのTK試験に関する知見	
487	ADME	Jin, H.; Zhang, Y.; Jiang, W.; Zhu, L.; Martin, J. W.	Isomer-Specific Distribution of Perfluoroalkyl S	2016	Environ Sci Technol 50: 7808-7815. doi: 10.1021/acs.est.6b01698	Perfluoroalkyl substances (PFASs) such as perfluorohexanesulfonate (PFHxS), perfluorooctanoate (PFOA), perfluorooctanesulfonate (PFOS) and PFOS-precursors are routinely measured in human plasma and serum, but their relative abundance in the blood cell fraction has not been carefully examined, particularly at the isomer-specific level. Human plasma and whole blood were collected and partitioning behaviors of PFASs and their isomers between plasma and blood cells were investigated. In human samples, mass fraction in plasma (Fp) for PFASs increased among perfluoroalkyl carboxylates as the carbon chain length increased from C6 (mean 0.24) to C11 (0.87), indicating preference for the plasma fraction with increasing chain length. However, among perfluoroalkyl sulfonates, PFHxS (mean 0.87) had a slightly higher Fp than PFOS (0.85). In vitro assays with spiked Sprague-Dawley rat blood were also conducted, and the results showed that PFOS-precursors had lower Fp values than perfluoroalkyl acids, with perfluorooctanesulfonamide having the lowest Fp (mean 0.24). Consistently, linear isomers of PFOS and PFOS-precursors had lower mean Fp than their corresponding total branched isomers. Multiplying by a factor of 2 is not a reasonable method to convert from whole blood to plasma PFAS concentrations, and current ratios could be used as more accurate conversion factors.		1	1			1								1			1			B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
488	ADME	Kabadi, Shruti V; Fisher, Jeffrey; Aungst, Jason; Rice, Penelope	Internal exposure-based pharmacokinetic eval	2018	Food Chem Toxicol. 2018 Feb;112:375-382. doi: 10.1016/j.fct.2018.01.012. Epub 2018 Jan 11.	Polyfluorinated compounds (PFCs) are authorized for use as greaseproofing agents in food contact paper. As C8-PFCs (8-carbons) are known to accumulate in tissues, shorter-chain C6-PFCs (6-carbons) have replaced C8-PFCs in many food contact applications. However, the potential of C6-PFCs for human biopersistence has not been fully evaluated. For the first time, we provide internal exposure estimates to key metabolites of 6:2 fluorotelomer alcohol (6:2 FTOH), a monomeric component of C6-PFCs, to extend our understanding of exposure beyond estimates of external exposure. Pharmacokinetic data from published rat and human studies on 6:2 FTOH were used to estimate clearance and area under the curve (AUC) for its metabolites: 5:3 fluorotelomer carboxylic acid (5:3 A), perfluorohexanoic acid (PFHxA) and perfluoroheptanoic acid (PFHpA). Internal exposure to 5:3 A was the highest of evaluated metabolites across species and it had the slowest clearance. Additionally, 5:3 A clearance decreased with increasing 6:2 FTOH exposure. Our analysis provides insight into association of increased internal 5:3 A exposure with high biopersistence potential of 6:2 FTOH. Our results identify 5:3 A as an important biomarker of internal 6:2 FTOH exposure for use in biomonitoring studies, and are potentially useful for toxicological assessment of chronic dietary 6:2 FTOH exposure.		1				1														B	C		
489	ADME	Kudo, N; Suzuki, E; Katakura, M; Ohmori, K; Noshiro, R; Kawashima, Y	Comparison of the elimination between perfluo	2001	Chem Biol Interact. 2001 Apr 16;134(2):203-16. doi: 10.1016/s0009-2797(01)00155-7.	Elimination in urine and feces was compared between four perfluorinated fatty acids (PFCAs) with different carbon chain length. In male rats, perfluoroheptanoic acid (PFHA) was rapidly eliminated in urine with the proportion of 92% of the dose being eliminated within 120 h after an intraperitoneal injection. Perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) was eliminated in urine with the proportions of 55, 2.0 and 0.2% of the dose, respectively. By contrast, four PFCAs were eliminated in feces with the proportion of less than 5% of the dose within 120 h after an injection. In female rats, the proportions of PFOA and PFNA eliminated in urine within 120 h were 80% and 51% of the dose, respectively, which were significantly higher compared with those in male rats. There was the tendency that PFCA with longer carbon chain length is less eliminated in urine in both male and female rats. Fecal elimination of PFCAs was not different between PFCAs in female rats and comparable to those in male rats. The rates of biliary excretion of PFCAs in male rats were slower than those in female rats. Sex-related difference in urinary elimination of PFOA was abolished when male rats had been castrated. On the contrary, treatment with testosterone suppressed the elimination of PFOA in urine in both castrated male rats and female rats. The effect of testosterone was in a time- and dose-dependent manner. These results suggest that PFCAs are distinguished by their carbon chain length by a renal excretion system, which is regulated by testosterone.			1			1							1					1			1		B	A	B	ラットを用いたPFNAのPKの性差に関する知見	
490	ADME	Ohmori, Kohtaro; Kudo, Naomi; Katayama, Kazunori; Kawashima, Yoichi	Comparison of the toxicokinetics between perf	2003	Toxicology. 2003 Mar 3;184(2-3):135-40. doi: 10.1016/s0300-483x(02)00573-5.	Toxicokinetics was compared between perfluoroheptanoic acid (PFHA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) in male and female rats. Half lives (t(1/2)) in male and female rats were calculated to be 0.10 and 0.05 days, respectively, for PFHA, 5.63 and 0.08 days for PFOA, 29.5 and 2.44 days for PFNA and 39.9 and 58.6 days for PFDA. Total clearance (CL(tot)) of PFHA was higher than those of other perfluorocarboxylic acids (PFCAs) in both male and female rats. By contrast, CL(tot) of PFDA was extremely low in both sexes. PFCAs having shorter carbon chain length showed higher CL(tot). There was a significant sex-related difference in CL(tot) of PFOA and PFNA. Distribution volumes in steady state (V(ss)) were not much different between PFCAs and between sexes. To estimate the role of urinary excretion in plasma clearance of PFCA, renal clearance (CL(R)) was determined for PFCAs. CL(R) of PFCAs were in the order PFHA>PFOA>PFNA approximately equal PFDA and PFHA approximately equal PFOA>PDNA>PFDA in male and female rats, respectively. There was a close relationship between CL(tot) and CL(R) (r(2)=0.981). Plasma protein binding, estimated in vitro, was over 98% for all PFCAs tested. The results indicate that CL(R) is responsible for the difference in CL(tot) between PFCAs having different carbon chain length and between sexes.		1	1			1				1					1		1			1	A	B	雌雄ラットを用いたPFHxA、PFNAのTK評価に関する知見	
491	ADME	Olsen, Geary W; Chang, Shu-Ching; Noker, Patricia E; Gorman, Gregory S; Ehresman, David J; Lieder, Paul H; Butenhoff, John L	A comparison of the pharmacokinetics of perfl	2009	Toxicology. 2009 Feb 4;256(1-2):65-74. doi: 10.1016/j.tox.2008.11.008. Epub 2008 Nov 19.	Materials derived from perfluorobutanesulfonyl fluoride (PBSF, C(4)F(9)SO(2)F) have been introduced as replacements for eight-carbon homolog products that were manufactured from perfluorooctanesulfonyl fluoride (POSF, C(8)F(17)SO(2)F). Perfluorobutanesulfonate (PFBS, C(4)F(9)SO(3)(-)) is a surfactant and potential degradation product of PBSF-derived materials. The purpose of this series of studies was to evaluate the pharmacokinetics of PFBS in rats, monkeys, and humans, thereby providing critical information for human health risk assessment. Studies included: (1) intravenous (i.v.) elimination studies in rats and monkeys; (2) oral uptake and elimination studies in rats; and (3) human serum PFBS elimination in a group of workers with occupational exposure to potassium PFBS (K(+)PFBS). PFBS concentrations were determined in serum (all species), liver (rats), urine (all species), and feces (rats). In rats, the mean terminal serum PFBS elimination half-lives, after i.v. administration of 30mg/kg PFBS, were: males 4.51+/-2.22h (standard error) and females 3.96+/-0.21h. In monkeys, the mean terminal serum PFBS elimination half-lives, after i.v. administration of 10mg/kg PFBS, were: males 95.2+/-27.1h and females 83.2+/-41.9h. Although terminal serum half-lives in male and female rats were similar, without statistical significance, clearance (CL) was significantly greater in female rats (469+/-40mL/h) than male rats (119+/-34mL/h) with the area under the curve (AUC) significantly larger in male rats (294+/-77microg.h/mL) than female rats (65+/-5microg.h/mL). These differences were not observed in male and femalemonkeys. Volume of distribution estimates suggested distribution was primarily extracellular in both rats and monkeys, regardless of sex, and urine appeared to be a major route of elimination. Among 6 human subjects (5 male, 1 female) followed up to 180 days, the geometric mean serum elimination half-life for PFBS was 25.8 days (95% confidence interval 16.6-40.2). Urine was observed to be a pathway of elimination in the human. Although species-specific differences exist, these findings demonstrate that PFBS is eliminated at a greater rate from human serum than the higher chain homologs of perfluorooctanesulfonate (PFOS) and perfluorohexanesulfonate (PFHxS). Thus, compared to PFOS and PFHxS, PFBS has a much lower potential for accumulation in human serum after repeated occupational, non-occupational (e.g., consumer), or environmental exposures.				1		1	1		1					1				1			1	A	A	ラット、サル、ヒトにおけるPFBSの体内動態比較に関する知見	
492	ADME	Russell, Mark H; Nilsson, Helena; Buck, Robert C	Elimination kinetics of perfluorohexanoic acid i	2013	Chemosphere. 2013 Nov;93(10):2419-25. doi: 10.1016/j.chemosphere.2013.08.060. Epub 2013 Sep 16.	Major fluorinated chemical manufacturers have developed new short-chain per- and polyfluorinated substances with more favorable environmental, health and safety profiles. This study provides the first evaluation of the elimination half-life of perfluorohexanoic acid (PFHxA) from the blood of humans. PFHxA biomonitoring data were obtained from a recently published study of professional ski wax technicians. These data were analyzed to provide estimates of the apparent half-life of PFHxA from humans, and comparisons were made with kinetic studies of PFHxA elimination from mice, rats and monkeys. The apparent elimination half-life of PFHxA in highly exposed humans ranged between 14 and 49 d with a geomean of 32 d. The half-lives of PFHxA in mice, rats, monkeys and humans were proportional to body weight with no differences observed between genders, indicating similar volumes of distribution and similar elimination mechanisms among mammalian species. Compared to long-chain perfluoroalkyl acid analogs, PFHxA is rapidly cleared from biota. The consistent weight-normalized elimination half-lives for PFHxA in mammalian species indicates that results obtained from animal models are suitable for establishment of PFHxA benchmark dose and reference dose hazard endpoints for use in human risk assessments.		1				1					1						1			1	A	A	マウス、ラット、サルにおけるPFHxAの半減期の比較に関する知見	
493	ADME	Tatum-Gibbs, Katoria; Wambaugh, John F; Das, Kaberi P; Zehr, Robert D; Strynar, Mark J; Lindstrom, Andrew B; Delinsky, Amy; Lau, Christopher	Comparative pharmacokinetics of perfluorononr	2011	Toxicology. 2011 Mar 15;281(1-3):48-55. doi: 10.1016/j.tox.2011.01.003. Epub 2011 Jan 13.	Perfluorononanoic acid (PFNA) is a fluorinated organic chemical found at low levels in the environment, but is detectable in humans and wildlife. The present study compared the pharmacokinetic properties of PFNA in two laboratory rodent species. Male and female Sprague-Dawley rats were given a single dose of PFNA by oral gavage at 1, 3, or 10mg/kg, and blood was collected from the tail vein at 1, 2, 3, 4, 7, 16, 21, 28, 35, 42 and 50 days after treatment. In addition, livers and kidneys were collected for PFNA analysis at the terminal time point. CD-1 mice were given a single oral dose of PFNA of 1 or 10mg/kg, and 4 males and 4 females were killed at similar time intervals; trunk blood, liver and kidney were collected. Serum and tissue concentrations of PFNA were determined by LC-MS/MS. Serum elimination of PFNA is by and large linear with exposure doses in the rat; however, like PFOA, a major sex difference in the rate of elimination is observed, with an estimated half-life of 30.6 days for males and 1.4 days for females. PFNA is stored preferentially in the liver but not in the kidneys. In the mouse, the rates of PFNA serum elimination are non-linear with exposure dose and are slightly faster in females than males, with terminal estimated serum half-life of 25.8-68.4 days and 34.3-68.9 days, respectively. PFNA is also stored preferentially in the mouse liver but not in the kidneys. Hepatic uptake appears to be more efficient and storage capacity greater in male mice than in females. These data suggest that (1) PFNA is more persistent in the mouse than in the rat; (2) there is a major sex difference in the serum elimination of PFNA in the rat,but much less so in the mouse; and (3) there is a significantly higher hepatic accumulation of PFNA in male mice than in females.		1	1			1									1		1			1	A	A	ラット、マウスにおけるPFNAの血中動態、組織分布に関する知見	
494	ADME	Yang, Ching-Hui; Glover, Kyle P; Han, Xing	Characterization of cellular uptake of perfluoro	2010	Toxicol Sci. 2010 Oct;117(2):294-302. doi: 10.1093/toxsci/kfq219. Epub 2010 Jul 16.	It has been hypothesized that human renal apical membrane transporters play a key role in human renal reabsorption of perfluorooctanoate (PFO), which contributes to the long half-life of PFO in humans. In the present study, PFO uptake kinetics of human organic anion-transporting polypeptide (OATP) 1A2, organic anion transporter (OAT) 4, and urate transporter 1 (URAT1) in stably transfected cell lines was investigated. OAT4 and URAT1, but not OATP1A2, were shown to mediate saturable PFO cellular uptake. OAT4-mediated PFO uptake was stimulated by a low extracellular pH, which was evidenced as a lower Michaelis constant (K(m)) at pH 6 (172.3 ± 45.9 μM) than that at pH 7.4 (310.3 ± 30.2 μM). URAT1-mediated PFO uptake was greatly enhanced by an outward Cl(-) gradient, and its K(m) value was determined to be 64.1 ± 30.5 μM in the absence of extracellular Cl(-). The inhibition of OATP1A2- or OAT4-mediated estrone-3-sulfate uptake or URAT1-mediated urate uptake has been compared for linear perfluorocarboxylates (PFCs) with carbon chain lengths from 4 to 12. A clear chain length-dependent inhibition was observed, suggesting that PFCs in general are substrates of OAT4 and URAT1 but with different levels of affinities to the transporters depending on their chain length. Our results suggest that OAT4 and URAT1 are key transporters in renal reabsorption of PFCs in humans and, as a result, may contribute significantly to the long half-life of PFO in humans.		1				1					1	1	1	1	1		1				B	B		
495	ADME	Zhang, Tao; Sun, Hongwen; Lin, Yan; Qin, Xiaolei; Zhang, Yanfeng; Geng, Xia; Kannan, Kurunthachalam	Distribution of poly- and perfluoroalkyl substar	2013	Environ Sci Technol. 2013 Jul 16;47(14):7974-81. doi: 10.1021/es400937y. Epub 2013 Jul 2.	Although levels of poly- and perfluoroalkyl substances (PFASs) in human maternal and neonatal blood have been widely reported in the literature, relationship of maternal-fetal transmission of PFASs with carbon chain length is presently not well understood. In this study, 11 PFASs were analyzed in matched samples, including not only maternal blood (MB, n = 31) and cord blood (CB, n = 30), but also placenta (n = 29) and amniotic fluid (AF, n = 29). Except for perfluorohexanoic acid (PFHxA), the detection frequencies of PFASs were similar among placenta, MB, and CB (>80% for 8 PFASs, nondetectable for 2 PFASs). Though only perfluorooctanoic acid (PFOA) was frequently detected (>90%) in AF, with a median concentration of 0.043 ng/mL, other 5 PFASs were also detectable in AF samples with low concentrations (mean: 0.013-0.191 ng/mL). This suggests that in addition to blood-borne in utero exposure, the fetus is also exposed to low levels of PFASs through AF. Concentrations of PFOA in AF were positively correlated with those in MB ($r = 0.738$, $p < 0.01$) and CB ($r = 0.683$, $p < 0.001$), suggesting that AF concentration could reflect fetal PFOA exposure during pregnancy and can be used as a biomarker. To clarify the effects of carbon chain length on maternal transfer of PFASs, we calculated maternal transfer efficiencies of PFASs from MB to CB (TMB-CB). A U-shaped trend in TMB-CB of C7-C12 perfluoroalkyl carboxylic acids (PFCAs) with increasing carbon chain length was found in this study for the first time. The U-shaped TMB-CB of PFCAs with carbon chain length is an integrated result of opposite trend of the ratiosbetween MB/placenta and placenta/CB based on carbon chain length. This is the first study to report the occurrence of PFASs in human placenta. The results reported here enable better understanding of the maternal-fetal transmission of PFASs.		1				1														1	A	A	PFHxAのヒト胎盤移行に関する知見	
496	ADME	Zhang, Y.; Beesoon, S.; Zhu, L.; Martin, J. W.	Biomonitoring of perfluoroalkyl acids in human	2013	Environ Sci Technol 47: 10619-10627. doi: 10.1021/es401905e	Perfluoroalkyl acids (PFAAs) are persistent and bioaccumulative compounds that have been associated with adverse health outcomes. In human blood, PFAAs exist as both linear and branched isomers, yet for most linear homologues, and for all branched isomers, elimination rates are unknown. Paired blood and urine samples (n = 86) were collected from adults in China. They were analyzed by a sensitive isomer-specific method that permitted the detection of many PFAAs in human urine for the first time. For all PFAAs except perfluoroundecanoate (PFUnA), levels in urine correlated positively with levels in blood. Perfluoroalkyl carboxylates (PFCAs) were excreted more efficiently than perfluoroalkane sulfonates (PFSAs) of the same carbon chain-length. In general, shorter PFCAs were excreted more efficiently than longer ones, but for PFSAs, perfluorooctanesulfonate (PFOS, a C8 compound) was excreted more efficiently than perfluorohexanesulfonate (PFHxS, a C6 compound). Among PFOS and perfluorooctanoate (PFOA) isomers, major branched isomers were more efficiently excreted than the corresponding linear isomer. A one-compartment model was used to estimate the biological elimination half-lives of PFAAs. Among all PFAAs, the estimated arithmetic mean elimination half-lives ranged from 0.5 ± 0.1 years (for one branched PFOA isomer, 5m-PFOA) to 90 ± 11 years (for one branched PFOS isomer, 1m-PFOS).Urinary excretion was the major elimination route for short PFCAs (C ≤ 8), but for longer PFCAs, PFOS and PFHxS, other routes of excretion likely contribute to overall elimination. Urinary concentrations are good biomarkers of the internal dose, and this less invasive strategy can therefore be used in future epidemiological and biomonitoring studies. The very long half-lives of long-chain PFCAs, PFHxS, and PFOS isomers in humans stress the importance of global and domestic exposure mitigation strategies.		1				1	1			1	1				1		1			1	A	A	ヒトにおけるPFHxAの尿中濃度からの推定半減期に関する知見	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
497	ADME	Bogdanska, Jasna; Sundström, Maria; Bergström, Ulrika; Borg, Daniel; Abedi-Valugerdi, Manuchehr; Bergman, Åke; DePierre, Joseph; Nobel, Stefan	Tissue distribution of 35S-labelled perfluorobu	2014	Chemosphere. 2014 Mar;98:28-36. doi: 10.1016/j.chemosphere.2013.09.062. Epub 2013 Nov 14.	Perfluorobutanesulfonyl fluoride (PBSF) has been introduced as a replacement for its eight-carbon homolog perfluorooctanesulfonyl fluoride (POSF) in the manufacturing of fluorochemicals. Fluorochemicals derived from PBSF may give rise to perfluorobutanesulfonic acid (PFBS) as a terminal degradation product. Although basic mammalian toxicokinetic data exist for PFBS, information on its tissue distribution has only been reported in one study focused on rat liver. Therefore, here we characterized the tissue distribution of PFBS in mice in the same manner as we earlier examined its eight-carbon homolog perfluorooctanesulfonate (PFOS) to allow direct comparisons. Following dietary exposure of adult male C57/BL6 mice for 1, 3 or 5d to 16 mg (35)S-PFBS kg(-1) d(-1), both scintillation counting and whole-body autoradiography (WBA) revealed the presence of PFBS in all of the 20 different tissues examined, demonstrating its ability to leave the bloodstream and enter tissues. After 5d of treatment the highest levels were detected in liver, gastrointestinal tract, blood, kidney, cartilage, whole bone, lungs and thyroid gland. WBA revealed relatively high levels of PFBS in male genital organs as well, with the exception of the testis. The tissue levels increased from 1 to 3 d of exposure but appeared thereafter to level-off in most cases. The estimated major body compartments were whole bone, liver, blood, skin and muscle. This exposure to PFBS resulted in 5-40-fold lower tissue levels than did similar exposure to PFOS, as well as in a different pattern of tissue distribution, including lower levels in liver and lungsrelative to blood.				1				1			1					1		1			1		1	A	B	マウスにおけるPBSFの組織分布に関する知見	
498	PBPK	Fàbrega, F; Kumar, V; Benfenati, E; Schuhmacher, M; Domingo, JL; Nadal, M.	Physiologically based pharmacokinetic modelir	2015	Toxicol Environ Chem. 97: 814-827. doi: 10.1080/02772248.2015.1060976	Currently, there are limited data on the levels of perfluoroalkyl substances other than perfluorooctane sulfonic acid and perfluorooctanoic acid in the human body. Most of this information has been extracted from biological monitoring of plasma while the occurrence of perfluoroalkyl substances in other human tissues is rarely studied. The objective of the present study was to develop a physiologically based pharmacokinetic model to assess the concentration of perfluoroalkyl substances in human tissues, based on an existing model previously validated for perfluorooctane sulfonic acid and perfluorooctanoic acid. Experimental data on concentrations of perfluoroalkyl substances in human tissues from individuals in Tarragona County (Catalonia, Spain) were used to estimate the values of some distribution and elimination parameters needed for the simulation. No significant correlations were found between these parameters and the chain lengths. The model was finally validated for five perfluoroalkyl substances.								1													No. 482と重複		D	D	No.482と同じ文献	
499	ADME	Huang, M. C.; Dzierlenga, A. L.; Robinson, V. G.; Waidyanatha, S.; Devito, M. J.; Eifrid, M. A.; Granville, C. A.; Gibbs, S. T.; Blystone, C. R.	Toxicokinetics of perfluorobutane sulfonate (P	2019	Toxicology Reports 6: 645-655. doi: 10.1016/j.toxrep.2019.06.016	Perfluorinated alkyl substances (PFAS) are persistent contaminants that have been detected in the environment and in humans. With the PFAS chemical class, there are perfluorinated alkyl acids, many of which have been associated with certain toxicities. Because toxicity testing cannot feasibly be conducted for each individual PFAS, the National Toxicology Program (NTP) designed studies to compare toxicities across different subclasses of PFAS and across PFAS of different chain lengths to better understand the structure-toxicity relationship. Pharmacokinetic studies were conducted in parallel to these toxicity studies to facilitate comparisons across PFAS and to provide context for human relevance. Here, the toxicokinetic parameters of perfluorobutane sulfonate (PFBS), perfluorohexane-1-sulphonic acid (PFHxS), or perfluorooctane sulfonate (PFOS) after a single intravenous or gavage administration in male and female Hsd:Sprague-Dawley rats are reported. Concentrations of these PFAS were measured in the liver, kidney, and brain. Plasma half-life increased with longer chain length after gavage administration: PFBS- males averaged 3.3 h, females 1.3 h; PFHxS- males averaged 16.3 days, females 2.1 days; PFOS- males and females averaged ˜ 20 days. There were dose-dependent changes in clearance and systemic exposure for all administered chemicals and the direction of change was different in PFOS compared to the others. Liver:plasma ratios ofPFOS were the highest followed by PFHxS and PFBS, while brain:plasma ratios were low in all three sulfonates. Sex differences in plasma half-life and tissue distribution were observed for PFBS and PFHxS, but not PFOS. These data provide a direct comparison of the kinetics of three different perfluoroalkyl sulfonic acids and allow for the contextualization of toxicity data in rats for human risk assessment of this chemical class.				1				1			1							1			1	A	A	ラットにおけるPFHxA、PFBSの組織分布、半減期に関する知見	
500	PBPK	Kim, Sook-Jin; Choi, Eun-Jeong; Choi, Go-Wun; Lee, Yong-Bok; Cho, Hea-Young	Exploring sex differences in human health risk	2019	Arch Toxicol. 2019 Feb;93(2):311-330. doi: 10.1007/s00204-018-2365-y. Epub 2018 Nov 27.	Perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA), which are classified as perfluoroalkyl and polyfluoroalkyl substances (PFASs), have been widely used in industrial applications as a surface protectant. PFASs have been detected in wildlife and in humans around the globe. The purposes of this study are to develop and validate a physiologically based pharmacokinetic (PBPK) model for detecting PFNA and PFDA in male and female rats, and to apply the model to a human health risk assessment regarding the sex difference. A PBPK model of PFNA and PFDA was established based on an in vivo study in male and female rats. Analytes in biological samples (plasma, nine tissues, urine, and feces) were determined by ultra-liquid chromatography coupled tandem mass spectrometry (UPLC-MS/MS) method. PFNA and PFDA showed a gender differences in the elimination half-life and volume of distribution. The tissue-plasma partition coefficients were the highest in the liver in both male and female rats. The predicted rat plasma and urine concentrations simulated and fitted were in good agreement with the observed values. The PBPK models of PFNA and PFDA in male and female rats were then extrapolated to a human PBPK model based on human physiological parameters. The external doses were calculated at 3.35 ng/kg/day (male) and 17.0 ng/kg/day (female) for PFNA and 0.530 ng/kg/day (male) and 0.661 ng/kg/day (female) for PFDA. Human risk assessment was estimated using Korean biomonitoring values considering the gender differences. This study provides valuable insight into human health risk assessment regarding PFNA and PFDA exposure.				1				1											1			1	A	B	PBPKモデルを用いたPFDAの性差、想定曝露用量に関する知見	
501	ADME	Lau, Christopher; Rumpler, Jason; Das, Kaberi P; Wood, Carman R; Schmid, Judith E; Strynar, Mark J; Wambaugh, John F	Pharmacokinetic profile of Perfluorobutane Su	2020	Toxicology. 2020 Aug;441:152522. doi: 10.1016/j.tox.2020.152522. Epub 2020 Jun 10.	Per- and polyfluoroalkyl substances (PFAS) are organic chemicals with wide industrial and consumer uses. They are found ubiquitously at low levels in the environment and are detectable in humans and wildlife. Perfluorobutane Sulfonate (PFBS) is a short-chained PFAS used to replace perfluorooctane sulfonate in commerce. In general, the rate of clearance for the short-chained PFAS is faster than that for the long-chained congeners. This study evaluated the pharmacokinetic properties of PFBS and its hepatic transcriptional responses in CD-1 mice. Males and females were given PFBS by oral gavage at 30 or 300 mg/kg; controls received 0.5 % Tween-20 vehicle. Trunk blood was collected at 0.5, 1, 2, 4, 8, 16 and 24 h thereafter; liver and kidney were also harvested. Serum and tissue concentrations of PFBS were determined by HPLC-MS-MS. Expression of several hepatic nuclear receptor target genes was determined by qPCR. The half-life of PFBS was estimated as 5.8 h in the males and 4.5 h in the females. Tmax was reached within 1-2 h. Volume of distribution was similar between the two sexes (0.32-0.40 L/kg). The rate of PFBS clearance was linear with exposure doses. Within 24 h, serum PFBS declined to less than 5 % of Cmax. PFBS was detected in liver or kidney, although tissue levels of the chemical were only a fraction of those in serum. At 24 h after administration of 300 mg/kg PFBS, elevated expression of several hepatic genes targeted for PPARα, PPARγ, and PXR but not by AhR, LXR or CAR was observed, with responses indistinguishable between males and females. Little to no transcriptional response was seen with the30 mg/kg dose. The short serum half-lives of PFBS (4-5 h) in mice were comparable to those reported in rats. Although detection of PFBS in liver was low compared to that in serum even at the 300 mg/kg dose, the tissue level was sufficient to activate several hepatic nuclear receptors, which may represent an acute response to the chemical at a high dose.				1				1														1	A	B	マウスにおけるPFBSの動態と核内受容体による転写活性化に関する知見	
502	ADME	Manzano-Salgado, Cyntia B; Casas, Maribel; Lopez-Espinosa, Maria-Jose; Ballester, Ferran; Basterrechea, Mikel; Grimalt, Joan O; Jiménez, Ana-Maria; Kraus, Thomas; Schettgen, Thomas; Sunyer, Jordi; Vrijheid, Martine	Transfer of perfluoroalkyl substances from mot	2015	Environ Res. 2015 Oct;142:471-8. doi: 10.1016/j.envres.2015.07.020. Epub 2015 Aug 7.	INTRODUCTION: Prenatal exposure to perfluoroalkyl substances (PFAS) might affect child health; thus estimating PFAS fetal burden is relevant. PFAS fetal burden is best estimated in cord samples; previous studies have used either maternal plasma or serum during pregnancy as proxy, but their validity is not clear. We aimed to evaluate PFAS transfer between mother and fetus and determine its predictors in a Spanish birth cohort. METHODS: We measured perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), and perfluorononanoate (PFNA) in maternal blood and cord serum from 66 mother-child pairs. We used Spearman's rank coefficients to correlate PFAS concentrations in first trimester maternal plasma and serum, with cord serum samples. We assessed PFAS placental transfer by calculating maternal to cord ratios and examined their association with maternal socio-demographic characteristics and child sex using linear regression models. RESULTS: Median concentrations of PFAS (ng/mL) of PFHxS, PFOS, PFOA, and PFNA in maternal plasma (0.79, 6.18, 2.85 and 0.84, respectively) and serum (0.84, 6.99, 2.97 and 0.85) were higher than in cord serum (0.40, 1.86, 1.98 and 0.32). PFBS was not detected. Positive Spearman's correlations (p-values<0.001) were found between maternal plasma and serum (≥0.80), maternal plasma and cord (≥0.66), and maternal serum and cord samples (≥0.67). Maternal plasma to cord ratios were above 1 (PFHxS: 2.35 [95%CI: 2.05, 2.70], PFOS: 3.33 [3.05, 3.62], PFOA: 1.37 [1.27, 1.48], PFNA: 2.39 [2.18, 2.63]); maternal serum to cord ratios weresimilar. Maternal to cord ratios decreased with maternal age, but not with other socio-demographic factors. CONCLUSIONS: Our results suggest that PFAS fetal body burden can be assessed using as proxy maternal plasma or serum collected early in pregnancy. Maternal age might influence PFAS placental transfer.				1	1			1		1					1					1	A	A	ヒト（スペイン）におけるPFNA、PFBSの胎児への移行性に関する知見	
503	ADME	Xu, Y.; Fletcher, T.; Pineda, D.; Lindh, C. H.; Nilsson, C.; Glynn, A.; Vogs, C.; Norström, K.; Lilja, K.; Jakobsson, K.; Li, Y.	Serum Half-Lives for Short- and Long-Chain P	2020	Environ Health Perspect 128: 77004. doi: 10.1289/EHP6785	Background: Firefighting foam-contaminated ground water, which contains high levels of perfluoroalkyl substances (PFAS), is frequently found around airports. In 2018 it was detected that employees at a municipal airport in northern Sweden had been exposed to high levels of short-chain PFAS along with legacy PFAS (i.e., PFOA, PFHxS, and PFOS) through drinking water. Objectives: In this study, we aimed to describe the PFAS profile in drinking water and biological samples (paired serum and urine) and to estimate serum half-lives of the short-chain PFAS together with legacy PFAS. Methods: Within 2 weeks after provision of clean water, blood sampling was performed in all 26 airport employees. Seventeen of them were then followed up monthly for 5 months. PFHxA, PFHpA, PFBS, PFPeS, and PFHpS together with legacy PFAS in water and biological samples were quantified using LC/MS/MS. Half-lives were estimated by assuming one compartment, first-order elimination kinetics. Results: The proportions of PFHxA, PFHpA, and PFBS were higher in drinking water than in serum. The opposite was found for PFHxS and PFOS. The legacy PFAS accounted for about 50% of total PFAS in drinking water and 90% in serum. Urinary PFAS levels were very low compared with serum. PFBS showed the shortest half-life (average 44 d [95% confidence interval (CI): 37, 55 d]), followed by PFHpA [62 d (95% CI: 51, 80 d)]. PFPeS and PFHpS showed average half-lives as 0.63 and 1.46 y, respectively. Branched PFOS isomers had average half-lives ranging from 1.05 to 1.26 y for different isomers. PFOA, PFHxS, and linear PFOS isomers showed average half-lives of 1.77, 2.87, and 2.93 y, respectively. Discussion: A general pattern of increasing half-lives with increasing chain length was observed. Branched PFOS isomers had shorter half-lives than linear PFOS isomers.				1	1			1												1	A	B	汚染された飲料水のPFHxA、PFBS濃度と血清濃度の知見	
504	ADME	Allendorf, Flora; Berger, Urs; Goss, Kai-Uwe; Ulrich, Nadin	Partition coefficients of four perfluoroalkyl acid	2019	Environ Sci Process Impacts. 2019 Nov 1;21(11):1852-1863. doi: 10.1039/c9em00290a. Epub 2019 Sep 2.	Perfluoroalkyl acids (PFAAs) are persistent, ubiquitous environmental contaminants and their long-chain representatives are bioaccumulative. The phase-out of these compounds (e.g. PFOA and PFOS) shifted the production to alternatives. However, little is known about the bioaccumulative behaviour of the alternatives, which are still highly fluorinated. PFAAs are predominantly detected in blood, where they bind to the transport protein serum albumin. This sorption can be described by the albumin/water partition coefficient. It is unclear whether the partition coefficients of the alternatives are lower than or in the same range as those of classical PFAAs. We determined albumin/water partition coefficients for seven perfluoroalkyl carboxylates, three perfluoroalkane sulfonates and four alternatives by dialysis experiments in a physiologically representative system. Quantification was done by LC-MS/MS and a mass balance approach. Logarithmic albumin/water partition coefficients for PFAAs range from 2.8 to 4.8 [L(water) kg(albumin)(-1)] and increase with increasing chain length. Perfluorinated sulfonates sorb more strongly than their carboxylate counterparts. The albumin/water partition coefficients for the alternatives (HFPO-DA, DONA, 9Cl-PF3ONS and PFECHS) are in the same range as for classical PFAAs. Structural modifications such as the introduction of ether groups into the chain do not reduce sorption to albumin, whereas the chlorine atom in 9Cl-PF3ONS seems to even increase the sorption to albumin. We further investigated whether the sorption strength could be affected in the presence of medium- or long-chainfatty acids. Binding competition between medium-chain fatty acids and PFAAs appeared to be possible. However, the presence of physiologically more relevant long-chain fatty acids should not alter the albumin/water partition coefficients of PFAAs.	1			1				1													C	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
505	ADME	Cannon, Ronald E; Richards, Alicia C; Trexler, Andrew W; Juberg, Christopher T; Sinha, Birandra; Knudsen, Gabriel A; Birnbaum, Linda S	Effect of GenX on P-Glycoprotein, Breast Canc	2020	Environ Health Perspect. 2020 Mar;128(3):37002. doi: 10.1289/EHP5884. Epub 2020 Mar 26.	BACKGROUND: Ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)propanoic acid (GenX) is a replacement for perfluorooctanoic acid in the production of fluoropolymers used in a variety of consumer products. GenX alters fetal development and antibody production and elicits toxic responses in the livers and kidneys of rodents. The GenX effect on the blood-brain barrier (BBB) is unknown. The BBB protects the brain from xenobiotic neurotoxicants and harmful endogenous metabolites. OBJECTIVES: We aimed to investigate the effects of GenX on the transport activity and expression of P-glycoprotein (P-gp), breast cancer resistance protein (BCRP), and multidrug resistance-associated protein 2 (MRP2) at the BBB. METHODS: Transporter activities were measured in isolated rat brain capillaries by a confocal microscopy-based method. ATPase (enzymatic hydrolysis of adenosine triphosphate to inorganic phosphate) levels were measured in vitro. Western blotting determined P-gp and BCRP protein levels. Cell survival after GenX exposure was determined for two human cell lines. RESULTS: Nanomolar levels of GenX inhibited P-gp and BCRP but not MRP2 transport activities in male and female rat brain capillaries. P-gp transport activity returned to control levels after GenX removal. GenX did not reduce P-gp- or BCRP-associated ATPase activity in an in vitro transport assay system. Reductions of P-gp but not BCRP transport activity were blocked by a peroxisome proliferator-activated receptor γ (PPARγ) antagonist. GenX reduced P-gp and BCRP transport activity in human cells. CONCLUSION: In rats, GenX at 0.1 - 100 nM rapidly (in 1-2 h) inhibited P-gp andBCRP transport activities at the BBB through different mechanisms. PPARγ was required for the GenX effects on P-gp but not BCRP transport activity.					1				1													B	B		
506	ADME	Gannon, Shawn A; Fasano, William J; Mawn, Michael P; Nabb, Diane L; Buck, Robert C; Buxton, L William; Jepson, Gary W; Frame, Steven R	Absorption, distribution, metabolism, excretion	2016	Toxicology. 2016 Jan 18;340:1-9. doi: 10.1016/j.tox.2015.12.006. Epub 2015 Dec 29.	Ammonium, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate has been developed as a processing aid used in the manufacture of fluoropolymers. The absorption, distribution, elimination, and distribution (ADME) and kinetic behavior of this substance has been evaluated in rats, mice, and cynomolgus monkeys by oral and intravenous routes of exposure and studied in both plasma and urine. The test substance is rapidly and completely absorbed in both rats and mice and both in vivo and in vitro experiments indicate that it is not metabolized. The test substance is rapidly eliminated exclusively in the urine in both rats and mice, with rats eliminating it more quickly than mice (approximately 5h elimination half-life in rats, 20 h half-life in mice). Pharmacokinetic analysis in monkeys, rats, and mice indicate rapid, biphasic elimination characterized by a very fast alpha phase and a slower beta phase. The beta phase does not contribute to potential accumulation after multiple dosing in rats or monkeys. Comparative pharmacokinetics in rats, mice, and monkeys indicates that the rat is more similar to the monkey and is therefore a more appropriate rodent model for pharmacokinetics in primates.					1				1				1									1	A	B	ラット、マウス、カニクイザルにおけるGenXの動態に関する知見	
507	ADME	Li, Chuan-Hai; Ren, Xiao-Min; Guo, Liang-Hong	Adipogenic Activity of Oligomeric Hexafluoropr	2019	Environ Sci Technol. 2019 Mar 19;53(6):3287-3295. doi: 10.1021/acs.est.8b06978. Epub 2019 Mar 1.	Hexafluoropropylene oxide trimer acid (HFPO-TA) and hexafluoropropylene oxide dimer acid (HFPO-DA) have been used as perfluorooctanoic acid (PFOA) alternatives in the fluoropolymer industry for years. Their widespread environmental distribution, high bioaccumulation capability, and human exposure have caused great concern. Nevertheless, their potential toxicity and health risk remain largely unknown. In the present study, we compared potential disruption effects of HFPO-TA, HFPO-DA, and PFOA on peroxisome proliferator-activated receptor γ (PPARγ) via the investigation of receptor binding, receptor activity, and cell adipogenesis effects. The receptor binding experiment showed HFPO-TA exhibited 4.8-7.5 folds higher binding affinity with PPARγ than PFOA, whereas HFPO-DA exhibited weaker binding affinity than PFOA. They also showed agonistic activity toward PPARγ signaling pathway in HEK 293 cells in the order of HFPO-TA > PFOA > HFPO-DA. Molecular docking simulation indicated HFPO-TA formed more hydrogen bonds than PFOA, whereas HFPO-DA formed fewer hydrogen bonds than PFOA. HFPO-TA promoted adipogenic differentiation and lipid accumulation in both mouse and human preadipocytes with potency higher than PFOA. Adipogenesis in human preadipocytes is a more sensitive end point than mouse preadipocytes. Collectively, HFPO-TA exerts higher binding affinity, agonistic activity, and adipogenesis activity than PFOA. The potential health risk of HFPO-TA should be of concern.					1				1			1									B	B		
508	ADME	Luebker, D. J.; Hansen, K. J.; Bass, N. M.; Butenhoff, J. L.; Seacat, A. M.	Interactions of fluorochemicals with rat liver fa	2002	Toxicology. 2002 Jul 15;176(3):175-85. doi: 10.1016/s0300-483x(02)00081-1.	Liver-fatty acid binding protein (L-FABP) is an abundant intracellular lipid-carrier protein. The hypothesis that perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), and certain related perfluorooctanesulfonamide-based fluorochemicals (PFOSAs) can interfere with the binding affinity of L-FABP for fatty acids was tested. The relative effectiveness of PFOA, PFOS, N-ethylperfluorooctanesulfonamide (N-EtFOSA), N-ethylperfluorooctanesulfonamido ethanol (N-EtFOSE), and of the strong peroxisome proliferator Wyeth-14643 (WY) to inhibit 11-(5-dimethylaminonapthalenesulphonyl)-undecanoic acid (DAUDA) binding to-L-FABP was determined. The dissociation constant (Kd) of the DAUDA-L-FABP complex was 0.47 nM. PFOS exhibited the highest level of inhibition of DAUDA-L-FABP binding in the competitive binding assays, followed by N-EtFOSA, WY, and, with equal IC(50)s, N-EtFOSE and PFOA. The in vitro data presented in this study support the hypothesis that these fluorochemicals may interfere with the binding of fatty acids or other endogenous ligands to L-FABP. Furthermore, this work provides evidence to support the hypothesis that displacement of endogenous ligands from L-FABP may contribute to toxicity in rodents fed these fluorochemicals.					1				1		1					1		1			C	B		
509	ADME	Sheng, Nan; Li, Juan; Liu, Hui; Zhang, Aiqian; Dai, Jiayin	Interaction of perfluoroalkyl acids with human	2016	Arch Toxicol. 2016 Jan;90(1):217-27. doi: 10.1007/s00204-014-1391-7. Epub 2014 Nov 5.	Perfluoroalkyl acids (PFAAs) are highly persistent and bioaccumulative, resulting in their broad distribution in humans and the environment. The liver is an important target for PFAAs, but the mechanisms behind PFAAs interaction with hepatocyte proteins remain poorly understood. We characterized the binding of PFAAs to human liver fatty acid-binding protein (hL-FABP) and identified critical structural features in their interaction. The binding interaction of PFAAs with hL-FABP was determined by fluorescence displacement and isothermal titration calorimetry (ITC) assay. Molecular simulation was conducted to define interactions at the binding sites. ITC measurement revealed that PFOA/PFNA displayed a moderate affinity for hL-FABP at a 1:1 molar ratio, a weak binding affinity for PFHxS and no binding for PFHxA. Moreover, the interaction was mainly mediated by electrostatic attraction and hydrogen bonding. Substitution of Asn111 with Asp caused loss of binding affinity to PFAA, indicating its crucial role for the initial PFAA binding to the outer binding site. Substitution of Arg122 with Gly caused only one molecule of PFAA to bind to hL-FABP. Molecular simulation showed that substitution of Arg122 increased the volume of the outer binding pocket, making it impossible to form intensive hydrophobic stacking and hydrogen bonds with PFOA, and highlighting its crucial role in the binding process. The binding affinity of PFAAs increased significantly with their carbon number. Arg122 and Asn111 played a pivotal role in these interactions. Our findings may help understand the distribution pattern, bioaccumulation, elimination, andtoxicity of PFAAs in humans.					1				1		1										C	B		
510	ADME	Gao, K.,e; Zhuang, T.; Liu, X.; Fu, J.; Zhang, J.; Fu, J.,ie; Wang, L.; Zhang, A.; Liang, Y.; Song, M.; Jiang, G.	Prenatal Exposure to Per- and Polyfluoroalkyl S	2019	Environ Sci Technol. 2019 Jun 4;53(11):6529-6538. doi: 10.1021/acs.est.9b00715. Epub 2019 May 23.	Information on placental transfer and adverse outcomes of short-chain per- and polyfluoroalkyl substance (PFASs) is limited, and factors responsible for PFAS placental transfer are still unclear. In the present study, concentrations of 21 PFASs were analyzed in 132 paired maternal and cord serum samples collected from residents in Beijing, China, and the placental transfer efficiency (PTE) of each PFAS was calculated. PTEs of short-chain perfluoroalkyl acids (PFAAs), including PFBA (146%), PFBS (97%), PFPeA (118%), and PFHxA (110%), were first reported, and a complete U-shaped trend of PTEs from C4 to C13 of perfluoroalkyl carboxylic acids (PFCAs) was obtained. Positive association between maternal weight and PTE of perfluorooctanesulfonate (PFOS) ($p < 0.05$) and negative association between maternal PFBA concentration and birth length ($p < 0.01$) were observed. Using in vitro experiments, we further determined equilibrium dissociation constants (Kds) of human serum albumin (HSA)-PFAS complexes (Kd-HP), serum proteins-PFAS complexes (Kd-SP), and liver-fatty acid binding protein (L-FABP)-PFAS complexes (Kd-LP) and found that they were all significantly correlated with PTEs of PFASs. The correlation coefficient was 0.92, 0.89, and 0.86, respectively ($p < 0.01$ in all three tests), suggesting that Kds of protein (serum)-PFAS complexes can playan important role in trans-placental transfer of PFASs in human and Kd-HP plays a pivotal role.					1				1											1	A	B	ヒト（中国）におけるPFBSの胎盤移行性に関する知見	
511	ADME	Kowalczyk, Janine; Ehlers, Susan; Oberhausen, Anja; Tischer, Marion; Fürst, Peter; Schafft, Helmut; Lahrssen-Wiederholt, Monika	Absorption, distribution, and milk secretion of t	2013	J Agric Food Chem. 2013 Mar 27;61(12):2903-12. doi: 10.1021/jf304680j. Epub 2013 Mar 13.	The transfer of the perfluoroalkyl acids (PFAAs) perfluorobutanesulfonate (PFBS), perfluorohexanesulfonate (PFHxS), perfluorooctanesulfonate (PFOS), and perfluorooctanoate (PFOA) from feed into tissue and milk of dairy cows was investigated. Holstein cows (n = 6) were fed a PFAA-contaminated feed for 28 days. After the PFAA-feeding period, three cows were slaughtered while the others were fed PFAA-free feed for another 21 days (depuration period). For PFAA analysis plasma, liver, kidney, and muscle tissue, urine, and milk were sampled and analyzed using high-performance liquid chromatography (HPLC) with tandem mass spectrometry (MS/MS). The average daily intake of dairy cows was 3.4 ± 0.7, 4.6 ± 1.0, 7.6 ± 3.7 and 2.0 ± 1.2 μg/kg body weight (bw) for PFBS, PFHxS, PFOS, and PFOA, respectively. Overall, PFBS, PFHxS, PFOS, and PFOA showed different kinetics in dairy cows. In plasma, concentrations of PFBS (mean = 1.2 ± 0.8 μg/L) and PFOA (mean = 8.5 ± 5.7 μg/L) were low, whereas PFHxS and PFOS continuously increased during the PFAA-feeding period up to maximal concentrations of 419 ± 172 and 1903 ± 525 μg/L, respectively. PFOS in plasma remained constantly high during the depuration period. PFOS levels were highest in liver, followed by kidney, without significant differences between feeding periods. The highest PFHxS levels were detected in liver and kidney of cows slaughtered on day 29 (61 ± 24 and 98 ± 31 μg/kg wet weight (ww)). The lowest PFAA levels were detected in muscle tissue. At the end of the feeding study, cumulative secretion in milk was determined for PFOS (14 ± 3.6%) and PFHxS (2.5 ± 0.2%). The other two chemicalswere barely secreted into milk: PFBS (0.01 ± 0.02%) and PFOA (0.1 ± 0.06%). Overall, the kinetics of PFOA were similar to those of PFBS and substantially differed from those of PFHxS and PFOS. The very low concentration of PFBS in plasma and milk, the relatively high urinary excretion, and only traces of PFBS in liver (0.3 ± 0.3 μg/kg ww) and kidney (1.0 ± 0.3 μg/kg ww) support the conclusion that PFBS does not accumulate in the body of dairy cows.					1				1											1	B	B		
512	ADME	Martin, Jonathan W; Mabury, Scott A; Solomon, Keith R; Muir, Derek C G	Bioconcentration and tissue distribution of per	2003	Environ Toxicol Chem. 2003 Jan;22(1):196-204. doi: 10.1002/etc.5620220126	Rainbow trout (Oncorhynchus mykiss) were exposed simultaneously to a homologous series of perfluoroalkyl carboxylates and sulfonates in a flow-through system to determine compound-specific tissue distribution and bioconcentration parameters for perfluorinated acids (PFAs). In general, PFAs accumulated to the greatest extent in blood > kidney > liver > gall bladder. Carboxylates and sulfonates with perfluoroalkyl chain lengths shorter than seven and six carbons, respectively, could not be detected in most tissues and were considered to have insignificant bioconcentration factors (BCFs). For detectable PFAs, carcass BCFs increased with increasing length of the perfluoroalkyl chain, ranging from 4.0 to 23,000, based on wet weight concentrations. Carboxylate carcass BCFs increased by a factor of eight for each additional carbon in the perfluoroalkyl chain between 8 and 12 carbons, but this relationship deviated from linearity for the longest PFA tested, possibly because of decreased gill permeability. In general, half-lives (3.9-28 d) and uptake rates (0.053-1.700 L/kg/d) also increased with increasing length of the perfluoroalkyl chain in all tissues. Sulfonates had greater BCFs, half-lives, and rates of uptake than the corresponding carboxylate of equal perfluoroalkyl chain length, indicating that hydrophobicity, as predicted by the critical micelle concentration, is not the only determinant of PFA bioaccumulation potential and that the acid function must be considered.					1				1	1						1					B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
513	ADME	Ross, I., McDonough, J., Miles, J., Storch, P., Kochunarayanan, P. T., Kalve, E., Hurst, K. & Dasgupta, S. S.	A review of emerging technologies for remedia	2018	Remediation, 28, 101-126.doi: 10.1002/rem.21553	The need for remediation of poly- and perfluoroalkyl substances (PFASs) is growing as a result of more regulatory attention to this new class of contaminants with diminishing water quality standards being promulgated, commonly in the parts per trillion range. PFASs comprise >3,000 individual compounds, but the focus of analyses and regulations has generally been PFASs termed perfluoroalkyl acids (PFAAs), which are all extremely persistent, can be highly mobile, and are increasingly being reported to bioaccumulate, with understanding of their toxicology evolving. However, there are thousands of polyfluorinated “PFAA precursors”, which can transform in the environment and in higher organisms to create PFAAs as persistent daughter products. Some PFASs can travel miles from their point of release, as they are mobile and persistent, potentially creating large plumes. The use of a conceptual site model (CSM) to define risks posed by specific PFASs to potential receptors is considered essential. Granular activated carbon (GAC) is commonly used as part of interim remedial measures to treat PFASs present in water. Many alternative treatment technologies are being adapted for PFASs or ingenious solutions developed. The diversity of PFASs commonly associated with use of multiple PFASs in commercial products is not commonly assessed. Remedial technologies, which are adsorptive or destructive, are considered for both soils and waters with challenges to their commercial application outlined. Biological approaches to treat PFASs report biotransformation which creates persistent PFAAs, no PFASs can biodegrade. Water treatment technologies applied ex situ could be used in a treatment train approach, for example, to concentrate PFASs and then destroy them on-site. Dynamic groundwater recirculation can greatly enhance contaminant mass removal via groundwater pumping. This review of technologies for remediation of PFASs describes that: GAC may be effective for removal of long-chain PFAAs, but does not perform well on short-chain PFAAs and its use for removal of precursors is reported to be less effective; Anion-exchange resins can remove a wider array of long- and short-chain PFAAs, but struggle to treat the shortest chain PFAAs and removal of most PFAA precursors has not been evaluated; Ozofractionation has been applied for PFASs at full scale and shown to be effective for removal of total PFASs; Chemical oxidation has been demonstrated to be potentially applicable for some PFAAs, but when applied in situ there is concern over the formation of shorter chain PFAAs and ongoing rebound from sorbed precursors; Electrochemical oxidation is evolving as a destructive technology for many PFASs, but can create undesirable by-products such as perchlorate and bromate; Sonolysis has been demonstrated as a potential destructive technology in the laboratory but there are significant challenges when considering scale up;										1														C	B		
514	ADME	Zhao, W.; Zitzow, J. D.; Weaver, Y.; Ehresman, D. J.; Chang, S. C.; Butenhoff, J. L.; Hagenbuch, B.	Organic anion transporting polypeptides contri	2017	Toxicol Sci. 2017 Mar 1;156(1):84-95. doi: 10.1093/toxsci/kfw236.	Perfluoroalkyl sulfonates (PFSAs) such as perfluorohexane sulfonate (PFHxS) and perfluorooctane sulfonate (PFOS) have very long serum elimination half-lives in humans, and preferentially distribute to serum and liver. The enterohepatic circulation of PFHxS and PFOS likely contributes to their extended elimination half-lives. We previously demonstrated that perfluorobutane sulfonate (PFBS), PFHxS, and PFOS are transported into hepatocytes both in a sodium-dependent and a sodium-independent manner. We identified Na+/taurocholate cotransporting polypeptide (NTCP) as the responsible sodium-dependent transporter. Furthermore, we demonstrated that the human apical sodium-dependent bile salt transporter (ASBT) contributes to the intestinal reabsorption of PFOS. However, so far no sodium-independent uptake transporters for PFSAs have been identified in human hepatocytes or enterocytes. In addition, perfluoroalkyl carboxylates (PFCAs) with 8 and 9 carbons were shown to preferentially distribute to the liver of rodents; however, no rat or human liver uptake transporters are known to transport these PFCAs. Therefore, we tested whether PFBS, PFHxS, PFOS, and PFCAs with 44752 carbons are substrates of organic anion transporting polypeptides (OATPs). We used CHO and HEK293 cells to demonstrate that human OATP1B1, OATP1B3, and OATP2B1 can transport PFBS, PFHxS, PFOS, and the 2 PFCAs (C8 and C9). In addition, we show that rat OATP1A1, OATP1A5, OATP1B2, andOATP2B1 transport all 3 PFSAs. In conclusion, our results suggest that besides NTCP and ASBT, OATPs also are capable of contributing to the enterohepatic circulation and extended human serum elimination half-lives of the tested perfluoroalkyl acids.				1						1								1					B	B		
515	ADME	Gannon, Shawn A; Johnson, Terry; Nabb, Diane L; Serex, Tessa L; Buck, Robert C; Loveless, Scott E	Absorption, distribution, metabolism, and excre	2011	Toxicology 283 (1), 55-62. doi: 10.1016/j.tox.2011.02.004. Epub 2011 Feb 22.	The absorption, tissue distribution, elimination, and metabolism of [1-^{14}C]-PFHx in rats and mice dosed orally at 2 or 100 mg/kg was evaluated following a single dose or after 14 consecutive doses. Absorption was rapid in rats as evidenced by a short time to maximum concentration (C(max)) of 30 min in male rats and 15 min in female rats at both the 2 and 100mg/kg dose level. The plasma elimination half-life was somewhat longer in males (1.5-1.7 h) than in females (0.5-0.7 h). Absorption in the mouse was also rapid with the maximum plasma concentration occurring between 15 and 30 min after dosing. The maximum concentration was not appreciably different between male and female mice (8 μg equiv./g at 2 mg/kg; ~350 μg equiv./g at 100 mg/kg). The primary route of elimination was via the urine. PFHx was not metabolized in rat or mouse hepatocytes, nor were any metabolites observed after oral dosing in either rodent species. Essentially 100% of the dose was eliminated in urine within 24 h demonstrating that PFHx is readily absorbed and bioavailability approaches 100%, even at a dose as high as 100 mg/kg. The route and extent of elimination was unchanged after 14 days of daily dosing. Tissues were collected at three time points (rat: 0.5, 2, and 24 h; mice: 0.25, 1, and 24 h) after dosing to investigate the tissue clearance kinetics of PFHx following a single dose at 2 or 100 mg/kg. In all tissues except skin, PFHx was not quantifiable 24 h after dosing in both sexes of the two species.			1							1						1					No. 483と重複		A	B	ラット、マウスにおけるPFHxの体内動態に関する知見	
516	PBPK	Lou, Inchio; Wambaugh, John F; Lau, Christopher; Hanson, Roger G; Lindstrom, Andrew B; Strynar, Mark J; Zehr, R Dan; Setzer, R Woodrow; Barton, Hugh A	Modeling single and repeated dose pharmacok	2009	Toxicol Sci. 2009 Feb;107(2):331-41. doi: 10.1093/toxsci/kfn234. Epub 2008 Nov 12.	Perfluorooctanoic acid (PFOA) displays complicated pharmacokinetics in that serum concentrations indicate long half-lives despite which steady state appears to be achieved rapidly. In this study, serum and tissue concentration time-courses were obtained for male and female CD1 mice after single, oral doses of 1 and 10 mg/kg of PFOA. When using one- and two-compartment models, the pharmacokinetics for these two dosages are not consistent with serum time-course data from female CD1 mice administered 60 mg/kg, or with serum concentrations following repeated daily doses of 20 mg/kg PFOA. Some consistency between dose regimens could be achieved using the saturable resorption model of Andersen et al. In this model PFOA is cleared from the serum into a filtrate compartment from which it is either excreted or resorbed into the serum by a process presumed transporter mediated with a Michaelis-Menten form. Maximum likelihood estimation found a transport maximum of T(m) = 860.9 (1298.3) mg/l/h and half-maximum concentration of K(T) = 0.0015 (0.0022) mg/l where the estimated standard errors (in parentheses) indicated large uncertainty. The estimated rate of flow into and out of the filtrate compartment, 0.6830 (1.0131) l/h was too large to be consistent with a biological interpretation. For these model parameters a single dose greater than 40 mg/kg, or a daily dose in excess of 5 mg/kg were necessary to observe nonlinear pharmacokinetics for PFOA in female CD1 mice. These data and modeling analyses more fully characterize PFOA in mice for purposes of estimating internal exposure for use in risk assessment.		1								1					1							D	C	マウスにおけるPFOAの体内動態に関する知見（PFHxAに関しては不明）	
517	ADME	Cui, Qianqian; Pan, Yitao; Zhang, Hongxia; Sheng, Nan; Wang, Jianshe; Guo, Yong; Dai, Jiayin	Occurrence and Tissue Distribution of Novel P	2018	Environ Sci Technol. 2018 Feb 6;52(3):982-990. doi: 10.1021/acs.est.7b03662. Epub 2018 Jan 23.	Research on perfluoroalkyl substances (PFASs) continues to grow. However, very little is known about these substances in amphibians. Here we report for the first time on the occurrence, tissue distribution, and bioaccumulation of two novel PFASs, chlorinated polyfluorinated ether sulfonic acid (6:2 Cl-PFESA) and hexafluoropropylene oxide trimer acid (HFPO-TA), in the black-spotted frog (Pelophylax nigromaculatus) from China. Frogs from cities with large-scale fluorochemical industries had significantly greater liver ΣPFAS levels (mean 54.28 ng/g in Changshu; 31.22 ng/g in Huantai) than those from cities without similar industry (9.91 ng/g in Zhoushan; 7.68 ng/g in Quzhou). Females had significantly lower liver PFAS levels than males, and older frogs tended to have lower PFAS levels than younger frogs. Skin, liver, and muscle contributed nearly 80% to the whole body burden of 6:2 Cl-PFESA in males, whereas the female ovary alone accounted for 58.4%. These results suggest substantial maternal transfer of 6:2 Cl-PFESA to eggs, raising concern regarding its developmental toxicity on frogs and other species. The bioaccumulation factor results (6:2 Cl-PFESA > PFOS; HFPO-TA > PFOA) suggest a stronger accumulative potential in the black-spotted frog for these alternative substances compared to their predecessors. Future studies on their toxicity and ecology risk are warranted.					1						1										C	C		
518	ADME	Gannon, S. A., Fasano, W. J., Mawn, M. P., Nabb, D. L., Buck, R. C., Buxton, L. W., Jepson, G. W. & Frame, S. R.	Absorption, distribution, metabolism, excretion	2016	Toxicology. 2016 Jan 18;340:1-9. doi: 10.1016/j.tox.2015.12.006. Epub 2015 Dec 29.	Ammonium, 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate has been developed as a processing aid used in the manufacture of fluoropolymers. The absorption, distribution, elimination, and distribution (ADME) and kinetic behavior of this substance has been evaluated in rats, mice, and cynomolgus monkeys by oral and intravenous routes of exposure and studied in both plasma and urine. The test substance is rapidly and completely absorbed in both rats and mice and both in vivo and in vitro experiments indicate that it is not metabolized. The test substance is rapidly eliminated exclusively in the urine in both rats and mice, with rats eliminating it more quickly than mice (approximately 5 h elimination half-life in rats, 20 h half-life in mice). Pharmacokinetic analysis in monkeys, rats, and mice indicate rapid, biphasic elimination characterized by a very fast alpha phase and a slower beta phase. The beta phase does not contribute to potential accumulation after multiple dosing in rats or monkeys. Comparative pharmacokinetics in rats, mice, and monkeys indicates that the rat is more similar to the monkey and is therefore a more appropriate rodent model for pharmacokinetics in primates.					1						1									No. 506と重複	1	A	B	ラット、マウス、カニクイザルにおけるGenXの体内動態（半減期）に関する知見	
519	ADME	Pizzurro, D. M.; Seeley, M.; Kerper, L. E.; Beck, B. D.	Interspecies differences in perfluoroalkyl subst	2019	Regul Toxicol Pharmacol. 2019 Aug;106:239-250. doi: 10.1016/j.yrtph.2019.05.008. Epub 2019 May 9.	Toxicokinetics are important for extrapolating health effects and effect levels observed in laboratory animals to humans for purposes of establishing health-based criteria. We conducted a comprehensive review of key absorption, distribution, metabolism, and excretion (ADME) parameters across different mammalian species for five perfluoroalkyl substances (PFAS) and discussed how these data can be used to inform human health risk assessment of these substances. Our analysis revealed several notable differences among the different PFAS regarding species- and substance-specific tissue partitioning, half-life, and transfer to developing offspring via the placenta or lactation, as well as highlighted data gaps for certain substances. We incorporated these observations in an analysis of whether health-based values for specific PFAS can be applied to other PFAS of differing chain length or toxicological mode of action. Overall, our analysis provides one of the first syntheses of available empirical PFAS toxicokinetic data to facilitate interpreting human relevance of animal study findings and developing health-based criteria for PFAS from such studies.		1		1							1					1					D	D	PFASの哺乳類における体内動態に関する知見（PFBS、PFBAに関して不明）	
520	ADME	Mamsen, L. S.; Björvang, R. D.; Mucs, D.; Vinnars, M. T.; Papadogiannakis, N.; Lindh, C. H.; Andersen, C. Y.; Damdimopoulou, P.	Concentrations of perfluoroalkyl substances (F	2019	Environ Int. 2019 Mar;124:482-492. doi: 10.1016/j.envint.2019.01.010. Epub 2019 Jan 24.	Background: The persistent environmental contaminants perfluoroalkyl substances (PFASs) have gained attention due to their potential adverse health effects, in particular following early life exposure. Information on human fetal exposure to PFASs is currently limited to one report on first trimester samples. There is no data available on PFAS concentrations in fetal organs throughout all three trimesters of pregnancy. Methods: We measured the concentrations of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorohexane sulfonic acid (PFHxS) in human embryos and fetuses with corresponding placentas and maternal serum samples derived from elective pregnancy terminations and cases of intrauterine fetal death. A total of 78 embryos and fetuses aged 7-42 gestational weeks were included and a total of 225 fetal organs covering liver, lung, heart, central nervous system (CNS), and adipose tissue were analyzed, together with 71 placentas and 63 maternal serum samples. PFAS concentrations were assayed by liquid chromatography/triple quadrupole mass spectrometry. Results: All evaluated PFASs were detected and quantified in maternal sera, placentas and embryos/fetuses. In maternal serum samples, PFOS was detected in highest concentrations, followed by PFOA > PFNA > PFDA = PFUnA = PFHxS. Similarly, PFOS was detected in highest concentrations in embryo/fetal tissues, followed by PFOA > PFNA = PFDA = PFUnA. PFHxS was detected in very few fetuses. In general, PFAS concentrations in embryo/fetal tissue (ng/g) were lower than maternal serum (ng/ml) but similar to placenta concentrations. The total PFAS burden (i.e. the sum of all PFASs) was highest in lung tissue in first trimester samples and in liver in second and third trimester samples. The burden was lowest in CNS samples irrespective of fetal age. The placenta:maternal serum ratios of PFOS, PFOA and PFNA increased across gestation suggesting bioaccumulation in the placenta. Further, we observed that the ratios were higher in pregnancies with male fetuses compared to female fetuses.Conclusions: Human fetuses were intrinsically exposed to a mixture of PFASs throughout gestation. The compounds were detected in all analyzed tissues, suggesting that PFASs reach and may affect many types of organs. Collectively, our results demonstrate that PFASs pass the placenta and deposit to embryo and fetal tissues, calling for risk assessment of gestational exposures.				1								1									1	A	A	ヒト胎児臓器、胎盤におけるPFNAの濃度に関する知見	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
521	ADME	Wang, Yiwen; Han, Wenchao; Wang, Caifeng; Zhou, Yijun; Shi, Rong; Bonefeld-Jørgensen, Eva Cecilie; Yao, Qian; Yuan, Tao; Gao, Yu; Zhang, Jun; Tian, Ying	Efficiency of maternal-fetal transfer of perfluor	2019	Environ Sci Pollut Res Int. 2019 Jan;26(3):2691-2698. doi: 10.1007/s11356-018-3686-3. Epub 2018 Nov 27.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) can be transferred from a mother to her fetus during pregnancy and adversely affect fetal development. However, the efficiency and influencing factors of PFASs maternal-fetal transfer remain unclear. We measured the levels of six perfluoroalkylcarboxylates, three perfluoroalkylsulfonates, and one sulfonamide in 369 pairs of maternal and umbilical cord serum and examined the transplacental transfer efficiency (TTE) of PFASs by the functional group and carbon chain length in a prospective birth cohort in Shandong, China. All ten PFASs were detected in both maternal and umbilical cord serum in nearly all samples. Maternal and cord levels were closely correlated (the correlation coefficient [r] ranging from 0.485 to 0.908) in most PFASs except perfluorobutane sulfonic acid (PFBS) (r = 0.159). TTE was significantly affected by the functional group and carbon chain length. Compared to perfluoroalkylcarboxylates, perfluoroalkylsulfonates had a lower ratio of maternal to fetal transfer. A U-shaped relationship between carbon chain length and TTE was observed for perfluoroalkylcarboxylates while a monotonic descending trend was identified between TTE and the increasing carbon chain length for perfluoroalkylsulfonates. PFASs can readily pass through the placenta. The functional group and carbon chain length are important determinants for the TTE of PFASs.				1											1					1	A	B	ヒトにおけるPFBSの胎盤移行性に関する知見	
522	ADME	Andersen, M. E.; Butenhoff, J. L.; Chang, S. C.; Farrar, D. G.; Kennedy, G. L.; Lau, C.; Olsen, G. W.; Seed, J.; Wallace, K. B.	Perfluoroalkyl acids and related chemistries--t	2008	Toxicol Sci. 2008 Mar;102(1):3-14. doi: 10.1093/toxsci/kfm270. Epub 2007 Nov 13.	The perfluoroalkyl acid salts (both carboxylates and sulfonates, hereafter designated as PFAAs) and their derivatives are important chemicals that have numerous consumer and industrial applications. However, recent discoveries that some of these compounds have global distribution, environmental persistence, presence in humans and wildlife, as well as toxicity in laboratory animal models, have generated considerable scientific, regulatory, and public interest on an international scale. The Society of Toxicology Contemporary Concepts in Toxicology Symposium, entitled "Perfluoroalkyl Acids and Related Chemistries: Toxicokinetics and Modes-of-Action Workshop" was held February 14-16, 2007 at the Westin Arlington Gateway, Arlington, VA. In addition to the Society of Toxicology, this symposium was sponsored by 3M Company, DuPont, Plastics Europe, and the U.S. Environmental Protection Agency. The objectives of this 3-day meeting were to -1 provide an overview of PFAA toxicity and description of recent findings with the sulfonates, carboxylates, and telomer alcohols; -2 address the toxicokinetic profiles of various PFAAs among animal models and humans, and the biological processes that are responsible for these observations; -3 examine the possible modes of action that determine the PFAA toxicities observed in animal models, and their relevance to human health risks; and -4 identify the critical research needs and strategies tofill the existing informational gaps that hamper risk assessment of these chemicals. This report summarizes the discourse that occurred during the symposium.														1						D	D	PFASの関連化学に関する知見（対象化合物に関する知見については不明）	
523	ADME	Gao, B.; He, X.; Liu, W.; Zhang, H.; Saito, N.; Tsuda, S.	Distribution of perfluoroalkyl compounds in rat	2015	J Expo Sci Environ Epidemiol. 2015 Nov-Dec;25(6):632-8. doi: 10.1038/jes.2014.54. Epub 2014 Aug 13.	Hair analysis is potentially advantageous in exposure assessment of perfluoroalkyl acids (PFAAs) as a non-invasive method, combined with the ability to reflect long-term exposure. The present study aims to assess the feasibility of using hair as an indicator of PFAA exposure. Adult male and female rats were subchronically exposed to selected PFAAs, including perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorooctanesulfonate (PFOS), for 90 days. Hair, serum, and other tissues, including liver, kidney, spleen, lung, brain and heart, as well as the urine and feces excretions, were analyzed for PFAA levels. PFOA/PFNA/PFOS were detected in rat hair in a dose-dependent manner, in the order of PFOS>PFNA>PFOA. Hair PFAA concentrations were higher in male rats than the female rats, except for PFOS at low dose. Moreover, significant positive correlations as well as similar PFAA profiles were observed between hair, serum, and other tissues. Besides, hair PFAAs were negatively correlated with the urinary excretion rate. Although the influencing factors in humans still need further investigation, the results suggested that hair is capable of reflecting PFAA exposure, and could be employed as an alternative exposure bioindicator of PFAAs.				1											1						B	B		
524	ADME	Genuis, Stephen J; Beesoon, Sanjay; Birkholz, Detlef	Biomonitoring and Elimination of Perfluorinate	2013	ISRN Toxicol. 2013 Sep 3;2013:483832. doi: 10.1155/2013/483832. eCollection 2013.	Perfluorinated compounds (PFCs) are man-made organofluorine chemicals manufactured and marketed for their stain-resistant properties. Polychlorinated biphenyls (PCBs) are anthropogenic organochlorine compounds previously used in various industrial and chemical applications prior to being banned in the Western world in the 1970s. Both PFCs and PCBs are persistent contaminants within the human organism and both have been linked to adverse health sequelae. Data is lacking on effective means to facilitate clearance of PFCs and PCBs from the body. Methods. Blood, urine, and sweat were collected from 20 individuals (10 healthy participants and 10 participants with assorted health problems) and analyzed for PFCs and PCBs using high performance liquid chromatography tandem mass spectrometry. Results. Some individual PCB congeners, but not all, were released into sweat at varying concentrations. None of the PFCs found in serum testing appeared to be excreted efficiently into perspiration. Conclusions. Induced perspiration may have some role in facilitating elimination of selected PCBs. Sweat analysis may be helpful in establishing the existence of some accrued PCBs in the human body. Sweating does not appear to facilitate clearance of accrued PFHxS (perfluorohexane sulfonate), PFOS (perfluorooctane sulfonate), or PFOA (perfluorooctanoic acid), the most common PFCs found in the human body.			1	1											1						B	B		
525	ADME	Gützkow, Kristine Bjerve; Haug, Line Småstuen; Thomsen, Cathrine; Sabaredzovic, Azemira; Becher, Georg; Brunborg, Gunnar	Placental transfer of perfluorinated compounds	2012	Int J Hyg Environ Health. 2012 Feb;215(2):216-9. doi: 10.1016/j.ijheh.2011.08.011. Epub 2011 Sep 19.	Perfluorinated compounds (PFCs) comprise a large group of man-made fluorinated chemicals used in a number of consumer products and industrial applications. PFCs have shown to be persistent, bio-accumulative and widespread in the environment. Animal studies have demonstrated hepatotoxicity, immunotoxicity, developmental toxicity as well as hormonal effects. We investigated prenatal exposure to several PFCs and detected up to seven different PFCs in 123 paired samples of human maternal and cord blood, from a subcohort of the Norwegian Mother and Child Cohort Study (MoBa). The maternal and foetal levels were significantly correlated for all PFCs tested with median PFC concentrations in cord blood ranging between 30 and 79% of the maternal concentrations, demonstrating placental passage. The composition of the different PFCs varied between cord and maternal blood, with a higher proportion of shorter chained PFCs together with a higher amount of the branched isomers of perfluorooctane sulfonate (PFOS) in cord blood. Additionally, the sulfonate group seems to impede transfer efficiency. This indicates a selective placental passage of the different PFCs and hence a specific foetal exposure.				1											1			1			D	B	PFASの母体血、臍帯血濃度に関する知見（PFNAに関しては不明）	
526	ADME	Hanssen, Linda; Dudarev, Alexey A; Huber, Sandra; Odland, Jon Øyvind; Nieboer, Evert; Sandanger, Torkjel M	Partition of perfluoroalkyl substances (PFASs)	2013	Sci Total Environ. 2013 Mar 1;447:430-7. doi: 10.1016/j.scitotenv.2013.01.029. Epub 2013 Feb 11.	Perfluoroalkyl substances (PFASs) are ubiquitous in the environment world-wide. Our overall objective was to assess the exposure to PFASs experienced by delivering women and their new-borns in the industrial city of Norilsk (arctic Russia) and the rural Aral Sea region of Uzbekistan, with the secondary objective of evaluating the distribution of PFASs between blood cell and plasma fractions. Six PFASs were detected in every sample from Norilsk city with the plasma concentration sequence of: PFOS > PFOA>PFNA>FOSA>PFHxS>PFUnDA. In the Uzbekistani samples, only PFOS was reported above the MDL (0.08 ng/mL). The median plasma concentrations of PFOS of 11.0 ng/mL for the Norilsk mothers was comparable to that reported for western countries, while that for Uzbekistan was considerably lower (0.23 ng/mL). Apparent increases in the maternal-cord concentration ratios for both whole blood and plasma were evident with the length of the carbon chain for both the carboxylate and the sulfonate PFASs. The median value of this ratio for FOSA in plasma was the lowest, while that for whole blood was the highest. Other than for FOSA, the observed plasma-whole blood concentration ratios for maternal and umbilical cord blood were consistent with a priori calculations using appropriate packed cell and plasma volumes for neonates and pregnant women at term. Clearly FOSA favored whole blood, and acid-base equilibrium calculations suggested that the resonance-stabilized sulfonamidate ion resides in the blood cell fraction. Thus for PFASs and related compounds with pK values with magnitudes comparable to physiological pH, it is pertinent to measure thecell-associated fraction (separately or as whole blood). Our study illustrates that consideration of both the physico-chemical properties of the contaminants and the physiological attributes of blood matrices were helpful in the interpretation of our findings.				1											1			1		1	A	B	ヒト（ロシア）母体臍帯血を用いたPFNAの血球移行性に関する知見	
527	ADME	Kim, S. K.; Lee, K. T.; Kang, C. S.; Tao, L.; Kannan, K.; Kim, K. R.; Kim, C. K.; Lee, J. S.; Park, P. S.; Yoo, Y. W.; Ha, J. Y.; Shin, Y. S.; Lee, J. H.	Distribution of perfluorochemicals between ser	2011	Environ Pollut. 2011 Jan;159(1):169-174. doi: 10.1016/j.envpol.2010.09.008. Epub 2010 Oct 6.	The levels of six perfluorocarboxylates (PFCAs), four perfloroalkylsulfonates (PFASs), and one sulfonamide were measured in paired samples of maternal serum, umbilical cord serum, and breast milk. The maternal and cord sera were strongly correlated with each other for all measured compounds (r>0.5 and p<0.01). Nevertheless, there was a significant difference in compound composition profile between the two sera matrices, with a more depletion of the longer chain compounds in cord serum. The transfer efficiency values from maternal to cord serum (TFCS/MS) decreased by 70% with each increasing unit of -CF2 chain within a PFCA group, and for perfluorooctanesulfonate (PFOS), by a half compared to perfluorooctanoate (PFOA). In contrast to the strong correlation in concentrations between the two sera matrices, the pattern of compounds in breast milk differed considerably with those in sera. Accordingly, compound- and matrix-specific transfer must be considered when assessing prenatal and postnatal exposure.				1											1			1			D	B	PFASの母体から臍帯血移行に関する知見（PFNAに関して不明）	
528	ADME	Needham, L. L.; Grandjean, P.; Heinzow, B.; Jørgensen, P. J.; Nielsen, F.; Patterson, D. G.; Sjödin, A.; Turner, W. E.; Weihe, P.	Partition of environmental chemicals between	2011	Environ Sci Technol. 2011 Feb 1;45(3):1121-6. doi: 10.1021/es1019614. Epub 2010 Dec 17.	Passage of environmental chemicals across the placenta has important toxicological consequences, as well as for choosing samples for analysis and for interpreting the results. To obtain systematic data, we collected in 2000 maternal and cord blood, cord tissue, placenta, and milk in connection with births in the Faroe Islands, where exposures to marine contaminants is increased. In 15 sample sets, we measured a total of 87 environmental chemicals, almost all of which were detected both in maternal and fetal tissues. The maternal serum lipid-based concentrations of organohalogen compounds averaged 1.7 times those of cord serum, 2.8 times those of cord tissue and placenta, and 0.7 those of milk. For organohalogen compounds detectable in all matrices, a high degree of correlation between concentrations in maternal serum and the other tissues investigated was generally observed (r(2) >; 0.5). Greater degree of chlorination resulted in lower transfer from maternal serum into milk. Concentrations of pentachlorbenzene, γ-hexachlorocyclohexane, and several polychlorinated biphenyl congeners with low chlorination were higher in fetal samples and showed poor correlation with maternal levels. Perfluorinated compounds occurred in lower concentrations in cord serum than in maternal serum. Cadmium, lead, mercury, and selenium were all detected in fetal samples, but only mercuryshowed close correlations among concentrations in different matrices. Although the environmental chemicals examined pass through the placenta and are excreted into milk, partitions between maternal and fetal samples are not uniform.				1											1						D	D	ヒト（フェロー諸島）における母体、臍帯血、臍帯組織、胎盤、母乳におけるPFAS濃度に関する知見（PFNAについては不明）	
529	ADME	Vanden Heuvel, J P; Kuslikis, B I; Van Rafelghem, M J; Peterson, R E	Disposition of perfluorodecanoic acid in male a	1991	Toxicol Appl Pharmacol. 1991 Mar 1;107(3):450-9. doi: 10.1016/0041-008x(91)90308-2.	The elimination, tissue distribution, and metabolism of [1-14C]PFDA were examined in male and female rats for 28 days after a single ip dose (9.4 mumol/kg, 5 mg/kg). A sex difference in the fecal elimination of perfluorodecanoic acid (PFDA) was observed with 51 and 24% of the administered 14C being recovered in the feces of male and female rats, respectively, by 28 days post-treatment. The cumulative excretion of PFDA-derived 14C in the urine in 28 days was less than 5% of the administered dose in both sexes. The sex-related difference in the rate of fecal elimination resulted in the observed difference in whole body elimination t1/2 of PFDA in males (t1/2 = 23 days) and females (t1/2 = 45 days). The liver contained the highest concentration of PFDA-derived 14C in both males and females, followed by the plasma and kidneys. The heart, fat pads, testes, and gastrocnemius muscle of males, and the ovaries of females contained much lower concentrations of PFDA. The reason for the high percentage of the ip dose of [1-14C]PFDA in the liver (53% males and 41% females, 2 hr post-treatment) was further examined using an in situ nonrecirculating liver perfusion technique. It was shown that approximately 25% of the [14C]PFDA in the perfusate was extracted by the liver in a single pass. The basis for the sex difference in fecal elimination of PFDA does not appear to be due to a sex difference in biliary excretion. In a 6-hr period, male and female rats with kidneys ligated eliminated essentially the same percentage dose of [14C]PFDA into bile. We had hypothesized that the persistence of PFDA in rats was due to formation of a PFDA-containinglipid (i.e., a [14C]PFDA-containing mono-, di-, or triacylglycerol, cholesteryl ester, methyl ester, or phospholipid). However, no evidence that PFDA is conjugated to form persistent hybrid lipids was obtained, nor were polar metabolites of PFDA detected in urine or bile. In addition, daily urinary excretion of fluoride in male and female rats before and after PFDA treatment was similar, suggesting that the parent compound is not defluorinated. Thus, the disposition of PFDA in male and female rats is characterized by an apparent lack of biotransformation.			1	1											1						D	B	ラットにおけるPFDAの体内動態に関する知見（PFHxA、PFNAに関して不明）	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
530	ADME	Vanden Heuvel, J P; Kuslikis, B I; Van Rafelghem, M J; Peterson, R E	Tissue distribution, metabolism, and eliminatio	1991	J Biochem Toxicol. 1991 Summer;6(2):83-92. doi: 10.1002/jbt.2570060202.	The elimination, tissue distribution, and metabolism of [1-14C]perfluorooctanoic acid (PFOA) was examined in male and female rats for 28 days after a single ip dose (9.4 mumol/kg, 4 mg/kg). A sex difference in urinary elimination of PFOA-derived 14C was observed. Female rats eliminated PFOA-derived radioactivity rapidly in the urine with 91% of the dose being excreted in the first 24 hr. In the same period, male rats eliminated only 6% of the administered 14C in the urine. The sex-related difference in urinary elimination resulted in the observed difference in the whole-body elimination half-life (t1/2) of PFOA in males (t1/2 = 15 days) and females (t1/2 less than 1 day). Analysis of PFOA-derived 14C in tissues showed that the liver and plasma of male rats and the liver, plasma, and kidney of female rats were the primary tissues of distribution. The relatively high concentration of PFOA in the male liver was further examined using an in situ nonrecirculating liver perfusion technique. It was shown that 11% of the PFOA infused was extracted by the liver in a single pass. The ability of the liver to eliminate PFOA into bile was examined in rats whose renal pedicles were ligated to alleviate sex differences in the urinary excretion of PFOA. In a 6-hr period following IP administration of PFOA, there was no apparent difference in biliary excretion, where both males and females eliminated less than 1% of the PFOA dose via this route. We hypothesized that the sex difference in the persistence of PFOA was due to a more rapid formation of a PFOA-containing lipid (i.e., a PFOA-containing mono-, di-, or triacylglycerol, cholesteryl ester,methyl ester, or phospholipid) in the male rat. Also, the increased urinary elimination of PFOA in females may have been due to increased metabolism to a PFOA-glucuronide or sulfate ester. However, no evidence that PFOA is conjugated to form a persistent hybrid lipid was obtained, nor were polar metabolites of PFOA in urine or bile detected. In addition, daily urinary excretion of fluoride in male and female rats before or after PFOA treatment were similar, suggesting that the parent compound is not defluorinated. Thus, the more rapid elimination of PFOA from female rats is not due to formation of a PFOA metabolite.		1	1										1								D	C	ラットにおけるPFOAの体内動態に関する知見（PFHxA、PFNAに関して不明）	
531	ADME	Bischel, Heather N; Macmanus-Spencer, Laura A; Luthy, Richard G	Noncovalent interactions of long-chain perfluo	2010	Environ Sci Technol. 2010 Jul 1;44(13):5263-9. doi: 10.1021/es101334s.	Preferential distribution of long-chain perfluoroalkyl acids (PFAAs) in the liver, kidney, and blood of organisms highlights the importance of PFAA-protein interactions in PFAA tissue distribution patterns. A serum protein association constant may be a useful parameter to characterize the bioaccumulative potential and in vivo bioavailability of PFAAs. In this work, association constants (K(a)) and binding stoichiometries for PFAA-albumin complexes are quantified over a wide range of PFAA:albumin mole ratios. Primary association constants for perfluorooctanoate (PFOA) or perfluorononanoate (PFNA) with the model protein bovine serum albumin (BSA) determined via equilibrium dialysis are on the order of 10(6) M(-1) with one to three primary binding sites. PFNA was greater than 99.9% bound to BSA or human serum albumin (HSA) at a physiological PFAA:albumin mole ratio (<10(-3)), corresponding to a high protein-water distribution coefficient (log K(PW) > 4). Nanoelectrospray ionization mass spectrometry (nanoESI-MS) data reveal PFAA-BSA complexes with up to eight occupied binding sites at a 4:1 PFAA:albumin mole ratio. Association constants estimated by nanoESI-MS are on the order of 10(5) M(-1) for PFOA and PFNA and 10(4) M(-1) for perfluorodecanoate and perfluorooctanesulfonate. The results reported here suggest binding through specific high affinity interactions at low PFAA:albumin mole ratios.	1	1	1									1								1	B	A		
532	ADME	Eryasa, B.; Grandjean, P.; Nielsen, F.; Valvi, D.; Zmirou-Navier, D.; Sunderland, E.; Weihe, P.; Oulhote, Y.	Physico-chemical properties and gestational d	2019	Environ Int. 2019 Sep;130:104874. doi: 10.1016/j.envint.2019.05.068. Epub 2019 Jun 11.	Background: Per- and polyfluoroalkyl substances (PFASs) are a growing public health concern. Some longer chain PFASs bioaccumulate and many compounds persist in the environment for long time periods. Recent studies have established their ability to pass through placenta, yet data on the transplacental transfer efficiency and partitioning of short and long chain PFASs in blood matrices are limited. Objectives: To assess predictors of the partitioning of 17 PFAS compounds detected in the maternal serum, umbilical cord serum and whole cord blood samples from matched mother-newborn pairs from two Faroe Islands cohorts. Methods: We examined 151 mother-newborn pairs from two successive Faroese birth cohorts. Cord:maternal serum (transplacental transfer) and serum:whole cord blood (blood partitioning) ratios were estimated for 17 PFAS compounds. We also examined the relationships of these ratios with maternal, newborns', and physico-chemical properties using multivariable regression analyses. Results: Moderate to high correlations were observed between maternal and cord serum PFAS concentrations (ρ : 0.41 to 0.95), indicating significant transfer of these compounds from the mother to the fetus. Median transplacental transfer ratios were generally below 1, except for perfluorooctane sulfonamide (FOSA), and ranged between 0.36 for perfluorodecanoate (PFDA) and perfluoroundecanoate (PFUnDA) and 1.21 for FOSA. Most PFASs exhibited a preference to the serum component of the blood, except FOSA and perfluoroheptanoate (PFHpA), with blood partitioning ratios ranging from 0.36 for FOSA to 2.75 for PFUnDA. Both the functional groups and carbon chain length of different PFASs were important predictors of transplacental transfer and blood partitioning. We observed a U-shaped relationship between transplacental transfer ratios and carbon chain length for perfluorocarboxylates and perfluorosulfonates. Importantly, gestational diabetes was also a strong predictor of transplacental transfer ratios, with significantly higher transfer in mothers with gestational diabetes. Conclusions: Our findings provide a better understanding of the transplacental transfer and blood partitioning of a large number of PFAS compounds. Results elucidate the importance of chemical structure for future risk assessments and choice of appropriate blood matrices for measurement of PFAS compounds.				1									1								D	B	ヒト（フェロー諸島）における母体、臍帯血乳におけるPFAS濃度に関する知見（PFNAについては不明）	
533	ADME	Gannon SA, Johnson T, Nabb DL, Serex TL, Buck RC and Loveless SE.	Absorption, distribution, metabolism, and excre	2011	Toxicology, 283, 55–62. doi: 10.1016/j.tox.2011.02.004	The absorption, tissue distribution, elimination, and metabolism of [1-^{14}C]-PFHx in rats and mice dosed orally at 2 or 100 mg/kg was evaluated following a single dose or after 14 consecutive doses. Absorption was rapid in rats as evidenced by a short time to maximum concentration (C(max)) of 30 min in male rats and 15 min in female rats at both the 2 and 100mg/kg dose level. The plasma elimination half-life was somewhat longer in males (1.5-1.7 h) than in females (0.5-0.7 h). Absorption in the mouse was also rapid with the maximum plasma concentration occurring between 15 and 30 min after dosing. The maximum concentration was not appreciably different between male and female mice (8 μg equiv./g at 2 mg/kg; ~350 μg equiv./g at 100 mg/kg). The primary route of elimination was via the urine. PFHx was not metabolized in rat or mouse hepatocytes, nor were any metabolites observed after oral dosing in either rodent species. Essentially 100% of the dose was eliminated in urine within 24 h demonstrating that PFHx is readily absorbed and bioavailability approaches 100%, even at a dose as high as 100 mg/kg. The route and extent of elimination was unchanged after 14 days of daily dosing. Tissues were collected at three time points (rat: 0.5, 2, and 24 h; mice: 0.25, 1, and 24 h) after dosing to investigate the tissue clearance kinetics of PFHx following a single dose at 2 or 100 mg/kg. In all tissues except skin, PFHx was not quantifiable 24 h after dosing in both sexes of the two species.		1	1										1	No. 483と重複		A	B	ラット、マウスにおけるPFHxAの体内動態に関する知見	
534	PBPK	Gribble, Matthew O; Bartell, Scott M; Kannan, Kurunthachalam; Wu, Qian; Fair, Patricia A; Kamen, Diane L	Longitudinal measures of perfluoroalkyl substa	2015	Environ Res. 2015 Nov;143(Pt B):82-8. doi: 10.1016/j.envres.2015.03.012. Epub 2015 Mar 26.	BACKGROUND: Charleston Harbor has elevated concentrations of PFAS in dolphins, but local human exposure data are limited. OBJECTIVES: We sought to describe PFAS serum concentrations' temporal trends among Gullah African American residents of coastal South Carolina. METHODS: Longitudinal measures of PFAS in blood serum from a Gullah clinical sample, without lupus, were examined using spaghetti plots and visit-to-visit change scores (e.g., differences in concentrations between visits) among the 68 participants with repeated measures available. We also modeled population-level trends among the 71 participants with any data using proportionate percentile models, accounting for clustering through robust standard errors. In a post-hoc analysis we examined heterogeneity of temporal trends by age through mixed-effects models for the log-transformed PFAS compounds. RESULTS: Population concentrations of PFOS dropped approximately 9 (95% CI: 8, 10) percent each year over 2003-2013. This was concordant with individual PFOS trajectories (median PFOS change score -21.7 ng/g wet weight, interquartile range of PFOS change scores: -32.8, -14.9) and reports for other populations over this time period. Several other compounds including PFOA, PFHxS, and PFuNDA also showed a population-level decrease. However, examination of individual trajectories suggested substantial heterogeneity. Post-hoc analyses indicated that PFAS trajectories were heterogeneous by age. CONCLUSIONS: Many PFAS compounds are decreasing in a sample of Gullah African Americans from coastal South Carolina. There may be age differences in the elimination kineticsof PFASs. The possible role of age as a modifier of PFAS serum trends merits further research.				1									1								D	B	ヒト（サウスカロライナ州）における曝露濃度に関する知見（PFNAについては不明）	
535	ADME	Guruge, Keerthi S; Noguchi, Michiko; Yoshioka, Koji; Yamazaki, Eriko; Taniyasu, Sachi; Yoshioka, Miyako; Yamanaka, Noriko; Ikezawa, Mitsutaka; Tanimura, Nobuhiko; Sato, Masumi; Yamashita, Nobuyoshi; Kawaguchi, Hiroaki	Microminipigs as a new experimental animal m	2016	J Appl Toxicol. 2016 Jan;36(1):68-75. doi: 10.1002/jat.3145. Epub 2015 Apr 15.	In this study, we evaluated the efficacy of a novel minipig strain, the Microminipig (MMPig), as an animal model for studying the pharmacokinetics of a mixture of 10 perfluoroalkyl acids (PFAAs). After a single oral dose was given, we found that the blood depuration of PFAAs (blood t1/2), which we calculated using first-order elimination curves, ranged from 1.6 to 86.6 days. Among the five body compartments analyzed, the liver was the greatest site of accumulation of perfluorooctanesulfonate and longer chain perfluorinated carboxylates such as perfluorodecanoic acid, perfluoroundecanoic acid and perfluorododecanoic acid. We observed an increasing accumulation trend of perfluorinated carboxylates in the organs associated with the fluorinated carbon chain length. The perfluorononanoic acid burden was the highest among the treated compounds 21 days after a single exposure, as 29% of the given perfluorononanoic acid dose was accumulated in the tissues. The persistence of PFAAs in edible pig tissues even after 21 days post-exposure raises concerns about the safety of swine products. This was the first study to use MMPigs to elucidate the pharmacokinetics of a group of environmental pollutants. We found that MMPigs could be excellent experimental animals for toxicological studies due to their easy handling, cost efficacy for target compounds and ease of waste treatment.	1	1	1									1								B	B		
536	ADME	Hebert, Paul C; MacManus-Spencer, Laura A	Development of a fluorescence model for the b	2010	Anal Chem. 2010 Aug 1;82(15):6463-71. doi: 10.1021/ac100721e.	A novel model for measuring the strength of perfluoroalkyl acid (PFAA) binding to human serum albumin (HSA) by use of the protein's native fluorescence is described. The model is derived from published properties of HSA and its interactions with other surfactants; it is consistent with these properties and experimental observations. The model's validity has been tested with both medium- to long-chain PFAAs (perfluoroheptanoate, perfluorooctanoate, perfluorononanoate, perfluorodecanoate, perfluoroundecanoate, perfluorohexanesulfonate, and perfluorooctanesulfonate) and short-chain PFAAs (perfluorohexanoate and perfluorobutanesulfonate). These experiments confirm the model as a valid description for the binding of medium- to long-chain PFAAs to HSA. Results indicate at least 2-3 PFAAs bind to each protein with affinity on the order of 10(4) M(-1). These binding strengths exhibit a dependence on protein concentration. Measured PFAA binding constants are approximately 10% of those values reported for fatty acids of similar chain length; correcting for protein concentration suggests the binding strengths may be as low as 2-3% of the corresponding fatty acids' affinities. Like fatty acids, the carboxylate PFAAs exhibit a trend of generally increasing binding strength with increased chain length. The model does not appear valid for the binding of short-chain PFAAs to HSA. Hill binding coefficients, fluorescence intensity measurements, and wavelengths of maximum emission suggest short-chain PFAAs associate with HSA differently and fail to promote the same conformational changes in the protein'stertiary structure as the medium- to long-chain PFAAs.				1									1								C	C		
537	ADME	Zhao, W.; Zitzow, J. D.; Ehresman, D. J.; Chang, S. C.; Butenhoff, J. L.; Forster, J.; Hagenbuch, B.	Na+/taurocholate cotransporting polypeptide a	2015	Toxicol Sci. 2015 Aug;146(2):363-73. doi: 10.1093/toxsci/kfv102. Epub 2015 May 21.	Among the perfluoroalkyl sulfonates (PFASs), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS) have half-lives of several years in humans, mainly due to slow renal clearance and potential hepatic accumulation. Both compounds undergo enterohepatic circulation. To determine whether transporters involved in the enterohepatic circulation of bile acids are also involved in the disposition of PFASs, uptake of perfluorobutane sulfonate (PFBS), PFHxS, and PFOS was measured using freshly isolated human and rat hepatocytes in the absence or presence of sodium. The results demonstrated sodium-dependent uptake for all 3 PFASs. Given that the Na(+)/taurocholate cotransporting polypeptide (NTCP) and the apical sodium-dependent bile salt transporter (ASBT) are essential for the enterohepatic circulation of bile acids, transport of PFASs was investigated in stable CHO Flp-In cells for human NTCP or HEK293 cells transiently expressing rat NTCP, human ASBT, and rat ASBT. The results demonstrated that both human and rat NTCP can transport PFBS, PFHxS, and PFOS. Kinetics with human NTCP revealed Km values of 39.6, 112, and 130 μM for PFBS, PFHxS, and PFOS, respectively. For rat NTCP Km values were 76.2 and 294 μM for PFBS and PFHxS, respectively. Only PFOS was transported by human ASBT whereas rat ASBT did not transport any of the testedPFASs. Human OST α / β was also able to transport all 3 PFASs. In conclusion, these results suggest that the long half-live and the hepatic accumulation of PFOS in humans are at least, in part, due to transport by NTCP and ASBT.				1									1								B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
538	遺伝毒性	Crebelli, R.; Caiola, S.; Conti, L.; Cordelli, E.; De Luca, G.; Dellatte, E.; Eleuteri, P.; Iacovella, N.; Leopardi, P.; Marcon, F.; Sanchez, M.; Sestili, P.; Siniscalchi, E.; Villani, P.	Can sustained exposure to PFAS trigger a gene	2019	Regul Toxicol Pharmacol 106: 169177. doi: 10.1016/j.yrtph.2019.05.005.	PFAS (perfluoroalkyl substances) are considered non-genotoxic. However, PFAS exposure has been associated with the induction of oxidative stress in vitro and in vivo, and the possible induction of indirect genotoxic effects under sustained PFAS exposure has not been investigated. In order to shed light on this aspect, in this study a comprehensive assessment of genotoxicity was carried out in mice administered with perfluorooctanoic acid (PFOA, 0.1, 1 and 5 mg/kg body weight) and its C4 analogue perfluorobutyric acid (PFBA, 5 mg/kg body weight) for five weeks through drinking water. Markers of cell toxicity, oxidative stress and DNA strand breaks were measured in liver, the main target of toxicity of PFOA in rodents; systemic genotoxicity was also assessed by the analysis of micronuclei in reticulocytes and spleen lymphocytes, and germ cell effects by the Comet assay on testis cells. PFOA administration at the highest dose (5 mg/kg body weight) induced marked liver hypertrophy with signs of cell injury (elevated ALT and AST), with no concurrent evidence of lipid peroxidation and oxidative stress (decreased antioxidant capacity). Only mild liver hypertrophy, with no other signs of toxicity, was determined by PFBA administration. No evidence of treatment related genotoxicity was observed in any experimental group. Overall, dataindicate that under the experimental conditions of this study, severe liver toxicity induced by PFOA administration is not associated with oxidative stress. Accordingly, no genotoxic effect is observed in liver and in the other tissues examined. Milder evidence of liver toxicity, with no genotoxicity, and a lower tendency to bioaccumulation were observed in PFBA treated mice.	1					1								1					1		A	-	PFBAへの持続的な暴露下で間接的な遺伝毒性作用が誘発される可能性について、ターゲットと考えられる肝臓でも検討しており、酸化ストレスと肝毒性の関係にも言及している。	
539	遺伝毒性	Eriksen, Kirsten Thorup; Raaschou-Nielsen, Ole; Sørensen, Mette; Roursgaard, Martin; Loft, Steffen; Møller, Peter	Genotoxic potential of the perfluorinated chem	2010	Mutat Res. 2010 Jul 19;700(1-2):39-43. doi: 10.1016/j.mrgentox.2010.04.024. Epub 2010 May 6.	Synthetically produced perfluorinated chemicals (PFCs) are widely used in industrial products because of their anti-wetting and surfactant properties. PFCs are suspected carcinogens and a possible mechanism of action is generation of oxidative stress. We have investigated the potential of five different PFCs to generate reactive oxygen species (ROS) and to induce oxidative DNA damage in HepG2 cells. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) increased the intracellular ROS production by 1.52-fold (95% CI, 1.37-1.67) and 1.25-fold (95% CI, 1.10-1.40), respectively. However, the increase in ROS production was not concentration-dependent and the compounds did not generate DNA damage that could be detected by the alkaline comet assay as strand breakage and alkali-labile sites or formamidopyrimidine-DNA-glycosylase (FPG) sites. Perfluorobutane sulfonate (PFBS) and perfluorohexanoic acid (PFHxA) did not generate ROS or DNA damage. Only the exposure to perfluorononanoic acid (PFNA) caused a modest increase in DNA damage at a cytotoxic concentration level, which was detected as lactate dehydrogenase (LDH) release into the cell medium. This was not related to ROS generation. Collectively, these results indicate that PFCs induce only modest effects in terms of ROS production and DNA damage in a cell line representing the human liver.		1	1	1		1	1			1	1				1			1		A	-	ヒトHepG2細胞におけるペルフルオロ化学物質PFOA、PFOS、PFBS、PFNAおよびPFHxAの遺伝毒性ポテンシャルを評価しており、酸化ストレスとの関係にも言及している。	
540	遺伝毒性	Nobels, Ingrid; Dardenne, Freddy; De Coen, Wim; Blust, Ronny	Application of a multiple endpoint bacterial rep	2010	Toxicol In Vitro. 2010 Sep;24(6):1768-74. doi: 10.1016/j.tiv.2010.07.002. Epub 2010 Jul 7.	Perfluorinated compounds are widely distributed in the environment; good knowledge about the toxic mode of action of these compounds can contribute to improved molecular design and risk assessment. The studied compounds were evaluated with a bacterial multiple endpoint reporter assay for responses in four different mode of action classes (oxidative damage, DNA damage, general cell lesions and membrane damage). The results of our study clearly demonstrate that inductions of stress responsive genes occur for the different compounds and confirm some of the known mechanisms of work for well studied compounds like PFOA and PFOS, and in addition provide new information for less studied compounds. Few inductions were observed after exposure to the low carbon number carboxylic acids, PFBtA (CF(3)(CF(2))(2)C(O)O(-)), PFPtA (CF(3)(CF(2))(3)C(O)O(-)), PFHxA (CF(3)(CF(2))(4)C(O)O(-)) and PFHpA (CF(3)(CF(2))(5)C(O)O(-)) at equimolar concentrations (0.0156-1 mM). The induction of membrane damage markers (MicF and OsmY) is prominently present after exposure to PFOS (CF(3)(CF(2))(7)SO(3)(-)) and even more after exposure to PFNA (CF(3)(CF(2))(7)C(O)O(-)). This is the first report describing the mode of action of carboxylic acids with 11 and 12 carbon atoms; they are equally potent inducers relative to PFOS and PFNA. Overall, the effects seen at the level of gene expression were higher for the sulfonic acids than for the carboxylic acids, but the effect of the chain length is more important than the effect of the functional group.			1	1			1													C	-		
541	細胞毒性	Sheng, N.; Cui, R.; Wang, J.; Guo, Y.; Wang, J.; Dai, J.	Cytotoxicity of novel fluorinated alternatives to	2018	Arch Toxicol. 2018 Jan;92(1):359-369. doi: 10.1007/s00204-017-2055-1. Epub 2017 Sep 1.	Although shorter chain homologues and other types of fluorinated chemicals are currently used as alternatives to long-chain perfluoroalkyl substances (PFASs), their safety information remains unclear and urgently needed. Here, the cytotoxicity of several fluorinated alternatives (i.e., 6:2 fluorotelomer carboxylic acid (6:2 FTCA), 6:2 fluorotelomer sulfonic acid (6:2 FTSA), 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFESA), and hexafluoropropylene oxide (HFPO) homologues) to human liver HL-7702 cell line were measured and compared with perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Their binding mode and affinity to human liver fatty acid binding protein (hL-FABP) were also determined. Compared with PFOA and PFOS, 6:2 Cl-PFESA, HFPO trimer acid (HFPO-TA), HFPO tetramer acid (HFPO-TeA), and 6:2 FTSA showed greater toxic effects on cell viabilities. At low exposure doses, these alternatives induced cell proliferation with similar mechanism which was different from that of PFOA and PFOS. Furthermore, binding affinity to hL-FABP decreased in the order of 6:2 FTCA < 6:2 FTSA < HFPO dimer acid (HFPO-DA) < PFOA < PFOS/6:2 Cl-PFESA/HFPO-TA. Due to their distinctive structure, 6:2 Cl-PFESA and HFPO homologues were bound to the hL-FABP inner pocket with unique binding modes and higher binding energy compared with PFOA and PFOS. This research enhances our understanding of the toxicity of PFAS alternatives during usage and provides useful evidence for the development of new alternatives.					1			1					1							B	-		
542	細胞毒性	Gorrochategui, Eva; Pérez-Albaladejo, Elisabet; Casas, Josefina; Lacorte, Silvia; Porte, Cinta	Perfluorinated chemicals: differential toxicity, i	2014	Toxicol Appl Pharmacol. 2014 Jun 1;277(2):124-30. doi: 10.1016/j.taap.2014.03.012. Epub 2014 Mar 26.	The cytotoxicity of eight perfluorinated chemicals (PFCs), namely, perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorododecanoic acid (PFDoA), perfluorobutanesulfonate (PFBS), perfluorohexanesulfonate (PFHxS) and perfluorooctanesulfonate (PFOS) was assessed in the human placental choriocarcinoma cell line JEG-3. Only the long chain PFCs--PFOS, PFDoA, PFNA, PFOA--showed significant cytotoxicity in JEG-3 cells with EC50 values in the range of 107 to 647 μM. The observed cytotoxicity was to some extent related to a higher uptake of the longer chain PFCs by cells (PFDoA>PFOS≫PFNA>PFOA>PFHxA). Moreover, this work evidences a high potential of PFOS, PFOA and PFBS to act as aromatase inhibitors in placental cells with IC50s in the range of 57-80 μM, the inhibitory effect of PFBS being particularly important despite the rather low uptake of the compound by cells. Finally, exposure of JEG-3 cells to a mixture of the eight PFCs (0.6 μM each) led to a relative increase (up to 3.4-fold) of several lipid classes, including phosphatidylcholines (PCs), plasmalogen PC and lyso plasmalogen PC, which suggests an interference of PFCs with membrane lipids. Overall, this work highlights the ability of the PFC mixture to alter cellular lipid pattern at concentrations well below those that generate toxicity, and the potential of the short chain PFBS, often considered a safe substitute of PFOS, to significantly inhibit aromatase activity in placental cells.				1	1						1	1								B	-		
543	細胞毒性	Liu, Shuyu; Yang, Renjun; Yin, Nuoya; Faiola, Francesco	The short-chain perfluorinated compounds PF	2020	J Environ Sci (China). 2020 Feb;88:187-199. doi: 10.1016/j.jes.2019.08.016. Epub 2019 Sep 3.	Per- and polyfluorinated alkyl substances (PFASs) are commonly used in industrial processes and daily life products. Because they are persistent, they accumulate in the environment, wildlife and humans. Although many studies have focused on two of the most representative PFASs, PFOS and PFOA, the potential toxicity of short-chain PFASs has not yet been given sufficient attention. We used a battery of assays to evaluate the toxicity of several four-carbon and six-carbon perfluorinated sulfonates and carboxyl acids (PFBS, PFHxS, PFBA and PFHxA), with a human mesenchymal stem cell (hMSC) system. Our results demonstrate significant cyto- and potential developmental toxicity for all the compounds analyzed, with shared but also distinct mechanisms of toxicity. Moreover, the effects of PFBS and PFHxS were stronger than those of PFBA and PFHxA, but occurred at higher doses compared to PFOS or PFOA.	1	1	1	1						1									C	-		
544	細胞毒性	Buhrke, Thorsten; Kibellus, Anja; Lampen, Alfonso	In vitro toxicological characterization of perfluo	2013	Toxicol Lett. 2013 Apr 12;218(2):97-104. doi: 10.1016/j.toxlet.2013.01.025. Epub 2013 Feb 4.	Perfluorooctanoic acid (PFOA) is in use for the production of fluoropolymers (PFT). Due to its toxic properties it was proposed to replace the substance in its industrial applications by homologous compounds with shorter carbon chain length that were supposed to be less toxic compared to PFOA, however, the smaller PFOA homologs are poorly characterized so far. In this study we have conducted a comparative analysis of the toxicity of perfluorinated carboxylic acids (PFCA) with a carbon chain length ranging from four to twelve carbon atoms. By using the human hepatocarcinoma cell line HepG2 as an in vitro model for human hepatocytes we could show a positive correlation between the carbon chain length of the respective PFCA and its cytotoxicity. There was, however, no indication of an apoptotic mechanism for cytotoxicity. All PFCA under investigation were negative in two independent genotoxicity assays. As PFOA, being a well-known peroxisome proliferator, the other PFCA tested in this study were also shown to activate human peroxisome proliferator-activated receptor alpha (PPARα) with PFOA having the highest potential of PPARα activation. Moreover, the compounds showed weak potential to activate PPARγ and hardly activated PPARδ. Taken together, the in vitro study revealed that PFCA with a shorter carbon chain length seem to be less toxic than PFOA.			1							1						1			B	-		
545	遺伝毒性	Takagi, A; Sai, K; Umemura, T; Hasegawa, R; Kurokawa, Y	Short-term exposure to the peroxisome prolife	1991	Cancer Lett. 1991 Apr;57(1):55-60. doi: 10.1016/0304-3835(91)90063-n.	To elucidate the relationship between peroxisome proliferation by perfluorinated compounds and oxidative DNA damage, perfluorooctanoic acid (PFOA), perfluorodecanoic acid (PFDA), perfluorobutyric acid (PFBA) and perfluorooctane (PFO) were administered to 6-week-old F-344 male rats. After a single intraperitoneal (i.p.) injection of PFOA, PFBA or PFO in corn oil at a dose of 100 mg/kg, significant increases of liver weight and 8-hydroxydeoxyguanosine (8-OH-dG) levels in liver DNA were observed in PFOA-treated rats. Oral administration of powdered diet containing 0.02% PFOA or 0.01% PFDA for 2 weeks resulted in significant increases of liver weight and 8-OH-dG levels in liver DNA in rats given both chemicals. On the other hand, no increase in 8-OH-dG levels in kidney DNA was found in either of the studies. Our results demonstrate that, as with other peroxisome proliferators (phthalic ester plasticizers and hypolipidemic drugs), PFOA and PFDA induced peroxisome proliferation also leads to organ specific oxidative DNA damage.	1													1				1	A	-	PFOAとPFDAによるペルオキシソーム増殖も臓器特異的な酸化的DNA損傷を引き起こすことを示している	
546	細胞毒性	Berntsen, Hanne Friis; Bjørklund, Cesilie Granum; Audinot, Jean-Nicolas; Hofer, Tim; Verhaegen, Steven; Lentzen, Esther; Gutleb, Arno Christian; Ropstad, Erik	Time-dependent effects of perfluorinated com	2017	Neurotoxicology. 2017 Dec;63:70-83. doi: 10.1016/j.neuro.2017.09.005. Epub 2017 Sep 15.	The toxicity of long chained perfluoroalkyl acids (PFAAs) has previously been reported to be related to the length of the perfluorinated carbon chain and functional group attached. In the present study, we compared the cytotoxicity of six PFAAs, using primary cultures of rat cerebellar granule neurons (CGNs). Two perfluoroalkyl sulfonic acids (PFSAs, chain length C(6) and C(8)) and four perfluoroalkyl carboxylic acids (PFCAs, chain length C(8)-C(11)) were studied. These PFAAs have been detected in human blood and the brain tissue of mammals. The cell viability trypan blue and MTT assays were used to determine toxicity potencies (based on LC(50) values) after 24h exposure (in descending order): perfluoroundecanoic acid (PFUnDA)≥perfluorodecanoic acid (PFDA)>perfluorooctanesulfonic acid potassium salt (PFOS)>perfluorononanoic acid (PFNA)>perfluorooctanoic acid (PFOA)>perfluorohexanesulfonic acid potassium salt (PFHxS). Concentrations of the six PFAAs that produced equipotent effects after 24h exposure were used to further explore the dynamics of viability changes during this period. Therefore viability was assessed at 10, 30, 60, 90, 120 and 180min as well as 6, 12, 18 and 24h. A difference in the onset of reduction in viability was observed, occurring relatively quickly (30-60min) for PFOS, PFDA and PFUnDA, and much slower (12-24h) for PFHxS, PFOA and PFNA. A slight protective effect of vitamin E against PFOA, PFNA and PFOS-induced reduction in viability indicated a possible involvement of oxidative stress. PFOA and PFOS did not induce lipid peroxidation on their own, but significantly accelerated cumenehydroperoxide-induced lipid peroxidation. When distribution of the six PFAAs in the CGN-membrane was investigated using NanoSIMS50 imaging, two distinct patterns appeared. Whereas PFHxS, PFOS and PFUnDA aggregated in large hotspots, PFOA, PFNA and PFDA showed a more dispersed distribution pattern. In conclusion, the toxicity of the investigated PFAAs increased with increasing carbon chain length. For molecules with a similar chain length, a sulfonate functional group led to greater toxicity than a carboxyl group.					1												1			B	-		
547	細胞毒性	Fang, Xuemei; Wu, Chao; Li, Hongxia; Yuan, Weifeng; Wang, Xin	Elevation of intracellular calcium and oxidative	2018	Toxicol Ind Health. 2018 Mar;34(3):139-145. doi: 10.1177/0748233717742262. Epub 2017 Nov 29.	Perfluorononanoic acid (PFNA) is one of the major perfluorinated compounds found in both biological and abiotic samples and has recently been demonstrated to cause neurobehavioral defects in mammals. In this study, pheochromocytoma-12 (PC12) cells were exposed to various doses of PFNA to explore the cytotoxicity of PFNA to neurons and the possible mechanisms underlying these effects. The results showed that exposure to PFNA dose-dependently decreased the viability of PC12 cells and increased the release of lactate dehydrogenase into cell culture media. Exposure to PFNA increased the malondialdehyde content and decreased the total antioxidant capacity and glutathione peroxidase activity in PC12 cell culture supernatants. Exposure to PFNA increased the intracellular calcium level and upregulated the Ca(2+)/calmodulin-dependent protein kinase II (CaMKII) expression in PC12 cells. PFNA also decreased Bcl-2 expression and increased Bax expression in PC12 cells. These results suggested that exposure to PFNA elevated the intracellular calcium level and activated the CaMKII signaling pathway, which may aggravate oxidative stress in PC12 cells and lead to cell damage or cell apoptosis.				1												1			B	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
548	遺伝毒性	Liu, Changhui; Chang, Victor W C; Gin, Karina Y H; Nguyen, Viet Tung	Genotoxicity of perfluorinated chemicals (PFCs	2014	Sci Total Environ. 2014 Jul 15;487:117-22. doi: 10.1016/j.scitotenv.2014.04.017. Epub 2014 Apr 27.	Concerns regarding perfluorinated chemicals (PFCs) have grown significantly in recent years. However, regulations and guidelines regarding the emission and treatment of PFCs are still missing in most parts of the world, mostly due to the lack of PFC toxicity data. In the current study, the genotoxic effects of four common PFCs, named perfluorooctanesulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) were investigated on marine mussels. The effects of exposure time and concentration on the toxic behavior of the compounds were also examined. Genotoxicity of PFCs was assessed in biomarker assays, showing that exposure to the target compounds could damage the organism's genetic material to varying extents, including DNA strand breaks and fragmentation, chromosomal breaks and apoptosis. The adverse effects increased with both exposure concentration and time and were related with the organism burden of PFCs. The integrated biomarker response analysis demonstrated that PFOS exhibited a higher genotoxicity than the other tested compounds. The EC50 values and confidence intervals based on integrative genotoxicity were 33 (29-37), 594 (341-1036), 195 (144-265) and 78 (73-84) μg/L for PFOS, PFOA, PFNA and PFDA respectively, classifying PFOS as a highly genotoxic compound. Although primary DNA damage was shown to be recoverable after exposure ceased, permanent genetic damage caused by elevated PFC concentrations was not restored. This is the first ecotoxicity study of PFCs that focuses on the genotoxic effects of the compounds, clearly indicating the genotoxicity of the tested PFCs anddemonstrating that functional groups have a major impact on the compounds' genotoxic behavior.			1															1			B	-		
549	細胞毒性	Rand, Amy A; Rooney, John P; Butt, Craig M; Meyer, Joel N; Mabury, Scott A	Cellular toxicity associated with exposure to pe	2014	Chem Res Toxicol. 2014 Jan 21;27(1):42-50. doi: 10.1021/tx400317p. Epub 2013 Dec 17.	The biotransformation of fluorotelomer based compounds yields saturated and unsaturated fluorotelomer aldehydes (FTALs and FTUALs, respectively) and carboxylic acids (FTCAs and FTUCAs, respectively) as intermediate metabolites that subsequently transform to perfluorinated carboxylic acids (PFCAs). Previous studies have demonstrated that the FTCAs and FTUCAs are 1 to 5 orders of magnitude more toxic than PFCAs after exposure to aquatic organisms. Additionally, FTUALs have demonstrated reactivity with proteins, which may be associated with toxicity through the inhibition of protein function. The purpose of this study was to carry out a comprehensive assessment of the relative toxicity between PFCAs and their intermediate precursor metabolites: the FTALs, FTUALs, FTCAs, and FTUCAs. Analytes were separately incubated with human liver epithelial (THLE-2) cells to assess how varying the functional group and the fluorinated chain length affects cell viability. For each analyte, dose-response EC50 values were calculated. The EC50 values for FTUCAs and FTCAs were similar, with values ranging from 22 ± 9 and 24 ± 9 μM for the 10:2 congeners to 1004 ± 20 and 1004 ± 24 μM for the 4:2 congeners, respectively. The EC50 values for the PFCAs ranged from 65 ± 41 (PFDA) to 1361 ± 146 (PFBA) μM. The range of toxicity between PFCAs and their acid precursors were similar. However, the comparative toxicity between the 6:2 and 8:2 congeners and their corresponding PFCA had toxicity thresholds that varied depending on the functional headgroup, where FTUALs ≥ FTALs > FTUCAs ≥ FTCAs > PFCAs. For all PFCAs and acid precursors,toxicity depended on the length of the fluorinated chain, where the longer chain lengths yielded greater bioaccumulation and enhanced toxicity, results which agreed with those previously reported. By contrast, FTALs and FTUALs were the most toxic of all the analytes examined, where toxicity was enhanced at shorter chain lengths, with EC50 values of 7 ± 1 μM (6:2 FTUAL) and 8.6 ± 0.8 μM (6:2 FTAL). DNA adducts were not detectable for the aldehyde precursors, using a quantitative long-range PCR method. Our data provide the first evidence that aldehyde intermediates have demonstrated toxicity in cellular systems that is more significant than PFCAs and their corresponding acid intermediates.	1	1	1														1			1	A	-	PFCAとその酸前駆体の細胞毒性を比較し、毒性はフッ素化鎖の長さに依存し、鎖長が長いほど生物濃縮性が高く、毒性も増強されることを示した。	
550	遺伝毒性	Saglio, G; Serra, A; Novarino, A; Falda, M; Gavosto, F	N-ras mutations in myeloid leukemias	1989	Tumori. 1989 Aug 31;75(4):337-40. doi: 10.1177/030089168907500407.	The presence of mutations activating the N-ras gene was investigated by the polymerase chain reaction technique in twenty patients with acute myeloblastic leukemia (AML) at onset and in four patients with Ph1 positive chronic myelogeneous leukemia (CML) either in chronic phase or in blast crisis. Four remission samples and four relapses from the AML cases were also studied. Mutations were found in five out of twenty (25%) untreated AML cases at onset. No mutations were detected in the complete remission samples, two of them with N-ras mutations during the leukemic phase. Two out of the four leukemia relapses were positive for the same N-ras mutation shown at presentation, whereas no new mutations were found in the other two initially negative cases. An N-ras mutation appeared during the blast crisis of one of the four CML, which were all negative during the chronic phase. In conclusion, whereas some data appear to be consistent with a role of the N-ras mutations as initiating events in myeloid leukemias, in other cases N-ras activation seems to represent a factor involved in progression. These data suggest that a partial overlapping between initiation and progression factors could exist in naturally occurring tumors.			1														1			C	-		
551	遺伝毒性	Wielsøe, Maria; Long, Manhai; Ghisari, Mandana; Bonefeld-Jørgensen, Eva C	Perfluoroalkylated substances (PFAS) affect o	2015	Chemosphere. 2015 Jun;129:239-45. doi: 10.1016/j.chemosphere.2014.10.014. Epub 2014 Nov 12.	Perfluoroalkylated substances (PFAS) have been widely used since 1950s and humans are exposed through food, drinking water, consumer products, dust, etc. The long-chained PFAS are persistent in the environment and accumulate in wildlife and humans. They are suspected carcinogens and a potential mode of action is through generation of oxidative stress. Seven long-chained PFAS found in human serum were investigated for the potential to generate reactive oxygen species (ROS), induce DNA damage and disturb the total antioxidant capacity (TAC). The tested PFAS were perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluoroctanoic acid (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnA), and perfluorododecanoate (PFDoA). Using the human hepatoma cell line (HepG2) and an exposure time of 24h we found that all three endpoints were affected by one or more of the compounds. PFHxS, PFOA, PFOS and PFNA showed a dose dependent increase in DNA damage in the concentration range from 2×10(-7) to 2×10(-5)M determined by the comet assay. Except for PFDoA, all the other PFAS increased ROS generation significantly. For PFHxS and PFUnA the observed ROS increases were dose-dependent. Cells exposed to PFOA were found to have a significant lower TAC compared with the solvent control, whereas a non-significant trend in TAC decrease was observed for PFOS and PFDoA and an increase tendency for PFHxS, PFNA and PFUnA. Our results indicate a possible genotoxic and cytotoxic potential of the PFAS in human liver cells.			1														1			B	-		
552	遺伝毒性	Yahia, Doha; Haruka, Igarashi; Kagashi, Yae; Tsuda, Shuji	8-Hydroxy-2'-deoxyguanosine as a biomarker o	2016	Environ Toxicol. 2016 Feb;31(2):192-200. doi: 10.1002/tox.22034. Epub 2014 Aug 12.	8-Hydroxy-2'-deoxyguanosine (8-OHdG) is the most common biomarker of oxidative DNA damage, it is formed by chemical carcinogens and can be measured in any species. Perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) are suspected genotoxic carcinogens through induction of reactive oxygen species that are responsible for oxidative DNA damage. This study was conducted to investigate the in vitro genotoxicity of PFOA and PFNA in human lymphoblastoid (TK6) cell line. TK6 cells were exposed to PFOA at 0, 125, 250, and 500 ppm and PFNA at 125 and 250 ppm for 2 h. Single cell gel electrophoresis (comet assay) was used to measure DNA damage; at least 50 cells per sample were analyzed using comet Assay Software Project (CASP). 8-OHdG was measured in DNA of exposed cells using high-performance liquid chromatography (HPLC)-mass spectrometry (MS)/MS. Results showed that both PFOA and PFNA induced DNA damage indicated by increased tail length (DNA migration). The level of 8-OHdG was increased in a dose-dependent manner in both PFOA and PFNA exposure. We concluded that PFOA and PFNA induced DNA damage and the biomarker of oxidative DNA damage (8-OHdG) could be measured by HPLC-MS/MS. In addition, PFNA produced high level of 8-OHdG at concentrations lower than PFOA, this may indicate that PFNA is more potent genotoxicant for TK6 cells than PFOA.			1														1			1	A	-	ヒトリンパ芽球様細胞株（TK6）におけるPFOAおよびPFNAのin vitro遺伝毒性を調べるため、コメットアッセイおよび8-OHdG測定を行い評価している。	
553	in vitro（PPAR）	Bjork, James A; Wallace, Kendall B	Structure-activity relationships and human rele	2009	Toxicol Sci. 2009 Sep;111(1):89-99. doi: 10.1093/toxsci/kfp093. Epub 2009 Apr 30.	Perfluoroalkyl acids (PFAAs) are widely distributed and environmentally persistent agents whose potential toxicity is not yet fully characterized. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid elicit a number of potential toxicities in rodents, the most prevalent of which are governed by activation of the peroxisome proliferator-activated receptor alpha (PPARalpha). The purpose of this investigation was twofold: (1) To conduct a structure-activity relationship study of the transcriptional activation of peroxisome proliferation in primary rat liver cell cultures for PFAA-related carboxylic and sulfonic acids of varying carbon chain length and (2) to explore whether this activity can be translated to human liver cells in culture. Exposure to PFOA caused a dose-dependent stimulation of the expression of acyl-CoA oxidase (Acox), Cte/Acot1, and Cyp4a1/11 transcripts that are indicative of peroxisome proliferation in primary rat hepatocytes. PFOA concentrations of 30 microM and above caused cell injury characterized by the expression of Ddit3. Perfluorobutanoic acid (PFBA), on the other hand, stimulated Acox, Cte/Acot1, and Cyp4a1/11 gene expression in primary rat hepatocytes only at concentrations of 100 microM and above. Neither PFOA nor PFBA at concentrations up to 200 microM stimulated PPARalpha-related gene expression in either primary or HepG2 human liver cells. These data demonstrate that (1) PFFAs cause a concentration- and chain length-dependent increase in expression of gene targets related to cell injury and PPARalpha activation in primary rat hepatocytes, (2) the sulfonates are less potent than the corresponding carboxylates in stimulating PPARalpha-related gene expression in rat hepatocytes, and (3) stimulation of PPARalpha-mediated gene transcription is a mechanism that is not shared by human liver cells, adding further substantiation that PPARalpha-dependent liver toxicity in rodents does not extrapolate to assessing human health concerns.	1	1				1									1		1			B	C	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	
554	in vitro（PPAR）	Rosen, Mitchell B; Das, Kaberi P; Wood, Carmen R; Wolf, Cynthia J; Abbott, Barbara D; Lau, Christopher	Evaluation of perfluoroalkyl acid activity using	2013	Toxicology. 2013 Jun 7;308:129-37. doi: 10.1016/j.tox.2013.03.011. Epub 2013 Apr 6.	While perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been studied at length, less is known about the biological activity of other perfluoroalkyl acids (PFAAs) detected in the environment. Using a transient transfection assay developed in COS-1 cells, our group has previously evaluated a variety of PFAAs for activity associated with activation of peroxisome proliferator-activated receptor alpha (PPARα). Here we use primary heptatocytes to further assess the biological activity of a similar group of PFAAs using custom designed Taqman Low Density Arrays. Primary mouse and human hepatocytes were cultured for 48h in the presence of varying concentrations of 12 different PFAAs or Wy14,643, a known activator of PPARα. Total RNA was collected and the expression of 48 mouse or human genes evaluated. Gene selection was based on either in-house liver microarray data (mouse) or published data using primary hepatocytes (human). Gene expression in primary mouse hepatocytes was more restricted than expected. Genes typically regulated in whole tissue by PPARα agonists were not altered in mouse cells including Acox1, Me1, Acaa1a, Hmgcs1, and Slc27a1. Cyp2b10, a gene regulated by the constitutive androstane receptor and a transcript normally up-regulated by in vivo exposure to PFAAs, was also unchanged in cultured mouse hepatocytes. Cyp4a14, Ehhadh, Pdk4, Cpt1b, and Fabp1 were regulated as expected in mouse cells. A larger group of genes were differentially expressed in human primary hepatocytes, however, little consistency was observed across compounds with respect to which genes produced asignificant dose response making the determination of relative biological activity difficult. This likely reflects weaker activation of PPARα in human versus rodent cells as well as variation among individual cell donors. Unlike mouse cells, CYP2B6 was up-regulated in human hepatocytes by a number of PFAAs as was PPARδ. Rankings were conducted on the limited dataset. In mouse hepatocytes, the pattern was similar to that previously observed in the COS-1 reporter cell assay. With the exception of PFHxA, longer chain PFAA carboxylates were the most active. The pattern was similar in human hepatocytes, although PFDA and PFOS showed higher activity than previously observed while PFOA showed somewhat less activity. These data reflect inherent challenges in using primary hepatocytes to predict toxicological response.	1					1									1					B	C	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	
555	in vitro（PPAR）	Rosenmai, Anna Kjerstine; Ahrens, Lutz; le Godec, Théo; Lundqvist, Johan; Oskarsson, Agneta	Relationship between peroxisome proliferator-	2018	J Appl Toxicol. 2018 Feb;38(2):219-226. doi: 10.1002/jat.3515. Epub 2017 Aug 31.	Peroxisome proliferator-activated receptor alpha (PPARα) is a molecular target for perfluoroalkyl substances (PFASs). Little is known about the cellular uptake of PFASs and how it affects the PPARα activity. We investigated the relationship between PPARα activity and cellular concentration in HepG2 cells of 14 PFASs, including perfluoroalkyl carboxylates (PFCAs), perfluoroalkyl sulfonates and perfluorooctane sulfonamide (FOSA). Cellular concentrations were determined by high-performance liquid chromatography-tandem mass spectrometry and PPARα activity was determined in transiently transfected cells by reporter gene assay. Cellular uptake of the PFASs was low (0.04-4.1%) with absolute cellular concentrations in the range 4-2500 ng mg(-1) protein. Cellular concentration of PFCAs increased with perfluorocarbon chain length up to perfluorododecanoate. PPARα activity of PFCAs increased with chain length up to perfluorooctanoate. The maximum induction of PPARα activity was similar for short-chain (perfluorobutanoate and perfluoropentanoate) and long-chain PFCAs (perfluorododecanoate and perfluorotetradecanoate) (approximately twofold). However, PPARα activities were induced at lower cellular concentrations for the short-chain homologs compared to the long-chain homologs. Perfluorohexanoate, perfluoroheptanoate, perfluorooctanoate, perfluorononanoate (PFNA) and perfluorodecanoate induced PPARα activities >2.5-fold compared to controls. The concentration-response relationships were positive for all the tested compounds, except perfluorooctane sulfonate PFOS and FOSA, and were compound-specific, asdemonstrated by differences in the estimated slopes. The relationships were steeper for PFCAs with chain lengths up to and including PFNA than for the other studied PFASs. To our knowledge, this is the first report establishing relationships between PPARα activity and cellular concentration of a broad range of PFASs.	1		1			1				1							1			B	C	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
556	in vitro（PPAR）	Wolf, Cynthia J; Schmid, Judith E; Lau, Christopher; Abbott, Barbara D	Activation of mouse and human peroxisome pr	2012	Reprod Toxicol. 2012 Jul;33(4):546-551. doi: 10.1016/j.reprotox.2011.09.009. Epub 2011 Nov 15.	Perfluorinated alkyl acids (PFAAs) are manufactured surfactants found globally in the environment and in tissues of humans and wildlife. Several PFAAs adversely affect rodents and activation of PPARα is thought to be their mode of action. Our previous study demonstrated that some PFAAs activate mouse and human PPARα in transiently transfected COS-1 cells. Here, we test more PFAAs for PPARα activation in the same system. Cells were transfected with either mouse or human PPARα-luciferase reporter plasmid, exposed the next day to either vehicle, PPARα agonist (WY14643), perfluoropentanoic acid (C5), perfluoroheptanoic acid (C7), perfluorooctanoic acid (C8), perfluoroundecanoic acid (C11), or perfluorododecanoic acid (C12) at concentrations from 0.5 μM to 100 μM, and luminescence was measured after 24h. C8 induced the highest activity for human PPARα, followed by C7, C5, and C11. C12 had little activity. C8 induced the highest activity for mouse PPARα, followed by C11, C7, C12 and C5. The two studies together found increasing activity of PPARα with increasing chain length of the PFAA up to perfluorononanoic acid (C9) and lower activity with longer chain PFAAs with both mouse and human PPARα.	1		1			1								1		1				B	C	C	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	
557	in vitro（PPAR）	Wolf, Cynthia J; Takacs, Margy L; Schmid, Judith E; Lau, Christopher; Abbott, Barbara D	Activation of mouse and human peroxisome pr	2008	Toxicol Sci. 2008 Nov;106(1):162-71. doi: 10.1093/toxsci/kfn166. Epub 2008 Aug 18.	Perfluoroalkyl acids (PFAAs) are surfactants used in consumer products and persist in the environment. Some PFAAs elicit adverse effects on rodent development and survival. PFAAs can activate peroxisome proliferator-activated receptor alpha (PPARalpha) and may act via PPARalpha to produce some of their effects. This study evaluated the ability of numerous PFAAs to induce mouse and human PPARalpha activity in a transiently transfected COS-1 cell assay. COS-1 cells were transfected with either a mouse or human PPARalpha receptor-luciferase reporter plasmid. After 24 h, cells were exposed to either negative controls (water or dimethyl sulfoxide, 0.1%); positive control (WY-14643, PPARalpha agonist); perfluorooctanoic acid or perfluorononanoic acid at 0.5-100 microM; perfluorobutanoic acid, perfluorohexanoic acid, perfluorohexane sulfonate, or perfluorodecanoic acid (PFDA) at 5-100 microM; or perfluorobutane sulfonate or perfluorooctane sulfonate at 1-250 microM. After 24 h of exposure, luciferase activity from the plasmid was measured. Each PFAA activated both mouse and human PPARalpha in a concentration-dependent fashion, except PFDA with human PPARalpha. Activation of PPARalpha by PFAA carboxylates was positively correlated with carbon chain length, up to C9. PPARalpha activity was higher in response to carboxylates compared to sulfonates. Activation of mouse PPARalpha was generally higher compared to that of human PPARalpha. We conclude that, in general, (1) PFAAs of increasing carbon backbone chain lengths induce increasing activity of the mouse and human PPARalpha with a few exceptions, (2) PFAA carboxylates arestronger activators of mouse and human PPARalpha than PFAA sulfonates, and (3) in most cases, the mouse PPARalpha appears to be more sensitive to PFAAs than the human PPARalpha in this model.	1					1	1			1				1						B	C	C	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	
558	in vitro（PPAR）	Zhang, Yi-Ming; Dong, Xiao-Yu; Fan, Li-Juan; Zhang, Zhi-Lei; Wang, Qian; Jiang, Nan; Yang, Xu-Shu	Poly- and perfluorinated compounds activate h	2017	Toxicology. 2017 Apr 1;380:23-29. doi: 10.1016/j.tox.2017.01.012. Epub 2017 Jan 20.	Poly- and perfluorinated compounds (PFCs), which have been detected worldwide in human blood, surface water and house dust, are suspected to induce potential endocrine-disrupting hormonal effects. In this study, cell-based reporter gene assays were used to determine the activity of a variety of PFCs against the human pregnane X receptor (hPXR) to identify the critical structural feature of PFCs related to their hPXR activity. Molecular docking studies combined with site-directed mutagenesis were employed to investigate the mechanism by which PFCs interact with and activate hPXR. We found that all tested PFCs can activate hPXR. The hPXR activity of the PFCs correlates with the carbon chain length and the functional group of the chemicals. Hydrogen bonding was characteristic of the interaction between PFCs and hPXR. We also identified the key residues within the hPXR ligand-binding pocket responsible for PFC-hPXR interaction. The outcome of the present study threw a light on the mechanism by which PFCs activate hPXR. PFCs may pose some potential endocrine-disrupting hormonal effects via activation of hPXR.	1		1			1														C	C	PXRも毒性機序に関連するが、重要度は低い。しかし作用機序の参考になり得る。	
559	in vitro（PPAR）	Wolf, Cynthia J; Rider, Cynthia V; Lau, Christopher; Abbott, Barbara D	Evaluating the additivity of perfluoroalkyl acids	2014	Toxicology. 2014 Feb 28;316:43-54. doi: 10.1016/j.tox.2013.12.002. Epub 2013 Dec 26.	Perfluoroalkyl acids (PFAAs) are found globally in the environment, detected in humans and wildlife, and are typically present as mixtures of PFAA congeners. Mechanistic studies have found that responses to PFAAs are mediated in part by PPARα. Our previous studies showed that individual PFAAs activate PPARα transfected into COS-1 cells. The goal of the current study was to determine if binary combinations of perfluorooctanoic acid (PFOA) and another PFAA act in an additive fashion to activate PPARα in the mouse one-hybrid in vitro model. COS-1 cells were transiently transfected with mouse PPARα luciferase reporter construct and exposed to either vehicle control (0.1% DMSO or water), PPARα agonist (WY14643, 10 μM), PFOA at 1-128 μM, perfluorononanoic acid (PFNA) at 1-128 μM, perfluorohexanoic acid (PFHxA) at 8-1024 μM, perfluorooctane sulfonate (PFOS) at 4-384 μM or perfluorohexane sulfonate (PFHxS) at 8-2048 μM to generate sigmoidal concentration-response curves. In addition, cells were exposed to binary combinations of PFOA+either PFNA, PFHxA, PFOS or PFHxS in an 8×8 factorial design. The concentration-response data for individual chemicals were fit to sigmoidal curves and analyzed with nonlinear regression to generate EC_{50}s and Hillslopes, which were used in response-addition and concentration-addition models to calculate predicted responses for mixtures in the same plate. All PFOA+PFAA combinations produced concentration-response curves that were closely aligned with the predicted curves for both response addition and concentration addition at low concentrations. However, at higher concentrations of allchemicals, the observed response curves deviated from the predicted models of additivity. We conclude that binary combinations of PFAAs behave additively at the lower concentration ranges in activating PPARα in this in vitro system.			1				1							1						B	A	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	
560	in vitro（肝毒性）	Behr, Anne-Cathrin; Plinsch, Christin; Braeuning, Albert; Buhrke, Thorsten	Activation of human nuclear receptors by perfl	2020	Toxicol In Vitro. 2020 Feb;62:104700. doi: 10.1016/j.tiv.2019.104700. Epub 2019 Oct 30.	Perfluoralkylated substances (PFAS) such as perfluorooctanoic acid (PFOA) or perfluorooctanesulfonic acid (PFOS) are used to produce, e.g., surface coatings with water- and dirt-repellent properties. These substances have been shown to be hepatotoxic in rodents, and the mechanism of action is mostly attributed to the PFAS-mediated activation of the peroxisome proliferator-activated receptor alpha (PPARα). In the present study, we investigated by using luciferase-based reporter gene assays whether PFOA, PFOS and six alternative PFAS can activate, in addition to PPARα, eight other human nuclear receptors. All tested PFAS except for perfluorobutanesulfonic acid (PFBS) were able to activate human PPARα. Perfluoro-2-methyl-3-oxahexanoic acid (PMOH) and 3H-perfluoro-3-[(3-methoxypropoxy) propanoic acid] (PMPP) were weak agonists of human PPARγ. The other human nuclear receptors (PPARδ, CAR, PXR, FXR, LXRα, RXRα and RARα) were not affected by any PFAS tested in this study. Although PMOH was more effective than PFOA in stimulating PPARα in the transactivation assay, it was less effective in stimulating PPARα-dependent target gene expression in human HepG2 hepatocarcinoma cells. Notably, any effect observed in this in vitro study only occurred at concentrations higher than 10 μM of the respective PFAS which is in all cases several magnitudes above the average blood concentration in the Western population. Thus, the results suggest that nuclear receptor activation may only play a minor role in potential PFAS-mediated adverse effects in humans.	1	1		1	1			1											1	A	B	ヒトではPPARαの親和性や発現量がげっ歯類に比して低いことから、PPAR以外の分子メカニズムの参考になる。	
561	in vitro（肝毒性）	Sun, Sujie; Guo, Hua; Wang, Jianshe; Dai, Jiayin	Hepatotoxicity of perfluorooctanoic acid and tv	2019	Environ Pollut. 2019 Mar;246:955-962. doi: 10.1016/j.envpol.2018.12.065. Epub 2019 Jan 4.	Perfluorooctanoic acid (PFOA) toxicity is of considerable concern due to its wide application, environmental persistence, and bioaccumulation. In the current study, we used a scaffold-free three-dimensional (3D) spheroid model of mouse liver cells (AML12) to explore the toxicity of PFOA and emerging alternatives (HFPO-DA and PFO4DA). Comparing the short-term (24 and 72 h treatment) toxicity of PFOA between conventional 2D monolayer cells and 3D spheroids, we found that spheroids had higher EC(50) values and lower ROS levels after treatment, indicating their greater resistance to PFOA. Cell viability (i.e., adenosine triphosphate (ATP) content and lactate dehydrogenase (LDH) leakage) and liver-specific function (i.e., albumin secretion) were stable in spheroids through 28 day of culture. However, under 100 and 200 μM-PFOA treatment for 28 day, ROS levels, LDH leakage, and caspase3/7 activity all increased significantly. As a sensitive parameter, ROS showed a significant increase at 21 day, even in the 50 μM-PFOA group. Consistent with the elevation of ROS and caspase3/7, the expressions of oxidative stress- and apoptosis-related genes, including Gsta2, Nqo1, Ho-1, caspase3, p53, and p21, were induced in dose- and time-dependent manners after PFOA exposure. The peroxisome proliferator-activated receptor alpha (PPARα) pathway was also activated after treatment, with significant induction of its target genes, Fabp4 and Scd1. Similar to PFOA, both HFPO-DA and PFO4DA activated the PPARα pathway, induced ROS levels, and initiated cell damage, though at a relatively lower extent than that of PFOA. Our resultsimply that the 3D spheroid model is a valuable tool in chronic toxicological studies.				1				1												C	C	methodologyをメインにしており、参考にはなる。	
562	in vitro（PPAR）	Tontonoz, P; Hu, E; Spiegelman, B M	Stimulation of adipogenesis in fibroblasts by P	1994	Cell. 1994 Dec 30;79(7):1147-56. doi: 10.1016/0092-8674(94)90006-x.	Peroxisome proliferator-activated receptor gamma 2 (PPAR gamma 2) is an adipocyte-specific nuclear hormone receptor that has recently been identified as a key regulator of two fat cell enhancers. Transcriptional activation by PPAR gamma 2 is potentiated by a variety of lipids and lipid-like compounds, including naturally occurring polyunsaturated fatty acids. We demonstrate here that retroviral expression of PPAR gamma 2 stimulates adipose differentiation of cultured fibroblasts. PPAR activators promote the differentiation of PPAR gamma 2-expressing cells in a dose-dependent manner. C/EBP alpha, a second transcription factor induced during adipocyte differentiation, can cooperate with PPAR gamma 2 to stimulate the adipocyte program dramatically. Our results suggest that the physiologic role of PPAR gamma 2 is to regulate development of the adipose lineage in response to endogenous lipid activators and that this factor may serve to link the process of adipocyte differentiation to systemic lipid metabolism.				1				1												C	D	PPARγも毒性に関連すると報告されているが、本論文のデータは重要度は低い	
563	in vitro（肝毒性）	Wen, Yi; Mirji, Niharika; Irudayaraj, Joseph	Epigenetic toxicity of PFOA and GenX in HepG	2020	Toxicol In Vitro. 2020 Jun;65:104797. doi: 10.1016/j.tiv.2020.104797. Epub 2020 Feb 14.	Perfluorooctanoic acid (PFOA), an extremely persistent perfluoroalkyl substance (PFAS), and 2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX), its shorter chain alternative, have been implicated in hepatocellular damage with unusual fat deposit and liver enlargement. In this study we explored the underlying mechanisms of PFOA and GenX induced hepatocellular damage. Liver hepatocellular carcinoma cell line HepG2 was used as a model to study induced liver inflammation in vitro at the cellular, genetic, and epigenetic levels. HepG2 cells were exposed to PFOA or GenX for 48 h and the DNA and RNA were extracted and analyzed. mRNA expression analysis of PFOA exposed cells showed that cell cycle homeostasis genes were affected significantly, as well as the ten-eleven translocation methylcytosine dioxygenases (TETs) and the essential lipid metabolism genes. GenX did not have as significant an effect. Global methylation levels of HepG2 cells were found to be inversely proportional to PFOA exposure levels. With GenX, the global methylation level decreased and then increased. Our work points to the fact that PFOA may contribute to higher overall epigenetic toxicity than GenX, and its induced epigenetic changes may play a major role in lipid metabolism gene regulation and fat deposits.				1				1											1	B	A	PODに関連しないが、毒性機序の参考にはなる	
564	in vitro（細胞間シグナル伝達）	Hu, Wenyue; Jones, Paul D; Upham, Brad L; Trosko, James E; Lau, Christopher; Giesy, John P	Inhibition of gap junctional intercellular commu	2002	Toxicol Sci. 2002 Aug;68(2):429-36. doi: 10.1093/toxsci/68.2.429.	Gap junctional intercellular communication (GJIC) is the major pathway of intercellular signal transduction, and is thus important for normal cell growth and function. Recent studies have revealed a global distribution of some perfluorinated organic compounds, especially perfluorooctane sulfonic acid (PFOS) in the environment. Because other perfluoroalkanes had been shown to inhibit GJIC, the effects of PFOS and related sulfonated fluorochemicals on GJIC were studied using a rat liver epithelial cell line (WB-F344) and a dolphin kidney epithelial cell line (CDK). In vivo effects on GJIC were studied in Sprague-Dawley rats orally exposed to PFOS for 3 days or 3 weeks. Effects on GJIC were measured using the scrape loading dye technique. PFOS, perfluorooctane sulfonamide (PFOSA), and perfluorohexane sulfonic acid (PFHA) were found to inhibit GJIC in a dose-dependent fashion, and this inhibition occurred rapidly and was reversible. Perfluorobutane sulfonic acid (PFBS) showed no significant effects on GJIC within the concentration range tested. A structure activity relationship was established among all 4 tested compounds, indicating that the inhibitory effect was determined by the length of fluorinated tail and not by the nature of the functional group. The results of the studies of the 2 cell lines and the in vivo exposure were comparable, suggesting that the inhibitory effects of the selected perfluorinated compounds on GJIC were neither species- nor tissue-specific and can occur both in vitro and in vivo.				1											1					B	B	毒性試験としてはPODの根拠になり得ないが、作用機序の参考に重要	
565	in vitro（肝毒性）	Wallace, K B; Kissling, G E; Melnick, R L; Blystone, C R	Structure-activity relationships for perfluoroalk	2013	Toxicol Lett. 2013 Oct 9;222(3):257-64. doi: 10.1016/j.toxlet.2013.07.025. Epub 2013 Aug 14.	Perfluorinated alkyl acids (PFAAs) represent a broad class of commercial products designed primarily for the coatings industry. However, detection of residues globally in a variety of species led to the discontinuation of production in the U.S. Although PFAAs cause activation of the PPARα and CAR nuclear receptors, interference with mitochondrial bioenergetics has been implicated as an alternative mechanism of cytotoxicity. Although the mechanisms by which the eight carbon chain PFAAs interfere with mitochondrial bioenergetics are fairly well described, the activities of the more highly substituted or shorter chain PFAAs are far less well characterized. The current investigation was designed to explore structure-activity relationships by which PFAAs interfere with mitochondrial respiration in vitro. Freshly isolated rat liver mitochondria were incubated with one of 16 different PFAAs, including perfluorinated carboxylic, acetic, and sulfonic acids, sulfonamides and sulfamido acetates, and alcohols. The effect on mitochondrial respiration was measured at five concentrations and dose-response curves were generated to describe the effects on state 3 and 4 respiration and respiratory control. With the exception of PFOS, all PFAAs at sufficiently high concentrations (>20 μM) stimulated state 4 and inhibited state 3 respiration. Stimulation of state 4 respiration was most pronounced for the carboxylic acids and the sulfonamides, which supports prior evidence that the perfluorinated carboxylic and acetic acids induce the mitochondrial permeability transition, whereas the sulfonamides are protonophoric uncouplers of oxidativephosphorylation. In both cases, potency increased with increasing carbon number, with a prominent inflection point between the six and eight carbon congeners. The results provide a foundation for classifying PFAAs according to specific modes of mitochondrial activity and, in combination with toxicokinetic considerations, establishing structure-activity-based boundaries for initial estimates of risk for noncancer endpoints for PFAAs for which minimal in vivo toxicity testing currently exists.		1		1										1					B	C	PODに関連しないが、毒性機序の参考にはなる	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
566	in vitro（PPAR）	Li, Chuan-Hai; Ren, Xiao-Min; Cao, Lin-Ying; Qin, Wei-Ping; Guo, Liang-Hong	Investigation of binding and activity of perfluor	2019	Environ Sci Process Impacts. 2019 Nov 1;21(11):1908-1914. doi: 10.1039/c9em00218a. Epub 2019 Jul 23.	Previously, perfluoroalkyl substances (PFASs) have been found to be associated with many adverse effects mediated by the peroxisome proliferator-activated receptor α（PPARα）and PPARγ. Here, we found another subtype of the peroxisome proliferator-activated receptors (PPARs); the PPARβ/δ mediated pathway might also be a potential adverse outcome pathway for PFASs. We investigated the direct binding and transcriptional activity of PFASs toward human PPARβ/δ, and further revealed the structure-binding and structure-activity relationship between PFASs and PPARβ/δ. The receptor binding experiment showed that their binding potency was dependent on the carbon chain length and the terminal functional group. For twelve perfluoroalkyl carboxylic acids (PFCAs), an inverted U-shaped relationship existed between the PPARβ/δ binding potency and the carbon chain length, with perfluorododecanoc acid (C12) showing the highest binding potency. The three perfluoroalkane sulfonic acids (PFSAs) exhibited a stronger binding potency than their PFCA counterparts. The two fluorotelomer alcohols (FTOHs) showed no binding potency. In receptor transcriptional activity assays, they enhanced the PPARβ/δ transcriptional activity. Their transcriptional activity was also related to the carbon chain length and the terminal functional group. Molecular docking analysis showed the PFASs fitted into the ligand binding pocket of PPARβ/δ with a binding geometry similar to a fatty acid.				1												1				C	C	PPARβ/δに関する論文で重要度は低い	
567	実験動物（肝毒性）	Abe, Taiki; Takahashi, Mirei; Kano, Makoto; Amaike, Yuto; Ishii, Chizuru; Maeda, Kazuhiro; Kudoh, Yuki; Morishita, Toru; Hosaka, Takuomi; Sasaki, Takamitsu; Kodama, Susumu; Matsuzawa, Atsushi; Kojima, Hiroyuki; Yoshinari, Kouichi	Activation of nuclear receptor CAR by an envir	2017	Arch Toxicol. 2017 Jun;91(6):2365-2374. doi: 10.1007/s00204-016-1888-3. Epub 2016 Nov 10.	Perfluorocarboxylic acids (PFCAs) including perfluorooctanoic acid (PFOA) are environmental pollutants showing high accumulation, thermochemical stability and hepatocarcinogenicity. Peroxisome proliferator-activated receptor α is suggested to mediate their toxicities, but the precise mechanism remains unclear. Previous reports also imply a possible role of constitutive androstane receptor (CAR), a key transcription factor for the xenobiotic-induced expression of various genes involved in drug metabolism and disposition as well as hepatocarcinogenesis. Therefore, we have investigated whether PFCAs activate CAR. In wild-type but not Car-null mice, mRNA levels of Cyp2b10, a CAR target gene, were increased by PFOA treatment. PFCA treatment induced the nuclear translocation of CAR in mouse livers. Since CAR activators are divided into two types, ligand-type activators and phenobarbital-like indirect activators, we investigated whether PFCAs are CAR ligands or not using the cell-based reporter gene assay that can detect CAR ligands but not indirect activators. As results, neither PFCAs nor phenobarbital increased reporter activities. Interestingly, in mouse hepatocytes, pretreatment with the protein phosphatase inhibitor okadaic acid prevented an increase in Cyp2b10 mRNA levels induced by phenobarbital as reported, but not that by PFOA. Finally, in human hepatocyte-like HepaRG cells, PFOA treatment increased mRNA levels of CYP2B6, a CAR target gene, as did phenobarbital. Taken together, our present results suggest that PFCAs including PFOA are indirect activators of mouse and human CAR and that the mechanism might be different from that for phenobarbital. The results imply a role of CAR in the hepatotoxicity of PFCAs.	1		1			1					1						1			B	C	CARに関するデータで参考になる	
568	実験動物（肝毒性）	Das, Kaberi P; Wood, Carmen R; Lin, Mimi T; Starkov, Anatoly A; Lau, Christopher; Wallace, Kendall B; Corton, J Christopher; Abbott, Barbara D	Perfluoroalkyl acids-induced liver steatosis: Eff	2017	Toxicology. 2017 Mar 1;378:37-52. doi: 10.1016/j.tox.2016.12.007. Epub 2016 Dec 31.	Persistent presence of perfluoroalkyl acids (PFAAs) in the environment is due to their extensive use in industrial and consumer products, and their slow decay. Biochemical tests in rodent demonstrated that these chemicals are potent modifiers of lipid metabolism and cause hepatocellular steatosis. However, the molecular mechanism of PFAAs interference with lipid metabolism remains to be elucidated. Currently, two major hypotheses are that PFAAs interfere with mitochondrial beta-oxidation of fatty acids and/or they affect the transcriptional activity of peroxisome proliferator-activated receptor α (PPARα) in liver. To determine the ability of structurally-diverse PFAAs to cause steatosis, as well as to understand the underlying molecular mechanisms, wild-type (WT) and PPARα-null mice were treated with perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), or perfluorohexane sulfonate (PFHxS), by oral gavage for 7days, and their effects were compared to that of PPARα agonist WY-14643 (WY), which does not cause steatosis. Increases in liver weight and cell size, and decreases in DNA content per mg of liver, were observed for all compounds in WT mice, and were also seen in PPARα-null mice for PFOA, PFNA, and PFHxS, but not for WY. In Oil Red O stained sections, WT liver showed increased lipid accumulation in all treatment groups, whereas in PPARα-null livers, accumulation was observed after PFNA and PFHxS treatment, adding to the burden of steatosis observed in control (untreated) PPARα-null mice. Liver triglyceride (TG) levels were elevated in WT mice by all PFAAs and in PPARα-null mice only byPFNA. In vitro β-oxidation of palmitoyl carnitine by isolated rat liver mitochondria was not inhibited by any of the 7 PFAAs tested. Likewise, neither PFOA nor PFOS inhibited palmitate oxidation by HepG2/C3A human liver cell cultures. Microarray analysis of livers from PFAAs-treated mice indicated that the PFAAs induce the expression of the lipid catabolism genes, as well as those involved in fatty acid and triglyceride synthesis, in WT mice and, to a lesser extent, in PPARα-null mice. These results indicate that most of the PFAAs increase liver TG load and promote steatosis in mice We hypothesize that PFAAs increase steatosis because the balance of fatty acid accumulation/synthesis and oxidation is disrupted to favor accumulation.				1		1	1									1		1		1	B	A	PPARαを介した毒性発現機序の参考になる	
569	実験動物（PPAR）	Foreman, Jennifer E; Chang, Shu-Ching; Ehresman, David J; Butenhoff, John L; Anderson, Cherie R; Palkar, Prajakta S; Kang, Boo-Hyon; Gonzalez, Frank J; Peters, Jeffrey M	Differential hepatic effects of perfluorobutyrate	2009	Toxicol Sci. 2009 Jul;110(1):204-11. doi: 10.1093/toxsci/kfp077. Epub 2009 Apr 9.	Perfluorobutyrate (PFBA) is a short chain perfluoroalkyl carboxylate that is structurally similar to perfluorooctanoate. Administration of PFBA can cause peroxisome proliferation, induction of peroxisomal fatty acid oxidation and hepatomegaly, suggesting that PFBA activates the nuclear receptor, peroxisome proliferator-activated receptor-alpha (PPAR-alpha). In this study, the role of PPAR-alpha in mediating the effects of PFBA was examined using PPAR-alpha null mice and a mouse line expressing the human PPAR-alpha in the absence of mouse PPAR-alpha (PPAR-alpha humanized mice). PFBA caused upregulation of known PPAR-alpha target genes that modulate lipid metabolism in wild-type and PPAR-alpha humanized mice, and this effect was not found in PPAR-alpha null mice. Increased liver weight and hepatocyte hypertrophy were also found in wild-type and humanized PPAR-alpha mice treated with PFBA, but not in PPAR-alpha null mice. Interestingly, hepatocyte focal necrosis with inflammatory cell infiltrate was only found in wild-type mice administered PFBA; this effect was markedly diminished in both PPAR-alpha null and PPAR-alpha humanized mice. Results from these studies demonstrate that PFBA can modulate gene expression and cause mild hepatomegaly and hepatocyte hypertrophy through a mechanism that requires PPAR-alpha and that these effects do not exhibit a species difference. In contrast, the PPAR-alpha-dependent increase in PFBA-induced hepatocyte focal necrosis with inflammatory cell infiltrate was mediated by the mouse PPAR-alpha but not the human PPAR-alpha. Collectively, these findings demonstrate that PFBAcan activate both the mouse and human PPAR-alpha, but there is a species difference in the hepatotoxic response to this chemical.	1					1	1						1		1	1				1	B	A	PPARαを介した毒性発現機序の参考になる	
570	実験動物（PPAR）	Ikeda, T; Aiba, K; Fukuda, K; Tanaka, M	The induction of peroxisome proliferation in rat	1985	J Biochem. 1985 Aug;98(2):475-82. doi: 10.1093/oxfordjournals.jbchem.a135302.	The induction of peroxisome proliferation in rat liver was examined after administration of perfluoro-n-decanoic acid (PFDA, C10), perfluoro-n-octanoic acid (PFOA, C8), perfluoro-n-butyric acid (PFBA, C4), 1-H,1-H-pentadecafluoro-n-octanol (PFOL, C8) perfluorododecane (PFD, C12), and perfluorooctane (PFO, C8). The peroxisome proliferation in the liver was detected by the following methods; 1) measurement of liver weight, 2) assay of hepatic catalase activity, 3) analysis of 600 X g supernatant of liver homogenates by SDS-polyacrylamide gel electrophoresis to observe the induction of the bifunctional enoyl-CoA hydratase in peroxisomes (80K-protein) and 4) observation by electron microscopy. The oral administration of powdered chow containing 0.02%-PFOA and PFBA to male rats of the Sprague-Dawley strain for 2 weeks and the single intraperitoneal injection of corn oil mixed with PFDA, PFOA, and PFOL at the dose of 100 mg/kg induced peroxisome proliferation markedly. PFOL, which has two hydrogen atoms around the hydroxylated carbon, should be metabolized to PFOA, which is an active inducer. Perfluorinated paraffins, PFD and PFO, did not show any induction, indicating the importance of the carboxylic group in the molecule for the peroxisome proliferation. Although the participation of thyroid hormone cannot be excluded, PFOA appears to act directly on the liver.	1					1									1					B	B	PPARαを介した毒性発現機序の参考になる	
571	実験動物（肝毒性）	Just, W W; Gorgas, K; Hartl, F U; Heinemann, P; Salzer, M; Schimassek, H	Biochemical effects and zonal heterogeneity of	1989	Hepatology. 1989 Apr;9(4):570-81. doi: 10.1002/hep.1840090411.	Rats were treated for 5 to 14 days with perfluoroacetate, perfluorobutyrate and perfluorooctanoate. Alterations in hepatic morphology with special reference to the peroxisomal compartment were investigated by light and electron microscopy following cytochemical staining of catalase activity with the alkaline 3,3'-diaminobenzidine medium. All three compounds induced hepatomegaly and peroxisome proliferation. Perfluorobutyrate and perfluorooctanoate were found to be more active than perfluoroacetate. Perfluorooctanoate-induced peroxisome proliferation was more prevalent in centrilobular than in periportal hepatocytes. Peroxisomes in centrilobular liver cells frequently were of round shape, exhibited diameters of up to 1.5 microns and were predominantly located within smooth endoplasmic reticulum-glycogen areas. In periportal cells, however, clusters of polymorphous peroxisomes ranging from 250 to 1,100 nm in diameter were observed at the periphery of smooth endoplasmic reticulum-glycogen regions. Peroxisome proliferation was accompanied by a change of peroxisomal and mitochondrial enzyme activities, in particular an increase in peroxisomal palmitoyl-CoA oxidation. Significant alterations in the concentration of peroxisomal matrix and membrane polypeptides were also noted. Within the first 2 days, perfluorooctanoate treatment exerted a strong hypolipidemic activity and both compounds perfluorooctanoate and perfluorobutyrate raised the level of hepatic free acid-soluble CoA nearly 10-fold as compared with control livers. The results suggest perfluorinated carboxylic acids to be model substances suitableto correlate biochemical and morphological parameters with the zonal heterogeneity of the peroxisomal compartment in rat liver. Due to the manifold hepatic effects, contact of humans with perfluorinated carboxylic acids or their metabolic precursors may represent a severe health risk.	1					1														B	B	PODに関連しないが、毒性機序の参考にはなる	
572	実験動物（肝毒性）	Permadi, H; Lundgren, B; Andersson, K; DePierre, J W	Effects of perfluoro fatty acids on xenobiotic-m	1992	Biochem Pharmacol. 1992 Sep 25;44(6):1183-91. doi: 10.1016/0006-2952(92)90383-t.	Male mice were exposed via their diet to perfluoro fatty acids of various chain-lengths (2-10 carbon atoms) at different doses (0.02 and 0.1% weight) and for different periods of time (2-10 days). Thereafter, we monitored effects on liver and body weights and a number of hepatic parameters, including mitochondrial protein content, microsomal contents of cytochromes P450 and b5, NADPH-cytochrome P450 reductase activity [measured as NADPH-cytochrome c reductase (EC 1.6.2.3)], microsomal and cytosolic epoxide hydrolase (EC 3.3.2.3) activities, cytosolic DT-diaphorase (EC 1.6.99.2), glutathione transferase (EC 2.5.1.18), glutathione peroxidase (EC 1.11.1.9) and superoxide dismutase (EC 1.15.1.1) activities, and levels of thiobarbituric acid-reactive material (as an indicator of lipid peroxidation) in the mitochondrial subfraction. The most dramatic changes observed were a 5-9-fold increase in mitochondrial protein, a 3-6-fold increase in the microsomal content of cytochrome P450, a 3-10-fold increase in cytosolic DT-diaphorase activity, an approximately 2-fold increase in cytosolic epoxide hydrolase activity and as much as a 60% decrease in the level of thiobarbituric acid-reactive compounds in the mitochondrial fraction. Smaller increases in microsomal epoxide hydrolase activity and decreases in cytosolic glutathione peroxidase activity were also observed. Of the perfluoro fatty acids tested, perfluorooctanoic acid caused the largest changes in the parameters examined here. Dietary exposure of mice to a 0.02% dose of this substance for 10 days results in a maximal or near-maximal effect in most cases.	1					1									1					B	D	PODに関連しないが、毒性機序の参考にはなる	
573	実験動物（肝毒性）	Permadi, H; Lundgren, B; Andersson, K; Sundberg, C; DePierre, J W	Effects of perfluoro fatty acids on peroxisome p	1993	Xenobiotica. 1993 Jul;23(7):761-70. doi: 10.3109/00498259309166782.	1. Male mice were fed a diet containing perfluoro fatty acids of varying chain length (i.e. perfluoroacetic, -butyric, -octanoic and -decanoic acids) at different doses (0.02 or 0.1% w/w of diet) for different periods of time (2-10 days), and effects on liver weight, hepatic mitochondrial protein and hepatic peroxisomal palmitoyl-CoA oxidation, lauroyl-CoA oxidase and catalase were monitored. 2. The greatest effects were obtained with perfluoro-octanoic and perfluoro decanoic acids, while perfluoro acetic acid was inactive. The effects with 0.02% w/w of diet perfluoro-octanoic acid were at least as great as those observed with 0.1%. A more detailed dose-response investigation focused on perfluoro-octanoic acid revealed that maximal effects with this substance could be obtained with a dietary dose of 0.01% for 10 days and that significant changes were also observed with 0.001%. 3. Maximal effects with 0.02% w/w of diet perfluoro-octanoic acid were attained after 6-10 days of feeding. 4. As with other peroxisome proliferators, perfluoro fatty acids increase mouse hepatic peroxisomal fatty acid beta-oxidation more extensively than they increase catalase, thus increasing hepatic oxidative stress. 5. As with other peroxisome proliferators, perfluoro fatty acids increase mouse liver mitochondrial protein. This effect is due primarily to a redistribution of mitochondria from the nuclear to the mitochondrial fraction, caused by an apparent decrease in the mean size of hepatic mitochondria after treatment.	1					1									1					B	D	PODに関連しないが、毒性機序の参考にはなる	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
574	実験動物（PPAR）	Rosen, Mitchell B; Das, Kaberi P; Rooney, John; Abbott, Barbara; Lau, Christopher; Corton, J Christopher	PPARα-independent transcriptional targets of	2017	Toxicology. 2017 Jul 15;387:95-107. doi: 10.1016/j.tox.2017.05.013. Epub 2017 May 27.	Perfluoroalkyl acids (PFAAs) are ubiquitous and persistent environmental contaminants. Compounds such as perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS) are readily found in the tissues of humans and wildlife. While PFOA and PFOS have been the subject of numerous studies since they were first described over a decade ago, less is known about the biological activity of PFHxS and PFNA. Most PFAAs are activators of peroxisome proliferator-activated receptor α (PPARα), although the biological effects of these compounds are likely mediated by other factors in addition to PPARα. To evaluate the effects of PFHxS and PFNA, male wild-type and Pparα-null mice were dosed by oral gavage with PFHxS (3 or 10mg/kg/day), PFNA (1 or 3mg/kg/day), or vehicle for 7days, and liver gene expression was evaluated by full-genome microarrays. Gene expression patterns were then compared to historical in-house data for PFOA and PFOS in addition to the experimental hypolipidemic agent, WY-14,643. While WY-14,643 altered most genes in a PPARα-dependent manner, approximately 11-24% of regulated genes in PFAA-treated mice were independent of PPARα. The possibility that PFAAs regulate gene expression through other molecular pathways was evaluated. Using data available through a microarray database, PFAA gene expression profiles were found to exhibit significant similarity to profiles from mouse tissues exposed to agonists of the constitutive activated receptor (CAR), estrogen receptor α (ERα), and PPARγ. Human PPARγ and ERα were activated by all four PFAAs intrans-activation assays from the ToxCast screening program. Predictive gene expression biomarkers showed that PFAAs activate CAR in both genotypes and cause feminization of the liver transcriptome through suppression of signal transducer and activator of transcription 5B (STAT5B). These results indicate that, in addition to activating PPARα as a primary target, PFAAs also have the potential to activate CAR, PPARγ, and ERα as well as suppress STAT5B.			1			1	1		1				1			1		1			1		B	A	PODに関連しないが、毒性機序の参考にはなる	
575	実験動物（PPAR）	Erol, E.; Kumar, L. S.; Cline, G. W.; Shulman, G. I.; Kelly, D. P.; Binas, B.	Liver fatty acid binding protein is required for h	2003	FASEB J. 2004 Feb;18(2):347-9. doi: 10.1096/fj.03-0330fje. Epub 2003 Dec 4.	Liver fatty acid binding protein (L-FABP) has been proposed to limit the availability of long-chain fatty acids (LCFA) for oxidation and for peroxisome proliferator-activated receptor alpha (PPAR-alpha), a fatty acid binding transcription factor that determines the capacity of hepatic fatty acid oxidation. Here, we used L-FABP null mice to test this hypothesis. Under fasting conditions, this mutation reduced beta-hydroxybutyrate (BHB) plasma levels as well as BHB release and palmitic acid oxidation by isolated hepatocytes. However, the capacity for ketogenesis was not reduced: BHB plasma levels were restored by octanoate injection; BHB production and palmitic acid oxidation were normal in liver homogenates; and hepatic expression of key PPAR-alpha target (MCAD, mitochondrial HMG CoA synthase, ACO, CYP4A3) and other (CPT1, LCAD) genes of mitochondrial and extramitochondrial LCFA oxidation and ketogenesis remained at wild-type levels. During standard diet, mitochondrial HMG CoA synthase mRNA was selectively reduced in L-FABP null liver. These results suggest that under fasting conditions, hepatic L-FABP contributes to hepatic LCFA oxidation and ketogenesis by a nontranscriptional mechanism, whereas L-FABP can activate ketogenic gene expression in fed mice. Thus, the mechanisms whereby L-FABP affects fatty acid oxidation may vary with physiological condition.					1			1														C	C	重要度は低い	
576	実験動物（肝毒性）	Maloney, E K; Waxman, D J	Trans-Activation of PPARalpha and PPARgamm	1999	Toxicol Appl Pharmacol. 1999 Dec 1;161(2):209-18. doi: 10.1006/taap.1999.8809.	A large number of industrial chemicals and environmental pollutants, including trichloroethylene (TCE), di(2-ethylhexyl)phthalate (DEHP), perfluorooctanoic acid (PFOA), and various phenoxyacetic acid herbicides, are nongenotoxic rodent hepatocarcinogens whose human health risk is uncertain. Rodent model studies have identified the receptor involved in the hepatotoxic and hepatocarcinogenic actions of these chemicals as peroxisome proliferator-activated receptor alpha (PPARalpha), a nuclear receptor that is highly expressed in liver. Humans exhibit a weak response to these peroxisome proliferator chemicals, which in part results from the relatively low level of PPARalpha expression in human liver. Cell transfection studies were carried out to investigate the interactions of peroxisome proliferator chemicals with PPARalpha, cloned from human and mouse, and with PPARgamma, a PPAR isoform that is highly expressed in multiple human tissues and is an important regulator of physiological processes such as adipogenesis and hematopoiesis. With three environmental chemicals, TCE, perchloroethylene, and DEHP, PPARalpha was found to be activated by metabolites, but not by the parent chemical. A decreased sensitivity of human PPARalpha compared to mouse PPARalpha to trans-activation was observed with some (Wy-14, 643, PFOA), but not other, peroxisome proliferators (TCE metabolites, trichloroacetate and dichloroacetate; and DEHP metabolites, mono[2-ethylhexyl]phthalate and 2-ethylhexanoic acid). Investigation of human and mouse PPARgamma revealed the transcriptional activity of this receptor to bestimulated by mono(2-ethylhexyl)phthalate, a DEHP metabolite that induces developmental and reproductive organ toxicities in rodents. This finding suggests that PPARgamma, which is highly expressed in human adipose tissue, where many lipophilic foreign chemicals tend to accumulate, as well as in colon, heart, liver, testis, spleen, and hematopoietic cells, may be a heretofore unrecognized target in human cells for a subset of industrial and environmental chemicals of the peroxisome proliferator class.					1			1														C	C	重要度は低い	
577	実験動物（肝毒性）	Minata, M.; Harada, K. H.; Kärrman, A.; Hitomi, T.; Hirosawa, M.; Murata, M.; Gonzalez, F. J.; Koizumi, A.	Role of peroxisome proliferator-activated recep	2010	Ind Health. 2010;48(1):96-107. doi: 10.2486/indhealth.48.96.	Peroxisome proliferator-activated receptor-alpha (PPARalpha) has been suggested to protect against chemically induced hepatobiliary injuries in rodents. This function could mask the potential toxicities of perfluorooctanoic acid (PFOA) that is an emerging environmental contaminant and a weak ligand of PPARalpha. However its function has not been clarified. In this study, PFOA was found to elicit hepatocyte and bile duct injuries in Pparalpha-null mice after 4 wk treatment with PFOA ammonium salt (0, 12.5, 25, 50 micromol/kg/d, gavage). In wild-type mice, PFOA caused major hepatocellular damage dose-dependently and minor cholangiopathy observed only at 25 and 50 micromol/kg. In treated Pparalpha-null mice, PFOA produced marked fat accumulation, severe cholangiopathy, hepatocellular damage and apoptotic cells especially in bile ducts. Oxidative stress was also increased 4-fold at 50 micromol/kg and TNF-alpha mRNA was upregulated more than 3-fold at 25 micromol/kg in Pparalpha-null mice. Biliary bile acid/phospholipid ratios were higher in Pparalpha-null mice than in wild-type mice. Results from these studies suggest that PPARalpha is protective against PFOA and have a critical role in drug induced hepatobiliary injury.					1			1														C	C	PFOA中心であり重要度は低い	
578	実験動物（肝毒性）	Wang, Jianshe; Wang, Xiaoyang; Sheng, Nan; Zhou, Xiujuan; Cui, Ruina; Zhang, Hongxia; Dai, Jiayin	RNA-sequencing analysis reveals the hepatoto	2017	J Appl Toxicol. 2017 Apr;37(4):436-444. doi: 10.1002/jat.3376. Epub 2016 Aug 24.	The toxicological impact of traditional perfluoroalkyl chemicals has led to the elimination and restriction of these substances. However, many novel perfluoroalkyl alternatives remain unregulated and little is known about their potential effects on environmental and human health. Daily administration of two alternative perfluoroalkyl substances, HFPO2 and HFPO4 (1 mg kg(-1) body weight), for 28 days resulted in hepatomegaly and hepatic histopathological injury in mice, particularly in the HFPO4 group. We generated and compared high-throughput RNA-sequencing data from hepatic tissues in control and treatment group mice to clarify the mechanism of HFPO2 and HFPO4 hepatotoxicity. We identified 146 (101 upregulated, 45 downregulated) and 1295 (716 upregulated, 579 downregulated) hepatic transcripts that exhibited statistically significant changes (fold change ≥2 or ≤0.5, false discovery rate < 0.05) after HFPO2 and HFPO4 treatment, respectively. Among them, 111 (82 upregulated, 29 downregulated) transcripts were changed in both groups, and lipid metabolism associated genes were dominant. Thus, similar to their popular predecessors, HFPO2 and HFPO4 exposure exerted hepatic effects, including hepatomegaly and injury, and altered lipid metabolism gene levels in the liver, though HFPO4 exerted greater hepatotoxicity than HFPO2. The unregulated use of these emerging perfluoroalkyl alternatives may affect environmental and human health, and their biological effects need further exploration.					1			1			1											B	C	RNA変動を網羅的に調べた研究であり、PODに根拠にはならないが、作用機序の参考にできる。	
579	実験動物（PPAR）	Gervois, Philippe; Kleemann, Robert; Pilon, Antoine; Percevault, Fréd éric; Koenig, Wolfgang; Staels, Bart; Kooistra, Teake	Global suppression of IL-6-induced acute phas	2004	J Biol Chem. 2004 Apr 16;279(16):16154-60. doi: 10.1074/jbc.M400346200. Epub 2004 Feb 5.	The peroxisome proliferator-activated receptor alpha (PPARalpha), which is highly expressed in liver, plays key roles in lipid metabolism and inflammation. Interleukin-6 (IL-6) is the principal inducer of acute phase response (APR) gene expression. In the present study, we demonstrate that chronic treatment with the PPARalpha agonist fenofibrate fully prevents the IL-6-induced APR gene expression in wild-type but not in PPARalpha-deficient mice. PPARalpha prevents the IL-6-induced expression of the positive APR genes fibrinogen-alpha, -beta, -gamma, haptoglobulin, and serum amyloid A and the IL-6-induced suppression of the negative APR gene, major urinary protein. Furthermore, the effect of PPARalpha on the APR gene expression does not simply consist in a delayed systemic response to IL-6 but occurs directly at the transcriptional level. This global suppression of acute phase gene transcription may be explained by two PPARalpha-dependent in vivo effects: 1) PPARalpha activation results in the down-regulation of the IL-6 receptor components gp80 and gp130 in the liver, thereby reducing the phosphorylation and activation of the downstream transcription factors STAT3 and c-Jun that transduce the IL-6 signal; and 2) PPARalpha reduces the basal expression of the transcription factors CCAAT enhancer-binding protein-alpha, -beta, -delta, which are responsible for immediate and maintained transcription of APR genes. A similar global effect of fenofibrate on acute phase protein expression is observed in hyperlipidemic patients chronically treated with fenofibrate, which displayed decreased plasmaconcentrations of the positive APR proteins fibrinogen, C-reactive protein, serum amyloid A, plasminogen, and alpha2-macroglobulin and increased plasma concentrations of the negative APR albumin, underlining the clinical significance of our findings.					1			1														C	C	サイトカインへの影響に関する研究であり、重要度はそれほど高くない。	
580	実験動物（肝毒性）	Bil, Wieneke; Zeilmaker, Marco; Fragki, Styliani; Lijzen, Johannes; Verbruggen, Eric; Bokkers, Bas	Risk Assessment of Per- and Polyfluoroalkyl Su	2021	Environ Toxicol Chem. 2021 Mar;40(3):859-870. doi: 10.1002/etc.4835. Epub 2020 Sep 8.	Per- and polyfluoroalkyl substances (PFAS) often occur together as contamination in exposure media such as drinking water or food. The relative potency factor (RPF) methodology facilitates the risk assessment of mixture exposure. A database of liver endpoints was established for 16 PFAS, using data with the same species (rat), sex (male), and exposure route (oral) and comparable exposure duration (42-90 d). Dose-response analysis was applied to derive the relative potencies of 3 perfluoroalkyl sulfonic acids (perfluorobutane sulfonic acid, perfluorohexane sulfonic acid, perfluorooctane sulfonic acid), 8 perfluoroalkyl carboxylic acids (perfluorobutanoic acid, perfluorohexanoic acid, perfluorononanoic acid, perfluoroundecanoic acid, perfluorododecanoic acid, perfluorotetradecanoic acid, perfluorohexadecanoic acid, perfluorooctadecanoic acid), 2 perfluoroalkyl ether carboxylic acids (tetrafluoro-2-[heptafluoropropoxy]propanoic acid, 3H-perfluoro-3-[(3-methoxy-propoxy)propanoic acid]), and 2 fluorotelomer alcohols (6:2 FTOH, 8:2 FTOH) compared to perfluorooctanoic acid (PFOA), based on liver effects. In addition, the RPFs of 7 other perfluoroalkyl acids were estimated based on read-across. This resulted in the relative potencies of 22 PFAS compared to the potency of index compound PFOA. The obtained RPFs can be applied to measured PFAS quantities, resulting in the sum of PFOA equivalents in a mixture. This sum can be compared with an established PFOA concentration limit (e.g., in drinking water or food) or an external health-based guidance value (e.g., tolerable daily intake, acceptable daily intake, or reference dose) to estimatethe risk resulting from direct oral exposure to mixtures. Assessing mixture exposure is particularly relevant for PFAS, with omnipresent exposure in our daily lives.	1	1	1								1								B	B	多数のPFASを扱っていることから	
581	実験動物（肝毒性）	Fang, Xuemei; Gao, Guizhen; Xue, Hongyu; Zhang, Xingtao; Wang, Haichao	Exposure of perfluorononanoic acid suppresse	2012	Toxicology. 2012 Apr 11;294(2-3):109-15. doi: 10.1016/j.tox.2012.02.008. Epub 2012 Mar 1.	Exposure to perfluorononanoic acid (PFNA), an increasingly persistent organic pollutant that has been detected in abiotic and biotic matrices, has been demonstrated to cause hepatotoxicity in animals. However, the effects of PFNA on hepatic glucose metabolism have not been fully characterized. In this study, male rats were exposed to 0, 0.2, 1 or 5mg/kg/d PFNA for 14 days to explore the specific effect of PFNA on hepatic glycometabolism and its underlying mechanisms. The results showed that administration of 5mg/kg/d PFNA significantly increased serum glucose and hepatic glycogen in rats. Quantitative real-time PCR analysis showed that PFNA exposure changed the expression levels of several genes related to hepatic glucose metabolism, such as the glucose-6-phosphatase (G6PC) gene and the glucose transporter 2 (GLUT2) gene, which were upregulated, and the glucokinase (GCK) gene and the phosphoinositide-3-kinase, catalytic, alpha polypeptide (PI3Kca) gene, which were decreased. The protein expression levels of phospho-insulin receptor 1(IRS1), phospho-PI3K, phospho-AKT and phospho-phosphoinositide-dependent kinase 1 (PDK1) were decreased in the livers of rats that received 5mg/kg/d PFNA. The expression of phospho-glycogen synthase kinase-3 beta (GSK3β, Ser 9) was increased, which explains the augment of hepatic glycogen. Significant increases in hydrogen peroxide (H(2)O(2)) and malondialdehyde (MDA) were found in the livers of 5mg/kg/d PFNA-treated rats. Thus, exposure to PFNA disordered glucose metabolism via inhibiting hepatic insulin signal pathway, accelerating the output of glucose and increasingglycogen synthesis in the rat liver. Furthermore, the oxidative stress induced by PFNA may be involved in this process.					1			1														B	A	データが限定的なためPODに根拠にはならないがメカニズムの参考になる。	
582	実験動物（肝毒性）	Fang, Xuemei; Gao, Guizhen; Xue, Hongyu; Zhang, Xingtao; Wang, Haichao	In vitro and in vivo studies of the toxic effects	2012	Environ Toxicol Pharmacol. 2012 Sep;34(2):484-494. doi: 10.1016/j.etap.2012.06.011. Epub 2012 Jul 1.	This study investigated the toxic effects of perfluorononanoic acid (PFNA), a persistent organic pollutant, on rat hepatocytes and Kupffer cells in vitro and in vivo. The results showed that administration of 5μM PFNA increased the viabilities of the hepatocytes and the Kupffer cells. An exposure of 50μM PFNA did not alter the viabilities of both cells, as well as the release of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) from the primary cultured hepatocytes or the hepatocytes co-cultured with Kupffer cells. An exposure of 100μM PFNA only decreased the viability of the hepatocytes. The administration of PFNA changed the hepatocyte expression of several genes related to lipid metabolism in vitro and in vivo. Oil Red O Staining revealed that 5mg PFNA/kg/D treatment lead to dramatic accumulation of lipids in rat liver. At the same dose PFNA damaged hepatocytes histopathologically. Up-regulated expressions of the inflammatory cytokines occurred in the Kupffer cells treated with 50μM PFNA and in the livers of the rat receiving a 5mg PFNA/kg/D treatment. In addition, these cytokines also increased in serum of the rat receiving higher dose of PFNA. In summary, on the one hand, PFNA exposure affected the viability of the hepatocytes, hepatic lipid metabolism and lead to lipid accumulation in liver. On the other hand, for the first time, PFNA exposure was demonstrated to affect the viability of the Kupffer cells as well as their expression of cytokines, which involved in regulation of various liver functions. Therefore, we conclude that both the hepatocyte and the Kupffer cell contribute to the observedhepatotoxicity of PFNA.					1			1														C	A	サイトカインへの影響に関する研究であり、重要度はそれほど高くない。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
583	実験動物（肝毒性）	Kennedy, G L Jr	Increase in mouse liver weight following feedin	1987	Toxicol Lett. 1987 Dec;39(2-3):295-300. doi: 10.1016/0378-4274(87)90245-1.	The weight of the mouse liver following feeding of ammonium perfluorooctanoate, ammonium perfluorononanoate, Telomer B ammonium sulfate, and WG-III was increased in a dose-dependent manner. Dietary levels of 3 ppm or greater ammonium perfluorooctanoate for either 14 or 21 days produced a significant elevation in liver weight both on an absolute and on an organ/body weight ratio basis. Similarly, ammonium perfluorononanoate produced significant increases at the lowest level tested, 3 ppm. Telomer B ammonium sulfate and WG-III also produced liver weight increases but at higher feeding levels. The striking increase in liver weight following relatively short-term exposures in mice makes this a useful screening test for comparing the liver-enlarging capacity of ammonium perfluorooctanoate and related fluorochemicals.			1												1				C	B	肝毒性のスクリーニングとしての研究であり、PODにはならない。	
584	実験動物（肝毒性）	Fang, Xuemei; Zou, Shanshan; Zhao, Yuanyuan; Cui, Ruina; Zhang, Wei; Hu, Jiayue; Dai, Jiayin	Kupffer cells suppress perfluorononanoic acid-	2012	Arch Toxicol. 2012 Oct;86(10):1515-25. doi: 10.1007/s00204-012-0877-4. Epub 2012 May 31.	Kupffer cells (KCs) have been demonstrated to play a role in the regulation of intra-hepatic lipid metabolism through the synthesis and secretion of biologically active products. The involvement of KCs in the disturbance of lipid metabolism that induced by perfluorononanoic acid (PFNA), a known agonist of the peroxisome proliferator-activated receptor alpha (PPARα), was investigated in this study. Rats were exposed to PFNA or PFNA combined with gadolinium chloride, an inhibitor of KCs, for 14 days. PFNA exposure dose-dependently increased absolute and relative liver weights, induced triglyceride accumulation, up-regulated the expression of both SERBP-1c and PPARα, and stimulated the release of TNF α and IL-1β. Inactivation of KCs markedly lowered TNF α and IL-1β level, enhanced PFNA-induced expression of PPARα and its target genes, and reduced liver triglyceride levels. In vitro, PFNA-induced expression of PPARα in primary cultured hepatocytes was suppressed by recombinant rat TNF α and IL-1β. Hower, inhibition of the NF-κB pathway prevented this. Transient transfection and promoter analysis further revealed that these two cytokines and NF-κB were coordinately involved in the suppression of PPARα promoter activity. Our data demonstrate that TNF α and IL-1β released from KCs following PFNA exposure can suppress the expression of PPARα via NF-κB pathway, which partially contribute to the evident accumulation of triglycerides in rat liver.			1												1				1	B	A	脂質代謝異常のメカニズムの参考にできる。	
585	実験動物（肝毒性）	Goecke-Flora, C M; Reo, N V	Influence of carbon chain length on the hepatic	1996	Chem Res Toxicol. 1996 Jun;9(4):689-95. doi: 10.1021/tx950217k.	Using nuclear magnetic resonance (NMR) spectroscopy, we investigated the importance of carbon chain length with regard to the hepatic effects associated with perfluoro-n-carboxylic acids. Male F-344 rats were administered a single intraperitoneal dose of either perfluoro-n-heptanoic acid (C7-PFA), perfluoro-n-nonanoic acid (C9-PFA), or perfluoro-n-undecanoic acid (C11-PFA). Data from previous studies involving perfluoro-n-octanoic acid (C8-PFA) and perfluoro-n-decanoic acid (C10-PFA) are included for comparison. Food consumption/body weight was monitored daily for all groups. C9- and C11-PFA treatment yields a prolonged hypophagic response while C7-PFA shows a more acute response. Fluorine-19 NMR spectra of urine and bile samples show no evidence of fluorometabolites and suggest that the distribution of perfluorocarbons into urine or bile is dependent upon carbon chain length. The aqueous solubility of C7-PFA appears to facilitate rapid urinary excretion, similar to that observed for C8-PFA. The relative hydrophobicity of C9- and C11-PFA appears to favor biliary enterohepatic recirculation, yielding a more protracted toxicity, similar to C10-PFA. Phosphorus-31 NMR studies of liver in vivo and liver extracts show that perfluorocarbons of > or = C9 carbons produce a significant increase in liver phosphocholine concentration. These data are discussed with regard to the impact of these chemicals on hepatic phospholipid metabolism. Hepatic peroxisomal fatty acyl CoA-oxidase activity (FAO) was measured to determine if C7-, C9-, and C11-PFA are peroxisome proliferators. Data indicate that the induction ofperoxisomal enzyme activity by perfluorocarbons requires a chain length greater than seven carbons. In general, these results demonstrate the significance of carbon chain length in the hepatotoxic response and provide clues toward understanding the processes involved in the biological activities associated with exposure to these compounds.			1												1				B	B	多数のPFASを扱っていることから	
586	実験動物（肝毒性）	Kudo, N; Bandai, N; Suzuki, E; Katakura, M; Kawashima, Y	Induction by perfluorinated fatty acids with dif	2000	Chem Biol Interact. 2000 Jan 15;124(2):119-32. doi: 10.1016/s0009-2797(99)00150-7.	The potency of the induction of peroxisomal beta-oxidation was compared between perfluorinated fatty acids (PFCAs) with different carbon chain lengths in the liver of male and female rats. In male rats, perfluoroheptanoic acid (PFHA) has little effect, although perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) potentially induced the activity. By contrast, PFHA and PFOA did not induce the activity of peroxisomal beta-oxidation in the liver of female rats while PFNA and PFDA effectively induced the activity. The induction of the activity by these PFCAs was in a dose-dependent manner, and there is a highly significant correlation between the induction and hepatic concentrations of PFCAs in the liver regardless of their carbon chain lengths. These results strongly suggest that the difference in their chemical structure is not the cause of the difference in the potency of the induction. Hepatic concentrations of PFOA and PFNA was markedly higher in male compared with female rats. Castration of male rats reduced the concentration of PFNA in the liver and treatment with testosterone entirely restored the reduction. In contrast to the results obtained from the in vivo experiments, the activity of peroxisomal beta-oxidation was induced by PFDA and PFOA to the same extent in cultured hepatocytes prepared from both male and female rats. These results, taken together, indicate that difference in accumulation between PFCAs in the liver was responsible for the different potency of the induction of peroxisomal beta-oxidation between PFCAs with different carbon chain lengths and betweensexes.			1												1		1		1	B	A	性差の参考にできる。	
587	実験動物（肝毒性）	Kudo, Naomi; Iwase, Yuko; Okayachi, Hiroshi; Yamakawa, Yoshihiro; Kawashima, Yoichi	Induction of hepatic peroxisome proliferation b	2005	Toxicol Sci. 2005 Aug;86(2):231-8. doi: 10.1093/toxsci/kfi191. Epub 2005 May 11.	The effects of dietary administration of 1H, 1H, 2H, 2H-perfluorodecanol (8-2 telomer alcohol), on peroxisome proliferation in the liver of mice were studied. Male ddY mice were fed on a diet containing 8-2 telomer alcohol at concentrations of 0, 0.025, 0.05, 0.1, and 0.2% (w/w) for 7, 14, 21, and 28 days. These treatments with 8-2 telomer alcohol caused liver enlargement in a dose- and duration-dependent manner. Peroxisome proliferation in the liver of mice was confirmed by electron microscopic examination. Peroxisomal acyl-CoA oxidase was induced by these treatments with 8-2 telomer alcohol in a dose- and time-dependent manner. The concentration of perfluorooctanoic acid (PFOA) and related compounds were determined in the liver and plasma, since PFOA had been shown to be a possible metabolite of 8-2 telomer alcohol and to cause significant peroxisome proliferation in rodents. Five metabolites, namely, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), 2H, 2H-perfluorodecanoic acid (8-2 telomer acid), and two unidentified metabolites, were present in the liver and serum. PFOA was confirmed to be accumulated in the liver of mice following the administration of 8-2 telomer alcohol in a dose- and duration-dependent manner. A linear relationship was observed between the concentration of PFOA and the activity of peroxisomal acyl-CoA oxidase in the liver of mice. These results strongly suggest that PFOA, but not 8-2 telomer alcohol itself, caused peroxisome proliferation in the liver. The present study provided evidence that 8-2 telomer alcohol is converted into PFOA in vivo and that the PFOA formed producesbiological effects in the liver of mice.			1												1		1		B	C	基本的な情報に留まる。PODにはならない。	
588	実験動物（肝毒性）	Kudo, Naomi; Suzuki-Nakajima, Erika; Mitsumoto, Atsushi; Kawashima, Yoichi	Responses of the liver to perfluorinated fatty a	2006	Biol Pharm Bull. 2006 Sep;29(9):1952-7. doi: 10.1248/bpb.29.1952.	The potency of the induction of hepatomegaly, peroxisomal beta-oxidation and microsomal 1-acylglycerophoshocholine (1-acyl-GPC) acyltransferase was compared among perfluorinated fatty acids (PFCAs) with 6-9 carbon chain length in the liver of male and female mice. All PFCAs examined induced hepatomegaly and peroxisomal beta-oxidation and the potency was in the order of perfluorononanonic acid (PFNA), perfluorooctanoic acid (PFOA), perfluoroheptanoic acid (PFHA) and perfluorohexanoic acid (PFHeA) when compared with the relative doses to induce the two parameters. Microsomal 1-acyl-GPC acyltransferase was induced by PFHA, PFOA and PFNA, as was peroxisomal beta-oxidation. No significant sex-related difference was observed in the induction of peroxisomal beta-oxidation by any PFCAs examined. PFNA and PFOA accumulated in the liver of both male and female mice in a dose-dependent manner. PFHA accumulated in the liver to a lesser extent; little PFHeA accumulated in the liver. Hepatic concentrations of PFNA, PFOA and PFHA were higher in male mice than those in female mice. One linear regression line was confirmed between the activities of peroxisomal beta-oxidation and hepatic concentrations of PFHeA, PFHA, PFOA and PFNA in male mice regardless of their carbon chain lengths, and the activities were saturable at the concentrations over approximately 500 nmol/g liver. Similar linear regression line was obtained between the two parameters in female mice. These results suggest (i) that the longer the perfluoroalkyl chain becomes, the more PFCA accumulates in the liver of both male and female mice, (ii) that theaccumulated PFCAs induce hepatomegaly, peroxisomal beta-oxidation and microsomal 1-acyl-GPC acyltransferase, and (iii) that the difference observed in the accumulation of PFHA, PFOA and PFNA in the liver between male and female mice is not enough to produce obvious sex-related difference in the induction of peroxisomal beta-oxidation.			1												1		1		B	B	ヒトへの外挿はできないがメカニズムの一部参考になる。	
589	実験動物（肝毒性）	Fang, Xuemei; Gao, Guizhen; Zhang, Xingtao; Wang, Haichao	Perfluorononanoic acid disturbed the metaboli	2015	Toxicol Mech Methods. 2015;25(8):622-7. doi: 10.3109/15376516.2015.1053649. Epub 2015 Jun 9.	Most studies on the liver toxicity of perfluorinated compounds (PFCs) are focused on healthy individuals, whereas the effects of PFCs on individuals with diabetes mellitus have not been fully characterized. This study aimed to investigate the acute exposure of perfluorononanoic acid (PFNA) on the metabolism of lipid in the liver of streptozotocin-induced diabetic rats. Male diabetic rats were orally dosed by gavage for 7 days with 0, 0.2, 1 and 5 mg/kg/day PFNA. The contents of lipid, the activities of enzyme, the expressions of protein in the liver and the serum parameters were detected. The results indicate that dose-dependent accumulation of triglyceride and total cholesterol occurred in the livers of diabetic rats after PFNA treatment. PFNA increased the activities of lipid synthetase, fatty acid synthease, glucose-6-phosphate dehydrogenase and decreased the activity of lipolytic enzyme, hepatic lipase, in the liver of diabetic rats. The changes of the isocitrate dehydrogenase, malicenzyme and lipoprotein lipase were not obvious. The expressions of protein related to lipid homeostasis, liver X receptor α and apolipoprotein E, were decreased after PFNA administration. Exposure to PFNA also increased the activity of serum alanine aminotransferase in diabetic rats. In conclusion, this study discloses that exposure to PFNA impacts on enzymes and proteins related to liver lipid metabolism and lead to obvious accumulation of lipid in the liver of diabetic rats, which may be responsible for hepatotoxicity of this compound in individuals with diabetes mellitus.			1												1		1		B	A	ヒトへの外挿はできないがメカニズムの一部参考になる。	
590	実験動物（肝毒性）	Rolfe M, James NH and Roberts RA.	Tumour necrosis factor alpha (TNF-alpha) sup	1997	Carcinogenesis, 18, 2277–2280. doi: 10.1093/carcin/18.11.2277.	Peroxisome proliferators (PPs) are a class of non-genotoxic rodent hepatocarcinogens that cause increased hepatocyte DNA synthesis, peroxisome proliferation and liver enlargement. We have demonstrated previously that PPs suppress both spontaneous rat hepatocyte apoptosis and that induced by the physiological negative regulator of liver growth, transforming growth factor beta (TGF beta1). Evidence suggests that the suppression of apoptosis by PPs is mediated via activation of the peroxisome proliferator activated receptor-alpha (PPAR alpha), a member of the nuclear hormone receptor superfamily. Here, we investigate the effects of tumour necrosis factor alpha (TNF alpha) on cultured rat or mouse hepatocytes to determine whether TNF alpha influences hepatocyte growth in a manner analogous to that seen with PPs. Rat recombinant TNF alpha was found to stimulate DNA synthesis and suppress apoptosis in isolated rat hepatocyte monolayers (P < or = 0.01). These effects were seen in the range of 500-5000 U/ml with a maximum effect at 5000 U/ml. Similarly, mouse recombinant TNF alpha was able to stimulate DNA synthesis in mouse hepatocyte monolayers (P < or = 0.01) with a maximal effect at 1000 U/ml. Suppression of mouse hepatocyte apoptosis by TNF alpha was not detected, possibly because of the low levels of apoptosis under control conditions. However, when the levels of mouse hepatocyte apoptosis were augmented using TGF beta1, TNF alpha caused a significant suppression (P < or = 0.01). The neutralization of TNF alpha using anti-TNF alpha antibodies abrogated significantly (P < or = 0.01) the suppression of apoptosis by the PP, nafenopin. These data that suggest TNF alpha may mediate, at least in part, the growth perturbation, liver enlargement and hepatocarcinogenesis seen in response to the PP class of non-genotoxic hepatocarcinogens.															1				C	C	PPsのgeneralな研究。	
591	in vitro（内分泌）	Ren, Xiao-Min; Zhang, Yin-Feng; Guo, Liang-Hong; Qin, Zhan-Fen; Lv, Qi-Yan; Zhang, Lian-Ying	Structure-activity relations in binding of perflu	2015	Arch Toxicol. 2015 Feb;89(2):233-42. doi: 10.1007/s00204-014-1258-y. Epub 2014 May 13.	Perfluoroalkyl compounds (PFCs) have been shown to disrupt thyroid functions through thyroid hormone receptor (TR)-mediated pathways, but direct binding of PFCs with TR has not been demonstrated. We investigated the binding interactions of 16 structurally diverse PFCs with human TR, their activities on TR in cells, and the activity of perfluorooctane sulfonate (PFOS) in vivo. In fluorescence competitive binding assays, most of the 16 PFCs were found to bind to TR with relative binding potency in the range of 0.0003-0.05 compared with triiodothyronine (T3). A structure-binding relationship for PFCs was observed, where fluorinated alkyl chain length longer than ten, and an acid end group were optimal for TR binding. In thyroid hormone (TH)-responsive cell proliferation assays, PFOS, perfluorohexadecanoic acid, and perfluorooctadecanoic acid exhibited agonistic activity by promoting cell growth. Furthermore, similar to T3, PFOS exposure promoted expression of three TH upregulated genes and inhibited three TH downregulated genes in amphibians. Molecular docking analysis revealed that most of the tested PFCs efficiently fit into the T3-binding pocket in TR and formed a hydrogen bond with arginine 228 in a manner similar to T3. The combined in vitro, in vivo, and computational data strongly suggest that some PFCs disrupt the normal activity of TR pathways by directly binding to TR.		1					1				1						1		D	B	16 種類のPFCs とヒトTR との結合相互作用 (in vitro) およびPFOS活性 (in vivo) の評価。調査対象物質の内容か判断できない。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
592	in vitro（免疫毒性）	Corsini, Emanuela; Sangiovanni, Enrico; Avogadro, Anna; Galbiati, Valentina; Viviani, Barbara; Marinovich, Marina; Galli, Corrado L; Dell'Agli, Mario; Germolec, Dori R	In vitro characterization of the immunotoxic po	2012	Toxicol Appl Pharmacol. 2012 Jan 15;258(2):248-55. doi: 10.1016/j.taap.2011.11.004. Epub 2011 Nov 18.	We have previously shown that PFOA and PFOS directly suppress cytokine secretion in immune cells, with different mechanisms of action. In particular, we have demonstrated a role for PPAR-α in PFOA-induced immunotoxicity, and that PFOS has an inhibitory effect on LPS-induced I-κB degradation. These studies investigate the immunomodulatory effects of four other PFCs, namely PFBS, PFOSA, PFDA, and fluorotelomer using in vitro assays. The release of the pro-inflammatory cytokines IL-6 and TNF-α was evaluated in lipolysaccharide (LPS)-stimulated human peripheral blood leukocytes (hPBL) and in the human promyelocytic cell line THP-1, while the release of IL-10 and IFN-γ was evaluated in phytohemagglutinin (PHA)-stimulated hPBL. All PFCs suppressed LPS-induced TNF-α production in hPBL and THP-1 cells, while IL-6 production was suppressed by PFOSA, PFOS, PFDA and fluorotelomer. PFBS, PFOSA, PFOS, PFDA and fluorotelomer inhibited PHA-induced IL-10 release, while IFN-γ secretion was affected by PFOSA, PFOS, PFDA and fluorotelomer. Leukocytes obtained from female donors appear to be more sensitive to the in vitro immunotoxic effects of PFCs when their responses are compared to the results obtained using leukocytes from male donors. Mechanistic investigations demonstrated that inhibition of TNF-α release in THP-1 cells occurred at the transcriptional level. All PFCs, including PFOA and PFOS, decreased LPS-induced NF-κB activation. With the exception of PFOA, none of the PFCs tested was able to activate PPARα driven transcription in transiently transfected THP-1 cells, excluding a role for PPARα in the immunomodulationobserved. PFBS and PFDA prevented LPS-induced I-κB degradation. Overall, these studies suggest that PFCs affect NF-κB activation, which directly suppresses cytokine secretion by immune cells. Our results indicate that PFOA is the least active of the PFCs examined followed by PFBS, PFDA, PFOS, PFOSA and fluorotelomer.				1				1			1										1	A	B	ヒト細胞を用いたin vitroによるPFBSを含むPFCsの免疫毒性活性の評価。メカニズムの参考。 ※元「水色セルのB」。in vitro評価のみの文献を含むメカニズムの参考と考えたもの。昨年度の方針ならC or Dだが、WGの検討からメカニズム関連の文献も確認しておいた方が良いと考え、このようなラベルとした。	
593	in vitro（内分泌）	Behr, Anne-Cathrin; Lichtenstein, Dajana; Braeuning, Albert; Lampen, Alfonso; Buhrke, Thorsten	Perfluoroalkylated substances (PFAS) affect n	2018	Toxicol Lett. 2018 Jul;291:51-60. doi: 10.1016/j.toxlet.2018.03.029. Epub 2018 Mar 27.	The perfluoroalkylated substances (PFAS) perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) are used for the fabrication of water- and dirt-repellent surfaces. The use of PFOS and PFOA was restricted due to their reprotoxic properties and their environmental persistence. Therefore, industry switches to alternative PFAS, however, in contrast to PFOA and PFOS only few toxicological data are available for their substitutes. The molecular mechanism(s) underlying reproductive toxicity of PFOA and PFOS are largely unknown. Here, the endocrine properties of PFOA, PFOS, and of six substitutes including perfluorohexanesulfonic acid (PFHxS), perfluorobutanesulfonic acid (PFBS), perfluorohexanoic acid (PFHxA), perfluorobutanoic acid (PFBA), ammonium perfluoro(2-methyl-3-oxahexanoate) (PMOH), and 3H-perfluoro-3-[(3-methoxypropoxy) propanoic acid] (PMPP) were examined in vitro by using human cell lines such as MCF-7, H295R, LNCaP and MDA-kb2. PFOA, PFOS and PMOH enhanced 17β-estradiol-stimulated estrogen receptor β activity, and PFOS, PMOH, PFHxA and PFBA enhanced dihydrotestosterone-stimulated androgen receptor activity. In the H295R steroidogenesis assay, PFOA and PFOS slightly enhanced estrone secretion, and progesterone secretion was marginally increased by PFOA. All these effects were only observed at concentrations above 10 μM, and none of the PFAS displayed any effect on any of the molecular endocrine endpoints at concentrations of 10 μM or below. Thus, as the blood serum concentrations of the different PFAS in the general Western population are in the range of 10 nM or below, the resultssuggest that PFAS might not exert endocrine effects in humans at exposure-relevant concentrations according to the molecular endpoints examined in this study.	1	1		1	1			1			1									1	A	B	ヒト細胞を用いたin vitroによる調査対象物質を含むPFASの評価 (ER, ARの活性にもステロイド生成にも影響を与えない結果)。メカニズムの参考。 ※元「水色セルのB」。in vitro評価のみの文献を含むメカニズムの参考と考えたもの。昨年度の方針ならC or Dだが、WGの検討からメカニズム関連の文献も確認しておいた方が良いと考え、このようなラベルとした。	
594	in vitro（内分泌）	Xin, Yan; Ren, Xiao-Min; Wan, Bin; Guo, Liang-Hong	Comparative in Vitro and in Vivo Evaluation of	2019	Environ Sci Technol. 2019 Jul 16;53(14):8371-8380. doi: 10.1021/acs.est.9b01579. Epub 2019 Jun 28.	As alternatives to perfluorooctanoic acid (PFOA), hexafluoropropylene oxide (HFPO) homologues, including hexafluoropropylene oxide dimer acid (HFPO-DA), hexafluoropropylene oxide trimer acid (HFPO-TA), and hexafluoropropylene oxide tetramer acid (HFPO-TeA), have been used in the fluoropolymer industry for a long period of time. These compounds have attracted widespread attention in recent years due to their environmental ubiquity and high bioaccumulation capability, as well as their toxicity. In our study, we evaluated the potential estrogenic effects of HFPOs in comparison to PFOA by ligand binding, transcriptional activity, and in vivo assays. Fluorescence ligand binding assays showed that both HFPO-TA and HFPO-TeA exhibited higher binding affinity to estrogen receptor ligand binding domains (ER-LBDs) than PFOA, with 2.5- and 57.5-fold higher affinity to ERα-LBD and 2.6- and 41.8-fold higher affinity to ERβ-LBD, respectively, whereas HFPO-DA exhibited weaker binding affinity than PFOA. Unlike PFOA, HFPO-TA and HFPO-TeA exhibited antagonistic activity toward the ERs' signaling pathway, with HFPO-TeA displaying the strongest potency. In silico study revealed that while PFOA binds with ERs in a similar fashion as 17β-estradiol, the HFPOs display an antagonistic binding mode. Using a zebrafish model, we further found that exposure to HFPO homologues significantly altered the levels of sex steroid hormones and vitellogenin. In general, both in vivo and in vitro results indicate that HFPO homologues might exert higher estrogenic effects than PFOA.					1			1													D	C	エストロゲン様作用のin vitro, in vivo評価。ゼブラフィッシュモデルを使用しており、ヒト健康リスク評価に適用可能か判断できない。	
595	in vitro（脂質代謝）	Qi, Weipeng; Clark, John M; Timme-Laragy, Alicia R; Park, Yeonhwa	Perfluorobutanesulfonic acid (PFBS) potentiat	2018	Food Chem Toxicol. 2018 Oct;120:340-345. doi: 10.1016/j.fct.2018.07.031. Epub 2018 Jul 18.	Perfluorobutanesulfonic acid (PFBS) is used as the replacement of perfluorooctanesulfonic acid (PFOS) since 2000 because of the concern on PFOS' persistence in the environment and the bioaccumulation in animals. Accumulating evidence has shown the correlation between the exposure to perfluorinated compounds and enhanced adipogenesis. There is no report, however, of the effect of PFBS on adipogenesis. Therefore, the present work aimed to investigate the role of PFBS in adipogenesis using 3T3-L1 adipocytes. PFBS treatment for 6 days extensively promoted the differentiation of 3T3-L1 preadipocytes to adipocytes, resulting in significantly increased triglyceride levels. In particular, the treatments of PFBS at the early adipogenic differentiation period (day 0-2) were positively correlated with increased the triglyceride accumulation on day 6. PFBS treatments significantly increased the protein and mRNA levels of the master transcription factors in adipocyte differentiation; CCAAT/enhancer-binding protein α (C/EBPα) and peroxisome proliferator-activated receptor gamma (PPARγ), along with acetyl-CoA carboxylase (ACC) and fatty acid synthase (FAS), the key proteins in lipogenesis. PFBS significantly activated the phosphorylation of extracellular signal-regulated kinase1/2 (ERK1/2) after 4-h treatment, and PFBS' effect on triglyceride was abolished by U0126, a specific MAPK/ERK kinase (MEK) inhibitor. In conclusion, PFBS increased the adipogenesis of 3T3-L1 adipocytes, in part, via MEK/ERK-dependent pathway.				1				1												1	A	A	PFBSは部分的にMEK/ERK依存性な経路を介して3T3-L1脂肪細胞の脂肪形成を促進。メカニズムの参考。 ※元「水色セルのB」。in vitro評価のみの文献を含むメカニズムの参考と考えたもの。昨年度の方針ならC or Dだが、WGの検討からメカニズム関連の文献も確認しておいた方が良いと考え、このようなラベルとした。	
596	in vitro（内分泌）	Kjeldsen, Lisbeth Stigaard; Bonefeld-Jørgensen, Eva Cecilie	Perfluorinated compounds affect the function	2013	Environ Sci Pollut Res Int. 2013 Nov;20(11):8031-44. doi: 10.1007/s11356-013-1753-3. Epub 2013 Jun 14.	Perfluorinated compounds (PFCs) are a large group of chemicals used in different industrial and commercial applications. Studies have suggested the potential of some PFCs to disrupt endocrine homeostasis, increasing the risk of adverse health effects. This study aimed to elucidate mechanisms behind PFC interference with steroid hormone receptor functions. Seven PFCs [perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnA), and perfluorododecanoate (PFDoA)] were analyzed in vitro for their potential to affect estrogen receptor (ER) and androgen receptor (AR) transactivity as well as aromatase enzyme activity. The PFCs were assessed as single compounds and in an equimolar mixture. PFHxS, PFOS and PFOA significantly induced the ER transactivity, whereas PFHxS, PFOS, PFOA, PFNA and PFDA significantly antagonized the AR activity in a concentration-dependent manner. Moreover, PFDA weakly decreased the aromatase activity at a high test concentration. A mixture effect more than additive was observed on AR function. We conclude that five of the seven PFCs possess the potential in vitro to interfere with the function of the ER and/or the AR. The observed mixture effect emphasizes the importance of considering the combined action of PFCs in future studies to assess related health risks.				1								1								1	A	B	PFNAを含む7種類のPFCsの性ホルモン受容体機能への影響のin vitro評価。PFNAはAR活性に拮抗。 5物質がER および/またはARの機能を障害する可能性を示唆。メカニズムの参考。 ※元「水色セルのB」。in vitro評価のみの文献を含むメカニズムの参考と考えたもの。昨年度の方針ならC or Dだが、WGの検討からメカニズム関連の文献も確認しておいた方が良いと考え、このようなラベルとした。	
597	in vitro（内分泌）	Halsne, Ruth; Tandberg, Julia Isabel; Lobert, Viola Hélène; Østby, Gunn Charlotte; Thoen, Even; Ropstad, Erik; Verhaegen, Steven	Effects of perfluorinated alkyl acids on cellular	2016	Toxicol Lett. 2016 Sep 30;259:95-107. doi: 10.1016/j.toxlet.2016.08.004. Epub 2016 Aug 7.	Perfluorinated alkyl acids (PFAAs) are stable chemicals detected in tissue and serum from various species, including humans, and have been linked to adverse health outcomes. Experimental PFAA exposure in rodents has been associated with changes in mammary gland development. The estrogen receptor (ER)-negative human breast epithelial cell line, MCF-10A, can be grown as monolayer, but also has the ability to form three-dimensional acini in vitro, reflecting aspects of mammary glandular morphogenesis. Cells were exposed to five different PFAAs, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA), both in monolayer and acini cultures. In monolayer cultures only the higher concentrations of PFOS, PFNA and PFDA (400-500 μM) caused a significant increase in cell death, whereas PFOA and PFUnDA had no effect. Normal acini maturation was negatively impacted by PFOS, PFNA and PFDA already at the lowest concentration tested (0.6 μM). Observed effects included loss of organization of the cell clusters and absence of a hollow lumen. Overall, this study demonstrated that PFAAs can interfere with cellular events related to normal development of glandular breast tissue through ER-independent mechanisms.				1								1								1	A	A	PFNAを含む5種類のPFAAsがER陰性のヒト乳腺上皮細胞MCF-10Aに与える影響のin vitro評価。ER非依存的メカニズムで乳腺発達を障害する可能性を示唆。メカニズムの参考。 ※元「水色セルのB」。in vitro評価のみの文献を含むメカニズムの参考と考えたもの。昨年度の方針ならC or Dだが、WGの検討からメカニズム関連の文献も確認しておいた方が良いと考え、このようなラベルとした。	
598	in vitro（内分泌）	Long, Manhai; Ghisari, Mandana; Bonefeld-Jørgensen, Eva Cecilie	Effects of perfluoroalkyl acids on the function	2013	Environ Sci Pollut Res Int. 2013 Nov;20(11):8045-56. doi: 10.1007/s11356-013-1628-7. Epub 2013 Mar 29.	Perfluoroalkyl acids (PFAAs) are perfluorinated compounds that widely exist in the environment and can elicit adverse effects including endocrine disruption in humans and animals. This study investigated the effect of seven PFAAs on the thyroid hormone (TH) system assessing the proliferation of the 3,3',5-triiodo-L-thyronine (T3)-dependent rat pituitary GH3 cells using the T-screen assay and the effect on the aryl hydrocarbon receptor (AhR) transactivation in the AhR-luciferase reporter gene bioassay. A dose-dependent impact on GH3 cells was observed in the range 1×10(-9)-1×10(-4) M: seven PFAAs (perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnA), and perfluorododecanoic acid (PFDoA)) inhibited the GH3 cell growth, and four PFAAs (PFOS, PFHxS, PFNA, and PFUnA) antagonized the T3-induced GH3 cell proliferation. At the highest test concentration, PFHxS showed a further increase of the T3-induced GH3 growth. Among the seven tested PFAAs, only PFDoA and PFDA elicited an activating effect on the AhR. In conclusion, PFAAs possess in vitro endocrine-disrupting potential by interfering with TH and AhR functions, which need to be taken into consideration when assessing the impact on human health.				1								1								1	A	A	PFNAを含む7種類のPFAAsの甲状腺ホルモンおよびAhR機能に対する影響のin vitro評価。PFNAはT3に誘導されるラット下垂体由来GH3細胞増殖に拮抗、甲状腺ホルモン機能を干渉することを示唆。メカニズムの参考。 ※元「水色セルのB」。in vitro評価のみの文献を含むメカニズムの参考と考えたもの。昨年度の方針ならC or Dだが、WGの検討からメカニズム関連の文献も確認しておいた方が良いと考え、このようなラベルとした。	
599	in vitro（内分泌）	Rosenmai, A K; Taxvig, C; Svingen, T; Trier, X; van Vugt-Lussenburg, B M A; Pedersen, M; Lesné, L; Jégou, B; Vinggaard, A M	Fluorinated alkyl substances and technical mix	2016	Andrology. 2016 Jul;4(4):662-72. doi: 10.1111/andr.12190. Epub 2016 May 6.	Migration of chemicals from packaging materials to foods may lead to human exposure. Polyfluoroalkyl substances (PFAS) can be used in technical mixtures (TMs) for use in food packaging of paper and board, and PFAS have been detected in human serum and umbilical cord blood. The specific structures of the PFAS in TMs are often unknown, but polyfluorinated alkyl phosphate esters (PAPs) have been characterized in TMs, food packaging, and in food. PAPs can be metabolized into fluorotelomer alcohols (FTOHs) and perfluoroalkyl carboxylic acids (PFCAs). Some PFAS have endocrine activities, highlighting the need to investigate these effects. Herein, we studied the endocrine activity of less characterized PFAS, including short-chain PFCAs and FTOHs, PAPs, and TMs of unknown chemical composition. Long-chain PFCAs were also included. We applied seven assays covering effects on estrogen, glucocorticoid, androgen, and peroxisome proliferator-activated receptor (PPAR) activity, as well as steroidogenesis in vitro and ex vivo. In general, PAPs, FTOHs, TMs, and long-chain PFCAs showed estrogenic activity through receptor activation and/or increasing 17β-estradiol levels. Furthermore, short- and long-chain PFCAs activated PPARα and PPARγ. Collectively, this means that (i) PAPs, FTOHs, and PFCAs exhibit endocrine activity through distinct and sometimes different mechanisms, (ii) two out of three tested TMs exhibited estrogenic activity, and (iii) short-chain FTOHs showed estrogenic activity and short-chain PFCAs generally activate both PPARα and PPARγ with similar potency and efficacy as long-chain PFCAs. In conclusion,several new and divergent toxicological targets were identified for different groups of PFAS.	1	1	1									1								D	B	食品包装紙に使用されるPFASとtechnical mixturesの内分泌関連活性のin vitro評価。要旨からは調査対象物質の内容か判断できない。	
600	実験動物（代謝）	Bao, Shihui; Zhang, Jing; Lin, Zixia; Su, Ke; Mo, Jingjing; Hong, Lin; Qian, Shuyi; Chen, Lianguo; Sun, Fa; Wen, Congcong; Wu, Qing; Hu, Lufeng; Lin, Guanyang; Wang, Xianqin	Serum metabolic changes in rats after intragas	2017	Biomed Chromatogr. 2017 Mar;31(3). doi: 10.1002/bmc.3814. Epub 2016 Sep 6.	Dextromethorphan is recognized as a substance of abuse around the world. An estimated 3.1 million people between the ages of 12 and 25 years (5.3%) misused over-the-counter cough and cold medications in 2006. In this study, we developed a serum metabolomic method by gas chromatography–mass spectrometry (GC–MS) to evaluate the effect of abuse of dextromethorphan on rats. The dextromethorphan-treated rats were given 12, 24 and 48 mg/kg (low, medium, high) of dextromethorphan by intragastric administration each day for 3 days. Partial least squares-discriminate analysis revealed that intragastric administration of dextromethorphan induced metabolic perturbations. Compared with the control (healthy) group, the levels of propanoic acid, urea, heptafluorobutanoic acid, 2-hexyldecanoic acid and butanedioic acid of the low group decreased; levels of propanoic acid and heptafluorobutanoic acid of the medium group decreased, while that of benzoic acid increased; and levels of 2-hexyldecanoic acid, glycerol and butanedioic acid of the high group increased. These biomarkers are involved in the citric acid cycle, urea cycle, glycerolipid metabolism and tricarboxylic acid cycle. The results indicate that the metabolomic method by GC–MS may be useful to elucidate abuse of dextromethorphan. According to the pathological changes in the liver at different dosages, dextromethorphan is not hepatotoxic after intragastric administration of 12, 24 and 48 mg/kg for 3 days.	1								1									C	C	デキストロメトルファンによる血清代謝変化を評価した文献。HFBA（PFBA）レベルを見ているが、本リスク評価には関係しないと思われる。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
601	実験動物（内分泌）	Feng, Xuejiao; Cao, Xinyuan; Zhao, Shasha; Wang, Xiaoli; Hua, Xu; Chen, Lin; Chen, Ling	Exposure of Pregnant Mice to Perfluorobutane	2017	Toxicol Sci. 2017 Feb;155(2):409-419. doi: 10.1093/toxsci/kfw219. Epub 2016 Nov 1.	Perfluorobutanesulfonate (PFBS) is widely used in many industrial products. We evaluated the influence of prenatal PFBS exposure on perinatal growth and development, pubertal onset, and reproductive and thyroid endocrine system in female mice. Here, we show that when PFBS (200 and 500 mg/kg/day) was orally administered to pregnant mice (PFBS-dams) on days 1-20 of gestation; their female offspring (PFBS-offspring) exhibited decreased perinatal body weight and delayed eye opening compared with control offspring. Vaginal opening and first estrus were also significantly delayed in PFBS-offspring, and diestrus was prolonged. Ovarian and uterine size, as well as follicle and corpus luteum numbers, were reduced in adult PFBS-offspring. Furthermore, pubertal and adult PFBS-offspring exhibited decreases in serum estrogen (E2) and progesterone (P4) levels with the elevation of luteinizing hormone levels. Notably, decreases in serum total thyroxine (T4) and 3,3', 5-triiodothyronine (T3) levels were observed in fetal, pubertal, and adult PFBS-offspring in conjunction with slight increases in thyroid-stimulating hormone (TSH) and thyrotropin-releasing hormone levels. In addition, PFBS-dams exhibited significant decreases in total T4 and T3 levels and free T4 levels and increases in TSH levels, but no changes in E2 and P4 levels. These results indicate that prenatal PFBS exposure (≥200 mg/kg/day) causes permanent hypothyroxinemia accompanied by deficits in perinatal growth, pubertal onset, and reproductive organ development in female mice.	1					1		1		1	1				1		1	HBGV設定根拠	1	-	-		
602	実験動物（内分泌）	Morreale de Escobar, G; Calvo, R; Obregon, M J; Escobar Del Rey, F	Contribution of maternal thyroxine to fetal thyr	1990	Endocrinology. 1990 May;126(5):2765-7. doi: 10.1210/endo-126-5-2765.	Normal dams were equilibrated isotopically with [125I]T4 infused from 11 to 21 days of gestation, at which time maternal and fetal extrathyroidal tissues were obtained to determine their [125I]T4 and T4 contents. The specific activity of the [125I]T4 in the fetal tissues was lower than in maternal T4 pools. The extent of this change allows evaluation of the net contribution of maternal T4 to the fetal extrathyroidal T4 pools. At 21 days of gestation, near term, this represents 17.5 +/- 0.9% of the T4 in fetal tissues, a value considerably higher than previously calculated. The methodological approach was validated in dams given a goitrogen to block fetal thyroid function. The specific activities of the [125I]T4 in maternal and fetal T4 pools were then similar, confirming that in cases of fetal thyroid impairment the T4 in fetal tissues is determined by the maternal contribution. Thus, previous statements that in normal conditions fetal thyroid economy near term is totally independent of maternal thyroid status ought to be reconsidered.	1					1														C	C	出産間近の正常ラットにおける胎児サイロキシンプールへの母体サイロキシンの寄与に関する文献。	
603	実験動物（代謝）	Bijland, S.; Rensen, P. C. N.; Pieterman, E. J.; Maas, A. C. E.; van Der Hoorn, J. W.; van Erk, M. J.; Havekes, L. M.; Willems van Dijk, K.; Chang, S. C.; Ehresman, D. J.; Butenhoff, J. L.; Princen, H. M. G.	Perfluoroalkyl sulfonates cause alkyl chain leng	2011	Toxicol Sci 123: 290-303. doi: 10.1093/toxsci/kfr142	Perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS) are stable perfluoroalkyl sulfonate (PFAS) surfactants, and PFHxS and PFOS are frequently detected in human biomonitoring studies. Some epidemiological studies have shown modest positive correlations of serum PFOS with non-high-density lipoprotein (HDL)-cholesterol (C). This study investigated the mechanism underlying the effect of PFAS surfactants on lipoprotein metabolism. APOE*3-Leiden.CETP mice were fed a Western-type diet with PFBS, PFHxS, or PFOS (30, 6, and 3 mg/kg/day, respectively) for 4-6 weeks. Whereas PFBS modestly reduced only plasma triglycerides (TG), PFHxS and PFOS markedly reduced TG, non-HDL-C, and HDL-C. The decrease in very low-density lipoprotein (VLDL) was caused by enhanced lipoprotein lipase-mediated VLDL-TG clearance and by decreased production of VLDL-TG and VLDL-apolipoprotein B. Reduced HDL production, related to decreased apolipoprotein AI synthesis, resulted in decreased HDL. PFHxS and PFOS increased liver weight and hepatic TG content. Hepatic gene expression profiling data indicated that these effects were the combined result of peroxisome proliferator-activated receptor alpha and pregnane X receptor activation. In conclusion, the potency of PFAS to affect lipoprotein metabolism increased with increasing alkyl chain length. PFHxS and PFOS reduce plasma TG and total cholesterol mainly by impairing lipoprotein production, implying that the reported positive correlations of serum PFOS and non-HDL-C are associative rather than causal.				1				1		1		1			1		1		1	B	A	APOE*3-Leiden.CETPマウスを用いたPFBS、PFHxS、PFOSの各混餌投与による影響評価。PFBSは血漿トリグリセリド（TG）のみをわずかに減少（PFHxSとPFOSは、TG、非HDL-C、HDL-Cを顕著に減少）。リポタンパク質代謝に影響を与えるPFASの活性は、アルキル鎖長の増加に伴い増加。（PFHxS と PFOS は、主にリポタンパク質産生の阻害により血漿 TG と総コレステロールを低下。既報の血清 PFOS と非HDL-Cの正の相関が因果関係ではなく関連性であることを示唆。）	
604	実験動物（免疫毒性）	Rushing, Blake R; Hu, Qing; Franklin, Jason N; McMahen, Rebecca; Dagnino, Sonia; Higgins, Christopher P; Strynar, Mark J; DeWitt, Jamie C	Evaluation of the immunomodulatory effects of	2017	Toxicol Sci. 2017 Jan 23:kfw251. doi: 10.1093/toxsci/kfw251.	2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate was designed to replace perfluorooctanoic acid (PFOA), which has been mostly phased out of U.S. production due to environmental persistence, detectable human and wildlife serum concentrations, and reports of systemic toxicity. In rodent models, PFOA exposure suppresses T cell-dependent antibody responses (TDAR) and vaccine responses in exposed humans. To determine replacement compound effects on TDAR and related parameters, male and female C57BL/6 mice were gavaged with 0, 1, 10, or 100 mg/kg/day for 28 days. Mice immunized with antigen on day 24 were evaluated for TDAR and splenic lymphocyte subpopulations five days later. Serum and urine were collected for test compound concentrations and liver peroxisome proliferation was measured. Relative liver weight at 10 and 100 mg/kg and peroxisome proliferation at 100 mg/kg were increased in both sexes. TDAR was suppressed in females at 100 mg/kg. T lymphocyte numbers were increased in males at 100 mg/kg; B lymphocyte numbers were unchanged in both sexes. Females had less serum accumulation and higher clearance than males, and males had higher urine concentrations than females at all times and doses. While this PFOA-replacement compound appears less potent at suppressing TDAR relative to PFOA, it produces detectable changes in parameters affected by PFOA; further studies are necessary to determine its full immunomodulatory profile and potential synergism with other per- and polyfluoroalkyl substances of environmental concern.					1			1			1								B	B	C57BL/6マウスにおける2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate（GenX）のT細胞依存性抗体産生（TDAR）および関連パラメータの評価。PFOA代替物は、PFOAよりTDARを抑制する作用は弱いが、PFOAの影響を受けるパラメータに変化をもたらす可能性を示唆。3用量（1, 10, or 100 mg/kg/day）設定しているが、影響は主に高用量曝露で検出されているよう。	
605	生態毒性（内分泌）	Chen, Lianguo; Hu, Chenyan; Tsui, Mirabelle M P; Wan, Teng; Peterson, Drew R; Shi, Qipeng; Lam, Paul K S; Au, Doris W T; Lam, James C W; Zhou, Bingsheng	Multigenerational Disruption of the Thyroid En	2018	Environ Sci Technol. 2018 Apr 3;52(7):4432-4439. doi: 10.1021/acs.est.8b00700. Epub 2018 Mar 26.	Accumulation of perfluorobutanesulfonate (PFBS) is frequently detected in biota, raising concerns about its ecological safety. However, hazardous effects of PFBS remain largely unexplored, especially for endocrine disrupting potency. In the present study, the multigenerational endocrine disrupting potential of PFBS was investigated by exposing F0 marine medaka eggs to PFBS at different concentrations (0, 1.0, 2.9, and 9.5 μg/L) until sexual maturity. The F1 and F2 generations were reared without continued exposure. Thyroidal disturbances were examined in all three generations. PFBS exposure decreased the levels of 3,5,3'-triiodothyronine (T3) in F0 female blood; however, it increased T3 or thyroxine (T4) levels in F0 brains, in which hyperthyroidism suppressed the local transcription of 5'-deiodinase 2 (Dio2). Obviously decreased T3 was transferred to F1 eggs, although the parental influences were reversed in F1 larvae. Delayed hatching was coupled with elevated T3 levels in F1 larvae. F1 adults showed comparable symptoms of thyroidal disruption with F0 adults. A slight recovery was noted in the F2 generation, although F2 larvae still exhibited thyroid disruption and synthesized excessive T4. Our results suggested that the offspring suffered more severe dysfunction of the thyroidal axis albeit without direct exposure. This study provided the first molecular insight about PFBS toxicology on the thyroid, beneficial to both human and environmental risk assessment.				1	1					1								C	A	甲状腺に対するPFBSの多世代影響を評価しているが、メダカの試験。	
606	生態毒性（内分泌）	Lou, Qin-Qin; Zhang, Yin-Feng; Zhou, Zhen; Shi, Ya-Li; Ge, Ya-Nan; Ren, Dong-Kai; Xu, Hai-Ming; Zhao, Ya-Xian; Wei, Wu-Ji; Qin, Zhan-Fen	Effects of perfluorooctanesulfonate and perfluo	2013	Ecotoxicology. 2013 Sep;22(7):1133-44. doi: 10.1007/s10646-013-1100-y. Epub 2013 Aug 2.	Perfluorobutanesulfonate (PFBS), as a substitute for perfluorooctanesulfonate (PFOS), is widespread in the environment and biotic samples as well as PFOS. To investigate effects of PFOS and PFBS on the growth and sexual development of amphibians, we exposed Xenopus laevis tadpoles at a series of concentrations of PFOS and PFBS (0.1; 1; 100; 1,000 μg/l) as well as 17-beta-estradiol (E2, 100 ng/l) and 5 alpha-androstan-17-beta-ol-3-one (DHT, 100 ng/l) from stage 46/47 to 2 months postmetamorphosis. We found that neither PFOS nor PFBS had a significant effect on the survival and growth. However, they caused hepatohistological impairment at higher concentrations (100; 1,000 μg/l). Unlike E2, PFOS at all concentrations did not alter the sex ratio and induce intersex, but caused degeneration of spermatogonia in testes except for the lowest concentration. PFBS had no effect on the sex ratio and gonadal histology. PFOS and PFBS promoted expression of estrogen receptor (ER) and androgen receptor (AR), but not affected aromatase expression in the brain. The increase in expression of ER and AR suggests an increase in the responsiveness to the corresponding sex hormone and potential effects on sexual development. Our results show that PFBS as well as PFOS have adverse effects on hepato-histology and sexual development on X. laevis. Also, PFOS- and PFBS-induced increase in ER and AR expression highlights the need to further study effects of PFOS and PFBS on subsequently gonadal development, sexual dimorphism, and secondary sex characteristics in X. laevis. It is debatable that PFBS is widely used as a substitute of PFOS.				1						1								C	A	アフリカツメガエルのオタマジャクシを用いた両生類の成長と性的発達に対するPFOSとPFBSの影響評価。	
607	生態毒性（内分泌）	Benninghoff, Abby D; Bisson, William H; Koch, Daniel C; Ehresman, David J; Kolluri, Siva K; Williams, David E	Estrogen-like activity of perfluoroalkyl acids in	2011	Toxicol Sci. 2011 Mar;120(1):42-58. doi: 10.1093/toxsci/kfq379. Epub 2010 Dec 16.	The objectives of this study were to determine the structural characteristics of perfluoroalkyl acids (PFAAs) that confer estrogen-like activity in vivo using juvenile rainbow trout (Oncorhynchus mykiss) as an animal model and to determine whether these chemicals interact directly with the estrogen receptor (ER) using in vitro and in silico species comparison approaches. Perfluorooctanoic (PFOA), perfluorononanoic (PFNA), perfluorodecanoic (PFDA), and perfluoroundecanoic (PFUnDA) acids were all potent inducers of the estrogen-responsive biomarker protein vitellogenin (Vtg) in vivo, although at fairly high dietary exposures. A structure-activity relationship for PFAAs was observed, where eight to ten fluorinated carbons and a carboxylic acid end group were optimal for maximal Vtg induction. These in vivo findings were corroborated by in vitro mechanistic assays for trout and human ER. All PFAAs tested weakly bound to trout liver ER with half maximal inhibitory concentration (IC(50)) values of 15.2-289 μM. Additionally, PFOA, PFNA, PFDA, PFUnDA, and perfluorooctane sulfonate (PFOS) significantly enhanced human ERα-dependent transcriptional activation at concentrations ranging from 10-1000 nM. Finally, we employed an in silico computational model based upon the crystal structure for the human ERα ligand-binding domain complexed with E2 to structurally investigate binding of these putative ligands to human, mouse, and trout ERα. PFOA, PFNA, PFDA, and PFOS all efficiently docked with ERα from different species and formed a hydrogen bond at residue Arg394/398/407 (human/mouse/trout) in a manner similar to theenvironmental estrogens bisphenol A and nonylphenol. Overall, these data support the contention that several PFAAs are weak environmental xenoestrogens of potential concern.				1							1	1			1			D	A	PFNAを含むPFAAsのエストロゲン様活性をin vivo（ニジマス雌魚）で、ヒトおよびニジマスのERとの相互作用を in vitroで評価。エストロゲン様活性を示唆。ヒトERも対象にしているためメカニズムの参考になるならB。	
608	実験動物（免疫毒性）	Fang, Xuemei; Feng, Yixing; Shi, Zhimin; Dai, Jiayin	Alterations of cytokines and MAPK signaling p	2009	Toxicol Sci. 2009 Apr;108(2):367-76. doi: 10.1093/toxsci/kfp019. Epub 2009 Feb 5.	Perfluorononanoate (PFNA), a perfluorinated alkyl acid containing nine carbon chains, has been detected in abiotic and biotic matrices worldwide. Although a few studies have reported toxic effects of PFNA, little information of the mechanism has been offered. In this study, the effects of PFNA exposure on thymus and the related mechanisms were investigated. Male rats were orally dosed with 0, 1, 3, or 5 mg PFNA/kg/day for 14 days. A significant decrease of body weight and thymus weight were observed in the rats receiving 3 or 5 mg PFNA/kg/day. Histopathological examination revealed dose-dependent increases in thymocyte apoptosis. Rats receiving 3 or 5 mg PFNA/kg/day exhibited increased interleukin (IL)-1 and decreased IL-2 concentrations in sera, whereas elevated IL-4 and cortisol levels only occurred in the highest dose group. Quantitative real-time PCR indicated that expression of peroxisome proliferator-activated receptor alpha (PPAR-alpha) was increased in the thymi of all dosed rats, and a similar trend occurred for PPAR-gamma in the two highest dose groups. The mRNA levels of c-Jun NH(2)-terminal kinase (JNK), nuclear factor-kappa B, p65 subunit, and inhibitory protein IkappaBalpha were unchanged; however, increased and decreased mRNA levels of p38 kinase were found in rats exposed to 3 or 5 mg PFNA/kg/day, respectively. Decreased Bcl-2 mRNA levels were observed in rats receiving 5 mg PFNA/kg/day. A significant increase in protein levels of phospho-JNK was found in all PFNA-treated rats. Phospho-p38 was significantly enhanced in 1 and 3 mg PFNA/kg/day groups, whereas phospho-IkappaBalpha remained consistent in all ratsstudied. Together, these data suggested that apart from the activation of PPARs, PFNA exposure in rats lead to the alteration of serum cytokines, which subsequently activated mitogen-activated protein kinase signaling pathways and potentially modulated the immune system. Additionally, increased serum cortisol and decreased expression of Bcl-2 in thymus likely contributed to the PFNA-induced thymocyte apoptosis.				1											1		1	1		1	A	A	PPARとは別に、PFNA経口曝露がラットの血清サイトカインおよびMAPK シグナル伝達経路を変化させ免疫系に影響を与える可能性を示唆。PFNAは3用量（1, 3, or 5 mg/kg/day）設定し、曝露による胸腺重量低下と胸腺細胞アポトーシスも検出。B or A候補。 ※元「赤字B」。調査対象物質3用量を設定したin vivo試験。	
609	実験動物（免疫毒性）	Fang, Xuemei; Feng, Yixing; Wang, Jianshe; Dai, Jiayin	Perfluorononanoic acid-induced apoptosis in r	2010	Toxicology. 2010 Jan 12;267(1-3):54-9. doi: 10.1016/j.tox.2009.10.020. Epub 2009 Oct 28.	Perfluoroalkyl acid (PFAA)-induced apoptosis has been reported in many cell types. However, minimal information on its mode of action is available. This study explored the possible involvement of apoptotic signaling pathways in a nine-carbon-chain length PFAA-perfluorononanoic acid (PFNA)-induced splenocyte apoptosis. After a 14-day exposure to PFNA, rat spleens showed dose-dependent levels of apoptosis. The production of pro-inflammatory and anti-inflammatory cytokines was significantly increased and decreased, respectively. However, protein levels of tumor necrosis factor receptor 1 (TNFR1), fas-associated protein with death domain (FADD), caspase 8 and caspase 3, which are involved in inflammation-related and caspase-dependent apoptosis, were discordant. Peroxisome proliferator-activated receptors alpha (PPARalpha) and PPARgamma genes expression was up-regulated in rats treated with 3 or 5 mg/kg/day of PFNA, and the level of hydrogen peroxide (H2O2) increased concurrently in rats treated with the highest dose. Moreover, superoxide dismutase (SOD) activity and Bcl-2 protein levels were dramatically decreased in spleens after treatment with 3 and 5 mg/kg/day of PFNA. However, protein levels of Bax were unchanged. Apoptosis-inducing factor (AIF), an initiator of caspase-independent apoptosis, was significantly increased in all PFNA-dosed rats. Thus, oxidative stress and the activation of a caspase-independent apoptotic signaling pathway contributed to PFNA-induced apoptosis in rat splenocytes.				1											1				B	B	PFNA曝露ラット脾細胞におけるPFNA誘導性アポトーシスのメカニズムに関する評価。酸化ストレスとcaspase非依存的経路の関与を示唆。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
610	実験動物（免疫毒性）	Fang, Xuemei; Zhang, Lianjun; Feng, Yixing; Zhao, Yong; Dai, Jiayin	Immunotoxic effects of perfluorononanoic acid	2008	Toxicol Sci. 2008 Oct;105(2):312-21. doi: 10.1093/toxsci/kfn127. Epub 2008 Jun 26.	The effects of perfluorononanoic acid (PFNA) on the immune system and its mechanism of action in mice have not been elucidated. Thus, BALB/c mice were exposed to the PFNA (0, 1, 3, or 5 mg/kg/day) for fourteen days. Exposure to PFNA led to a decrease in body weight and in the weight of the lymphoid organs. Cell cycle arrest and apoptosis were observed in the spleen and thymus following PFNA exposure. In the thymus, PFNA mostly modulated CD4+CD8+ thymocytes, whereas the F4/80+, CD11c+, and CD49b+ cells were major targets in the spleen. Although concanavalin A-induced T lymphocyte blastogenesis was not altered by PFNA, production of interleukin (IL)-4 and interferon-gamma by splenic lymphocytes was remarkably impaired. The levels of cortisol and adrenocorticotrophic hormone in sera were increased; however, the expression of glucocorticoid receptor in the thymus was unchanged. In addition, expression of the peroxisome proliferator-activated receptors (PPAR-alpha and PPAR-gamma) and IL-1beta were upregulated significantly in the thymus at a dose of 1 mg PFNA/kg/day. No significant changes in expression of the inhibitory protein IkappaBalpha and IkappaBalpha kinase were observed. Together, these results suggest that PFNA exerts toxic effects on lymphoid organs and T cell and innate immune cell homeostasis in mice and that these effects may result from the activation of PPAR-alpha, PPAR-gamma, and the hypothalamic-pituitary-adrenal axis. Interestingly, at the transcriptional level, the nuclear factor-kappa B signaling pathway appears to be uninvolved in the immunotoxic potential of PFNA.			1											1		1					B	B	BALB/c マウスを用いたPFNAの免疫毒性の評価。PFNA曝露はマウスのリンパ組織、T細胞および自然免疫細胞に毒性を示し、これらの作用はPPARα、PPARγおよび視床下部-下垂体-副腎軸の活性化に起因している可能性を示唆（転写レベルでは、NFκBシグナル伝達経路は関与していないよう）。PFNAは3用量（1, 3, or 5 mg/kg/day）設定	
611	実験動物（代謝）	Wang, Jianshe; Yan, Shengmin; Zhang, Wei; Zhang, Hongxia; Dai, Jiayin	Integrated proteomic and miRNA transcriptiona	2015	J Proteome Res. 2015 Jan 2;14(1):330-41. doi: 10.1021/pr500641b. Epub 2014 Sep 24.	Perfluoroalkyl chemicals (PFASs) are a class of highly stable man-made compounds, and their toxicological impacts are currently of worldwide concern. Administration of perfluorononanoic acid (PFNA), a perfluorocarboxylic acid (PFCA) with a nine carbon backbone, resulted in dose-dependent hepatomegaly in mice (0, 0.2, 1, and 5 mg/kg body weight, once a day for 14 days) and an increase in hepatic triglycerides (TG) and total cholesterol (TCHO) in the median dose group as well as serum transaminases in the high dose group. Using isobaric tags for relative and absolute quantitation (iTRAQ), we identified 108 (80 up-regulated, 28 down-regulated) and 342 hepatic proteins (179 up-regulated, 163 down-regulated) that exhibited statistically significant changes (at least a 1.2-fold alteration and $P < 0.05$) in the 1 and 5 mg/kg/d PFNA treatment groups, respectively. Sixty-six proteins (54 up-regulated, 12 down-regulated) significantly changed in both of the two treatment groups. Among these 54 up-regulated proteins, most were proteins related to the lipid metabolism process (31 proteins). The mRNA analysis results further suggested that PFNA exposure not only resulted in a fatty acid oxidation effect but also activated mouse liver genes involved in fatty acid and cholesterol synthesis. Additionally, three (2 down-regulated, 1 up-regulated) and 30 (14 down-regulated, 16 up-regulated) microRNAs (miRNAs) exhibited at least a 2-fold alteration ($P < 0.05$) in the 1 and 5 mg/kg/d PFNA treatment groups, respectively, Three miRNAs (up-regulated: miR-34a; down-regulated: miR-362-3p and miR-338-3p) significantly changed in bothof the two treatment groups. The repression effect of miR-34a on fucosyltransferase 8 (Fut8) and lactate dehydrogenase (Ldha) was confirmed by luciferase activity assay and Western blot analysis. The results implied that PFNA exerted a hepatic effect, at least partially, by miRNAs mediated post-translational protein repression.			1											1		1					A	A	PFNA曝露マウスの肝毒性メカニズムに関する評価（肝毒性の分類かも？）。PFNA曝露（0.2, 1, and 5 mg/kg/day）は用量依存的にマウスの肝腫大を誘導、中央用量群ではTGと総コレステロール（TCHO）が増加し、高用量群では血清トランスアミナーゼが増加。iTRAQ（isobaric tags for relative and absolute quantitation）を用いて、有意な発現変動を示した肝タンパク質を同定。発現上昇したほとんどが脂質代謝に関連するタンパク。mRNA解析も実施し、PFNAは少なくとも部分的には、miRNAを介した翻訳後タンパク質抑制によって肝機能に影響を及ぼすことを示唆。。B or A候補。 ※元「赤字B」。調査対象物質3用量を設定したin vivo試験。	
612	実験動物（免疫毒性）	Rockwell, Cheryl E; Turley, Alexandra E; Cheng, Xingguo; Fields, Patrick E; Klaassen, Curtis D	Acute Immunotoxic Effects of Perfluorononano	2013	Clin Exp Pharmacol. 2013;Suppl 4:S4-002. doi: 10.4172/2161-1459.S4-002.	otrganic perfluorochemicals (PFCs) have become an environmental concern due to widespread detection in human blood and experimental evidence for immune, developmental, and liver toxicity. Whereas the blood concentrations of many PFCs are declining, blood levels of Perfluorononanoic Acid (PFNA) are rising in the United States. The purpose of the present studies was to determine the effects of PFNA on lymphoid organs and immune cells of C57BL/6 mice. The present study demonstrates that PFNA produces immunotoxic effects in both male and female C57BL/6 mice as evidenced by splenic atrophy, decreased splenocyte numbers, and a marked reduction in thymocyte viability. The current study also demonstrates that the effects of PFNA on different leukocyte populations are not uniform. The CD4(+)CD8(+) double-positive thymocytes were particularly sensitive to PFNA in which the proportion of this population was >95% decreased relative to the entire CD4(+) thymocyte population in PFNA-treated mice. Interestingly, PFNA also markedly increased serum levels of TNF α in response to LPS in mice. Collectively, the present studies demonstrate that PFNA decreases lymphocyte viability and alters the immune response to LPS in C57BL/6 mice.			1											1		1					B	C	C57BL/6マウスにおけるPFNAの急性免疫毒性の評価。PFNA曝露はリンパ球生存率を低下させ（CD4+CD8+胸腺細胞は特に感受性が高く、その細胞の割合はPFNA曝露マウスのCD4+胸腺細胞全体に対して95%以上減少）、LPS に対する免疫応答を変化させることを示唆。曝露用量等実験条件の詳細は要旨からは不明。	
613	実験動物（免疫毒性）	Rockwell, Cheryl E; Turley, Alexandra E; Cheng, Xingguo; Fields, Patrick E; Klaassen, Curtis D	Persistent alterations in immune cell populatio	2017	Food Chem Toxicol. 2017 Feb;100:24-33. doi: 10.1016/j.fct.2016.12.004. Epub 2016 Dec 8.	Perfluorononanoic acid (PFNA) is a perfluoroalkyl substance (PFAS) that is structurally related to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Whereas PFOA and PFOS are known immunotoxicants, PFNA is less well characterized. Our previous study showed that PFNA has immunomodulatory effects on leukocyte populations and immune function. The present studies sought to determine whether, and to what degree, the immune system recovered 28 days after PFNA exposure. None of the parameters measured had fully recovered. A few parameters had partially recovered, including decreased spleen size and the decreased ratio of the CD4(+)/CD8(+) double-positive population in thymus. The majority of effects of PFNA remained unchanged 28 days after exposure, including decreased proportion of intact thymocytes (as determined by FSC vs SSC), alterations in the ratios of immune cell populations in spleen and the CD4(+), CD8(+) and double-negative populations in thymus. Notably, PFNA markedly increased the TNF α response to LPS in vivo, and no recovery was evident 28 days after exposure. The effect of PFNA on CD4(+) T cells, CD8(+) T cells and CD19(+) cells was more pronounced in females. The current study demonstrates that a single high dose exposure to PFNA (e.g. as might occur accidentally in an occupational setting) has long-lasting effects on the immune system.			1											1		1					B	C	C57Bl/6 マウスにおけるPFNA単回高用量曝露による免疫細胞機能への長期的な影響を示した論文。特に、PFNAはin vivoでLPSに対するTNF-α応答を顕著に増加させ、曝露後 28日経過しても回復しないこと、CD4+ T、CD8+ T、CD19+細胞に対する影響は、雌ではより顕著であることを示唆。	
614	実験動物（免疫毒性）	Lee, Jun-Kyoung; Kim, Sang-Hyun	Correlation between mast cell-mediated allerg	2018	J Toxicol Environ Health A. 2018;81(9):302-313. doi: 10.1080/15287394.2018.1440188. Epub 2018 Feb 26.	Perfluorinated compounds (PFC) have widely been used in numerous applications including clothing, food packaging, and nonstick coating. With the widespread use of PFC, concerns regarding potential adverse health effects in humans and wildlife have increased. In spite of the known PFC-mediated immunotoxiciy, correlation with PFC and allergic inflammation still requires elucidation. The aim of this study was to examine the effect of four types of PFC (perfluoroheptanoic acid [PFHpA], perfluorononanoic acid [PFNA], perfluorodecanoic acid [PFDA], and perfluoroundecanoic acid [PFUnA]) on mast cell-mediated allergic inflammation in the presence of high-affinity immunoglobulin (Ig) E receptor (FcεRI) cross-linking. Among PFC family, long-chain PFDA and PFUnA increased release of histamine and β-hexosaminidase by up-regulation of intracellular calcium levels in IgE-stimulated mast cells. In addition, PFDA and PFUnA enhanced gene expression of pro-inflammatory cytokines, such as tumor necrosis factor (TNF)-α, interleukin (IL)-1β, IL-6, and IL-8 by activation of nuclear factor-κB in IgE-stimulated mast cells. In ovalbumin (OVA)-induced model of systemic anaphylaxis in the presence of hypothermia, PFNA, PFDA, and PFUnA exacerbated allergic symptoms accompanied by elevation in serum histamine, TNF-α, IgE, and IgG(1). Our data indicate that some PFC aggravated high-affinity IgE receptor (FcεRI)-mediated mast cell degranulation and allergic symptoms. Consequently, the results demonstrated that carbon-chain length of PFC may serve as a factor in allergic inflammation.			1											1							B	D	PFNAを含む4 種類のPFCsの炭素鎖長とマスト細胞を介したアレルギー炎症との関連性を評価。低体温を呈するOVA誘発全身性アナフィラキシーモデルでは、PFNA、PFDA、PFUnA が血清ヒスタミン、TNF-α、IgE、IgG の上昇を伴うアレルギー症状を悪化。（長鎖 PFDA と PFUnA は、IgE 刺激を受けた肥満細胞のヒスタミンとβ-ヘキソサミニダーゼ放出を増加、さらに炎症誘発性サイトカインの遺伝子発現を増強。） PFC炭素鎖の長さがアレルギー性炎症の要因となる可能性を示唆。曝露用量等実験条件の詳細は要旨からは不明。	
615	生態毒性（生殖発生毒性スクリーニング）	Gaballah, Shaza; Swank, Adam; Sobus, Jon R; Howey, Xia Meng; Schmid, Judith; Catron, Tara; McCord, James; Hines, Erin; Strynar, Mark; Tal, Tamara	Evaluation of Developmental Toxicity, Develop	2020	Environ Health Perspect. 2020 Apr;128(4):47005. doi: 10.1289/EHP5843. Epub 2020 Apr 9.	BACKGROUND: Per- and polyfluoroalkyl substances (PFAS) are a diverse class of industrial chemicals with widespread environmental occurrence. Exposure to long-chain PFAS is associated with developmental toxicity, prompting their replacement with short-chain and fluoroether compounds. There is growing public concern over the safety of replacement PFAS. OBJECTIVE: We aimed to group PFAS based on shared toxicity phenotypes. METHODS: Zebrafish were developmentally exposed to 4,8-dioxa-3H-perfluorononanoate (ADONA), perfluoro-2-propoxypropanoic acid (GenX Free Acid), perfluoro-3,6-dioxa-4-methyl-7-octene-1-sulfonic acid (PFESA1), perfluorohexanesulfonic acid (PFHxS), perfluorohexanoic acid (PFHxA), perfluoro-n-octanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), or 0.4% dimethyl sulfoxide (DMSO) daily from 0-5 d post fertilization (dpf). At 6 dpf, developmental toxicity and developmental neurotoxicity assays were performed, and targeted analytical chemistry was used to measure media and tissue doses. To test whether aliphatic sulfonic acid PFAS cause the same toxicity phenotypes, perfluorobutanesulfonic acid (PFBS; 4-carbon), perfluoropentanesulfonic acid (PFPeS; 5-carbon), PFHxS (6-carbon), perfluoroheptanesulfonic acid (PFHpS; 7-carbon), and PFOS (8-carbon) were evaluated. RESULTS: PFHxS or PFOS exposure caused failed swim bladder inflation, abnormal ventroflexion of the tail, and hyperactivity at nonteratogenic concentrations. Exposure to PFHxA resulted in a unique hyperactivity signature. ADONA, PFESA1, or PFOA exposure resulted in detectable levels of parent compound in larval tissue but yielded negativetoxicity results. GenX was unstable in DMSO, but stable and negative for toxicity when diluted in deionized water. Exposure to PFPeS, PFHxS, PFHpS, or PFOS resulted in a shared toxicity phenotype characterized by body axis and swim bladder defects and hyperactivity. CONCLUSIONS: All emerging fluoroether PFAS tested were negative for evaluated outcomes. Two unique toxicity signatures were identified arising from structurally dissimilar PFAS. Among sulfonic acid aliphatic PFAS, chemical potencies were correlated with increasing carbon chain length for developmental neurotoxicity, but not developmental toxicity. This study identified relationships between chemical structures and in vivo phenotypes that may arise from shared mechanisms of PFAS toxicity. These data suggest that developmental neurotoxicity is an important end point to consider for this class of widely occurring environmental chemicals.				1		1	1			1											C	C	Zebrafishのデータをどのようにリスク評価に生かせるのか疑問であり、Cとした。	
616	生態毒性（生殖発生毒性スクリーニング）	Chen, Lianguo; Tsui, Mirabelle M P; Shi, Qipeng; Hu, Chenyan; Wang, Qi; Zhou, Bingsheng; Lam, Paul K S; Lam, James C W	Accumulation of perfluorobutane sulfonate (PF	2018	Aquat Toxicol. 2018 Aug;201:1-10. doi: 10.1016/j.aquatox.2018.05.018. Epub 2018 May 25.	As an alternative to perfluorooctane sulfonate (PFOS), increasing usage of perfluorobutane sulfonate (PFBS) has led to ubiquitous presence in the environment. PFBS is also shown to potently disrupt the thyroid endocrine system. Considering the regulation of thyroid hormones in visual development, PFBS is likely to adversely affect the development and function of visual systems, which is a sensitive target of environmental pollutants. Therefore, the present study exposed marine medaka embryos to environmentally realistic concentrations of PFBS (0, 1.0, 2.9 and 9.5 μg/L) for an entire life-cycle. After exposure until sexual maturity, eyes of adult medaka were dissected to directly investigate the ocular accumulation and toxicity of PFBS. For the first time, substantial accumulation of an environmental pollutant (i.e., PFBS) was observed in the eye tissue. PFBS exposure was also found to impair the visual development and function in a sex-dependent manner. In female medaka, weight of eyes was significantly decreased, while content of water was increased, probably resulting in higher intraocular pressure. Multiple neural signaling processes were also disturbed by PFBS life-cycle exposure, including cholinergic, glutamatergic, GABAergic and monoaminergic systems. Increased levels of norepinephrine and epinephrine neurotransmitters may adaptively decrease the intraocular hypertension in female eyes. In addition, proteomic profiling identified the visual proteins of differential expressions (e.g., beta and gamma crystallins, arrestin and lumican), which were significantly associated with visual perception and motoractivity of eyes. Overall, this study found that PFBS was able to accumulate in the eyes and induce ocular toxicities. The susceptibility and sex-specific responses of visual systems to environmental pollutants warrants more works for a comprehensive risk assessment.				1							1										C	C		
617	生態毒性（生殖発生毒性スクリーニング）	Chen, Lianguo; Lam, James C W; Hu, Chenyan; Tsui, Mirabelle M P; Lam, Paul K S; Zhou, Bingsheng	Perfluorobutanesulfonate Exposure Skews Sex	2019	Environ Sci Technol. 2019 Jul 16;53(14):8389-8397. doi: 10.1021/acs.est.9b01711. Epub 2019 Jul 3.	Perfluorobutanesulfonate (PFBS) is increasingly polluting aquatic environments due to worldwide manufacturing and application. However, toxicological knowledge regarding PFBS exposure remains scarce. Here, we showed that PFBS life-cycle exposure at environmentally realistic concentrations (0, 1.0, 2.9, and 9.5 μg/L) skewed the sex ratio in fish toward male dominance, while reproductive functions of female fish were greatly impaired, as characterized by extremely small ovaries, blocked oocyte development, and decreased egg production. Endocrine disruption through the hypothalamus-pituitary-gonad axis was induced by PFBS exposure, showing antiestrogenic activity in females but estrogenic activity in males. PFBS was found to gradually accumulate in F0 adults during continuous exposure but can be rapidly eliminated when depurated in clean water. Parental exposure also transferred PFBS pollutant to F1 offspring eggs. Although no trace of PFBS was detected in F1 adults and F2 eggs, adverse effects from parental exposure persisted in F1 and F2 offspring. These transgenerational effects implicate PFBS as an ongoing threat to the fitness and sustainability of fish populations. The dramatic impairment of fish reproduction highlights the urgency of re-evaluations of the ecological and evolutionary consequences of PFBS exposure.				1							1										C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
618	生態毒性（生殖発生毒性スクリーニング）	Chen, Lianguo; Tsui, Mirabelle M P; Hu, Chenyan; Wan, Teng; Au, Doris W T; Lam, James C W; Lam, Paul K S; Zhou, Bingsheng	Parental Exposure to Perfluorobutanesulfonate	2019	Environ Sci Technol. 2019 Oct 15;53(20):12018-12025. doi: 10.1021/acs.est.9b03865. Epub 2019 Oct 2.	Perfluorobutanesulfonate (PFBS), an environmental pollutant of emerging concern, significantly impairs offspring development and overall health after parental exposure. However, the true inducer of offspring developmental defects among the complexity of parental influences remains unknown. In the present study, marine medaka (Oryzias melastigma) were exposed to environmentally realistic concentrations of PFBS (0, 1, 3, and 10 μg/L) for an entire life cycle. By mixing and mating control and exposed medaka (male or female), a crossbreeding strategy was employed to produce offspring eggs from various crossbreeds, with the aim of differentiating the maternal and paternal influences. Measurements of swimming performance in larval offspring showed that larvae of exposed male parents swam hyperactively in comparison to the control larvae. Contrasting trends in PFBS transfer and maternal factor transfer (e.g., proteins and lipids) to that of swimming behavior eliminated these two factors as major inducers of offspring developmental impairment. Inheritance of the exposed paternal methylome marks in offspring may be partially responsible for abnormal swimming behavior, although different toxic mechanisms may be involved depending on the exposure concentration. Overall, these findings suggest that inheritance of epigenetic modifications implicates a long-lasting threat of PFBS to the fitness and sustainability of fish populations.				1						1												C	C		
619	生態毒性（生殖発生毒性スクリーニング）	Hagenaars, A; Vergauwen, L; De Coen, W; Knapen, D	Structure-activity relationship assessment of f	2011	Chemosphere. 2011 Jan;82(5):764-72. doi: 10.1016/j.chemosphere.2010.10.076. Epub 2010 Dec 15.	Perfluorinated compounds (PFCs) are a group of anthropogenic chemicals containing diverse functional groups and chain lengths. They are known to be persistent and bioaccumulative explaining their worldwide environmental presence. The toxicological information on these chemicals is still incomplete and insufficient to assess their environmental impact and structure-activity relationship. In the present study, the developmental effects of PFOS (perfluorooctane sulfonate, C8), PFOA (perfluorooctanoic acid, C8), PFBS (perfluorobutane sulfonate, C4) and PFBA (perfluorobutanoic acid, C4) were evaluated in zebrafish embryos (Danio rerio). The different chain lengths and functional groups of the selected chemicals made it possible to determine the structure-activity relationship of these compounds. PFCs with longer chain lengths (C8) tend to be more toxic than PFCs with shorter chain lengths (C4). Comparison based on the functional groups of compounds with the same chain length indicates that PFCs with a sulfonate group have a larger toxic potential than the ones with a carboxyl group. Furthermore, exposure to the different PFCs resulted in some general effects, such as deformations of the tail and an uninflated swim bladder, as well as in more specific effects which might be related to the structure of the tested chemicals. Oedemas and effects on length could only be detected in 8-carbon PFCs while malformations of the head were a more specific action of the sulfonated PFCs. Effects on hatching rate and success were found in PFOA exposed embryos and heart rates were affected after exposure to PFOS, PFOA and PFBS.				1						1												C	C		
620	生態毒性（生殖発生毒性スクリーニング）	Sant, Karilyn E; Venezia, Olivia L; Sinno, Paul P; Timme-Laragy, Alicia R	Perfluorobutanesulfonic Acid Disrupts Pancrea	2019	Toxicol Sci. 2019 Jan 1;167(1):258-268. doi: 10.1093/toxsci/kfy237.	Following the phase-out of highly persistent perfluorosulfonates in the United States from non-stick and stain-resistant products in the early 2000s, perfluorobutanesulfonic acid (PFBS) has replaced these compounds as a primary surfactant. Measurements of PFBS in environmental and human samples have been rising in recent years, raising concerns about potential negative health effects. We previously found that embryonic exposures to a related compound, perfluorooctanesulfonic acid (PFOS), decreased pancreas length and insulin-producing islet area in zebrafish embryos (Danio rerio). The objective of this study was to compare the effects of PFBS exposures on pancreatic organogenesis with our previous PFOS findings. Dechorionated zebrafish embryos from two different transgenic fish lines (Tg[insulin:GFP], Tg[ptf1a:GFP]) were exposed to 0 (0.01% DMSO), 16, or 32 μM PFBS daily beginning at 1 day post fertilization (dpf) until 4 and 7 dpf when they were examined using fluorescent microscopy for islet area and morphology, and exocrine pancreas length. PFBS-exposed embryos had significantly increased caudal fin deformities, delayed swim bladder inflation, and impaired yolk utilization. Incidence of fish with significantly stunted growth and truncated exocrine pancreas length was significantly increased, although these two effects occurred independently. Islet morphology revealed an increased incidence of severely hypomorphic islets (areas lower than the 1st percentile of controls) and an elevated occurrence of fragmented islets. RNA-Seq data (4 dpf) also identify disruptions in regulationof lipid homeostasis. Overall, this work demonstrates that PFBS exposure can perturb embryonic development, energy homeostasis, and pancreatic organogenesis.				1						1												C	C		
621	生態毒性（生殖発生毒性スクリーニング）	Ulhaq, Mazhar; Carlsson, Gunnar; Örn, Stefan; Norrgren, Leif	Comparison of developmental toxicity of seven	2013	Environ Toxicol Pharmacol. 2013 Sep;36(2):423-426. doi: 10.1016/j.etap.2013.05.004. Epub 2013 May 22.	The toxicity of individual perfluoroalkyl acids (PFAAs) has been suggested to be determined by the carbon chain length as well as the functional group attached. We tested seven different PFAAs including both sulfonic and carboxylic PFAAs with different chain length to evaluate the developmental toxicity in zebrafish embryos. Generally, the acute toxicity of PFAAs is relatively low to zebrafish embryos. The EC50 values ranged from 1.5 to 2200mg/L. We observed a relationship between higher toxicity with longer carbon chain. In addition, we also observed a higher toxicity for sulfonic PFAAs than for carboxylic PFAAs.				1						1												C	C		
622	生態毒性（生殖発生毒性スクリーニング）	Ulhaq, Mazhar; Orn, Stefan; Carlsson, Gunnar; Morrison, David A; Norrgren, Leif	Locomotor behavior in zebrafish (Danio rerio) l	2013	Aquat Toxicol. 2013 Nov 15;144-145:332-40. doi: 10.1016/j.aquatox.2013.10.021. Epub 2013 Oct 24.	Perfluoroalkyl acids (PFAAs) are persistent organic contaminants that have been detected in wildlife, humans and the environment. Studies have shown that the toxicity of PFAAs is determined by the carbon chain length as well as the attached functional group. The locomotor activity of zebrafish larvae has become widely used for evaluation of chemicals with neurotoxic properties. In the present study the behavioral effects of seven structurally different PFAAs (i.e. TFAA, PFBA, PFOA, PFNA, PFDA, PFBS and PFOS) were evaluated in zebrafish larvae. Exposure to high concentrations of TFAA, PFNA, PFBS and PFOS resulted in distinct changes in behavioral patterns. Based on redundancy analysis, our results demonstrate three main factors affecting zebrafish larval locomotor behavior. The strongest effect on behavior was determined by the carbon chain length and the attached functional group. PFAAs with longer carbon chain length as well as PFAAs with attached sulfonic groups showed larger potential to affect locomotor behavior in zebrafish larvae. Also the concentration of the PFAAs determined the behavior responses. The results of the present study are in agreement with previous studies showing correlations between the chemical structure of PFAAs and the toxicological effects.				1						1												C	C		
623	in vitro（生殖毒性）	Feng, Yixing; Fang, Xuemei; Shi, Zhimin; Xu, Muqi; Dai, Jiayin	Effects of PFNA exposure on expression of jun	2010	Reprod Toxicol. 2010 Nov;30(3):429-37. doi: 10.1016/j.reprotox.2010.05.010. Epub 2010 May 16.	Perfluorononanoic acid (PFNA, C9), a synthetic perfluorinated chemical containing nine carbons, has been identified in humans and wildlife worldwide. Sertoli cell plays a key role in spermatogenesis; however, the toxic effects of PFNA on Sertoli cells have not been studied. The aim of this study was to investigate the effects of PFNA exposure on cell junction molecules and factors specifically secreted by Sertoli cells. Primary Sertoli cells from 20- to 21-day-old rats were exposed to increasing PFNA concentrations (0, 1, 10, 25, 50, or 75 μM) for 24h. No significant changes in the expression of cytoskeleton-associated molecules were noted, although the mRNA levels of vimentin were upregulated dramatically in cells exposed to 50 and 75 μM PFNA. Meanwhile, the mRNA levels of Sertoli cell-specific secretions, such as Mullerian inhibiting substance (MIS), androgen binding protein (ABP), inhibin B, transferrin, and follicle-stimulating hormone receptor (FSH-R) changed significantly in experimental groups. Wilms' tumor gene (WT1), a transcription factor, was upregulated significantly in cells exposed to 1-75 μM PFNA. In additional studies, male rats were exposed to 0, 1, 3, or 5mg/kg-d PFNA for 14 days. Vacuoles in the cytoplasm of Sertoli cells were observed in the ultrastructure of testis. Furthermore, the changes in the concentrations of MIS and inhibin B in serum and the protein levels of WT1 and transferrin in testis were similar to the mRNA expression levels of those observed after in vitro treatment. In conclusion, these findings demonstrated that PFNA treatment led to the damage of specific secretory functions of Sertolicells and that these effects might be an underlying cause of the male-specific reproductive toxicity of PFNA.				1											1						B	C		
624	実験動物（生殖発生毒性）	Buist, Susan C N; Cherrington, Nathan J; Choudhuri, Supratim; Hartley, Dylan P; Klaassen, Curtis D	Gender-specific and developmental influences	2002	J Pharmacol Exp Ther. 2002 Apr;301(1):145-51. doi: 10.1124/jpet.301.1.145.	Rat organic anion transporter 1 (Oat1), Oat2, and Oat3, members of the organic anion transporter family, transport some organic anions across cellular membranes. Previously, highest Oat1 and Oat3 mRNA expression was reported in kidney and Oat2 in liver. However, gender and developmental differences in Oat expression remain unknown. This study describes gender- and age-specific patterns of rat organic anion transporter expression in various tissues. Oat mRNA expression was evaluated in adult male and female Sprague-Dawley rat tissues, and developmental expression was also determined in kidneys of Sprague-Dawley rats ranging in age from days 0 through 45. Expression was quantified using branched-DNA signal amplification. Oat1 mRNA expression was primarily observed in kidney. Surprisingly, Oat2 mRNA expression was also highest in kidney rather than in liver. Moreover, considerably higher Oat2 levels were seen in female kidney as compared with male. Finally, Oat3 mRNA expression was highest in kidney of both genders, whereas a male-predominant pattern was observed in liver. At birth, all kidney Oat mRNA levels were low. Renal Oat1 expression gradually increased throughout development, approaching adult levels at 30 days of age, where at days 40 and 45 Oat1 levels were greater in males than females. Oat2 expression in kidney was minimal through day 30 but increased dramatically at day 35 in females only. Lastly, Oat3 mRNA expression in kidney matured earliest, rapidly increasing from birth through day 10. These data indicate that Oat mRNA expression is primarily localized to the kidney, and observed expression patterns may explainsome previously recognized age- and gender-dependent toxicities associated with chemical exposure.	1					1												B	C		
625	実験動物（生殖発生毒性）	Chang, Sue; Butenhoff, John L; Parker, George A; Coder, Prägati S; Zitzow, Jeremiah D; Krisko, Ryan M; Bjork, James A; Wallace, Kendall B; Seed, Jennifer G	Reproductive and developmental toxicity of po	2018	Reprod Toxicol. 2018 Jun;78:150-168. doi: 10.1016/j.reprotox.2018.04.007. Epub 2018 Apr 22.	Potassium perfluorohexanesulfonate (K(+)PFHxS) was evaluated for reproductive/developmental toxicity in CD-1 mice. Up to 3 mg/kg-d K(+)PFHxS was administered (n = 30/sex/group) before mating, for at least 42 days in F(0) males, and for F(0) females, through gestation and lactation. F(1) pups were directly dosed with K(+)PFHxS for 14 days after weaning. There was an equivocal decrease in live litter size at 1 and 3 mg/kg-d, but the pup-born-to-implant ratio was unaffected. Adaptive hepatocellular hypertrophy was observed, and in 3 mg/kg-d F(0) males, it was accompanied by concomitant decreased serum cholesterol and increased alkaline phosphatase. There were no other toxicologically significant findings on reproductive parameters, hematology/clinical pathology/TSH, neurobehavioral effects, or histopathology. There were no treatment-related effects on postnatal survival, development, or onset of preputial separation or vaginal opening in F(1) mice. Consistent with previous studies, our data suggest that the potency of PFHxS is much lower than PFOS in rodents.	1					1							1	1				1	A	A	マウスでの検討であるが、PFHxSのトキシコキネティクスも調べているため、有用であると考えられる。	
626	実験動物（生殖発生毒性）	Das, Kaberi P; Grey, Brian E; Zehr, Robert D; Wood, Carmen R; Butenhoff, John L; Chang, Shu-Ching; Ehresman, David J; Tan, Yu-Mei; Lau, Christopher	Effects of perfluorobutyrate exposure during pr	2008	Toxicol Sci. 2008 Sep;105(1):173-81. doi: 10.1093/toxsci/kfn099. Epub 2008 May 28.	Perfluorobutyrate (PFBA) is a perfluoroalkyl acid (PFAA) found in the environment. Previous studies have indicated developmental toxicity of PFAAs (perfluorooctane sulfonate [PFOS] and perfluorooctanoate [PFOA]); the current study examines that of PFBA. PFBA/NH4(+) was given to timed-pregnant CD-1 mice by oral gavage daily from gestational day (GD) 1 to 17 at 35, 175, or 350 mg/kg (chosen to approximate the developmentally toxic doses of PFOA); controls received water. At GD 18, serum levels of PFBA were 3.8, 4.4, and 2.5 microg/ml, respectively, in the three treated groups. PFBA did not significantly affect maternal weight gain, number of implantations, fetal viability, fetus weight, or incidence of fetal malformations. Incidence of full-litter loss was significantly greater in the 350 mg/kg group, and maternal liver weights were significantly increased in the 175 and 350 mg/kg groups. In contrast to PFOA and PFOS, PFBA exposure during pregnancy did not adversely affect neonatal survival or postnatal growth. Liver enlargement was detected in the PFBA-exposed pups on postnatal day (PD) 1, but not by PD 10. Expression of selected hepatic genes in PFBA-exposed pups at PD 1 did not reveal any significant changes from controls. A significant delay in eye-opening in offspring was detected in all three PFBA groups, and slight delays in the onset of puberty were noted in the 175 and 350 mg/kg groups. These data suggest that exposure to PFBA during pregnancy in the mouse did not produce developmental toxicity comparable to that observed with PFOA, in part, due to rapid elimination of the chemical.	1					1							1	1			HBGV設定根拠	1	-	-		
627	実験動物（生殖発生毒性）	Iwai, Hiroyuki; Hoberman, Alan M	Oral (Gavage) Combined Developmental and P	2014	Int J Toxicol. 2014 May;33(3):219-237. doi: 10.1177/1091581814529449. Epub 2014 Apr 3.	The reproductive toxicity potential of Ammonium Salt of Perfluorinated Hexanoic Acid (PFHxA Ammonium Salt) in pregnant Crl: CD1(ICR) mice was investigated. Twenty females/group were administered the test substance or vehicle once daily from gestation day 6 through 18. Phase 1 doses: 0, 100, 350, and 500 mg/kg/d; phase 2: 0, 7, 35, and 175 mg/kg/d. Parameters evaluated include mortality, viability, body weights, clinical signs, abortions, premature deliveries, pregnancy and fertility, litter observations, maternal behavior, and sexual maturity in the F1 generation. The level of PFHxA Ammonium Salt was measured in the liver of F0 and F1 mice. At doses of 350 and 500 mg/kg/d maternal mortalities, excess salivation and changes in body weight gains occurred. Pup body weights were reduced on postpartum day (PPD) 0 in all the dosage groups, but persisted only in the 350 and 500 mg/kg/d groups. Additional effects at 300 and 500 mg/kg/d included stillbirths, reductions in viability indices, and delays in physical development. Levels of PFHxA Ammonium Salt in the livers of the 100 mg/kg/d dams were all below the lower limit of quantization (0.02 μg/mL); in the 350 mg/kg/d group, 3 of the 8 samples had quantifiable analytical results. In phase 2 no PFHxA Ammonium Salt was found in the liver. Adverse effects occurred only in the 175 mg/kg/d group and consisted of increased stillborn pups, pups dying on PPD 1, and reduced pup weights on PPD 1. Based on these data, the maternal and reproductive no observable adverse effect level of PFHxA Ammonium Salt is 100 mg/kg/d.			1				1						1	1					C	A		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
628	実験動物（生殖発生毒性）	Lieder, Paul H; York, Raymond G; Hakes, Daniel C; Chang, Shu-Ching; Butenhoff, John L	A two-generation oral gavage reproduction stu	2009	Toxicology. 2009 May 2;259(1-2):33-45. doi: 10.1016/j.tox.2009.01.027. Epub 2009 Feb 11.	Perfluorobutanesulfonate (PFBS) is a surfactant and degradation product of substances based on perfluorobutanesulfonyl fluoride. A two-generation reproductive rat study has been conducted with potassium PFBS (K(+)PFBS). Parental-generation (P) rats were dosed orally by gavage with 0, 30, 100, 300 and 1000mg K(+)PFBS/kg/day for 10 weeks prior to and through mating (males and females), as well as during gestation and lactation (females only). First generation (F1) pups were dosed similarly, beginning at weaning. Second generation (F2) pups were not directly dosed but potentially exposed to PFBS through placental transfer and nursing, and the study was terminated 3 weeks after their birth. Endpoints evaluated included body weight, food consumption, clinical signs, estrus cycling, sperm quality, pregnancy, natural delivery, litter outcomes, and developmental landmarks. The no-observable-adverse effect dose level (NOAEL) in the parental generations (P and F1) was 100mg/kg/day. In the 300 and 1000mg/kg/day dose group rats, there were (1) increased liver weight (absolute or relative) and corresponding increased incidence of adaptive hepatocellular hypertrophy (male only) and (2) increased incidence of minimal to mild microscopic findings in the medulla and papilla of the kidneys (male and female). There were no K(+)PFBS treatment-related effects on fertility or reproduction among the P or the F1 rats. There were no microscopic changes in male or female reproductive organs, and no biologically relevant effects on sperm parameters, mating, estrous cycles, pregnancy, and natural delivery in the P- orF1-generations. There were no K(+)PFBS treatment-related effects on survival of pups in the two-generation study. Litter size and average pup birth weight per litter were not statistically significantly different from controls in any dose group. In the F1-generation, terminal body weight was reduced in males at 1000mg/kg/day. Preputial separation was slightly delayed (approximately 2 days) at this dose, a finding consistent with the body weight reduction. Essentially no effects were observed in the F1 females. F2 pups had normal body weights. The reproductive NOAEL was >1000mg/kg/day in both generations.				1					1				1			1			1		HBGV設定根拠	1	-	-		
629	実験動物（生殖発生毒性）	Blake, B. E.; Cope, H. A.; Hall, S. M.; Keys, R. D.; Mahler, B. W.; Mccord, J.; Scott, B.; Stapleton, H. M.; Strynar, M. J.; Elmore, S. A.; Fenton, S. E.	Evaluation of Maternal, Embryo, and Placental	2020	Environ Health Perspect. 2020 Feb;128(2):27006. doi: 10.1289/EHP6233. Epub 2020 Feb 13.	BACKGROUND: Perfluorooctanoic acid (PFOA) is a poly- and perfluoroalkyl substance (PFAS) associated with adverse pregnancy outcomes in mice and humans, but little is known regarding one of its replacements, hexafluoropropylene oxide dimer acid (HFPO-DA, referred to here as GenX), both of which have been reported as contaminants in drinking water.OBJECTIVES:We compared the toxicity of PFOA and GenX in pregnant mice and their developing embryo-placenta units, with a specific focus on the placenta as a hypothesized target.METHODS: Pregnant CD-1 mice were exposed daily to PFOA (0, 1, or) or GenX (0, 2, or) via oral gavage from embryonic day (E) 1.5 to 11.5 or 17.5 to evaluate exposure effects on the dam and embryo-placenta unit. Gestational weight gain (GWG), maternal clinical chemistry, maternal liver histopathology, placental histopathology, embryo weight, placental weight, internal chemical dosimetry, and placental thyroid hormone levels were determined.RESULTS: Exposure to GenX or PFOA resulted in increased GWG, with increase in weight most prominent and of shortest latency with GenX exposure. Embryo weight was significantly lower after exposure to PFOA (9.4% decrease relative to controls). Effect sizes were similar for higher doses (PFOA and GenX) andlower doses (PFOA and GenX), including higher maternal liver weights, changes in liver histopathology, higher placental weights and embryo-placenta weight ratios, and greater incidence of placental abnormalities relative to controls. Histopathological features in placentas suggested that PFOA and GenX may exhibit divergent mechanisms of toxicity in the embryo-placenta unit, whereas PFOA- and GenX-exposed livers shared a similar constellation of adverse pathological features.CONCLUSIONS: Gestational exposure to GenX recapitulated many documented effects of PFOA in CD-1 mice, regardless of its much shorter reported half-life; however, adverse effects toward the placenta appear to have compound-specific signatures.					1				1												1	B	A		
630	実験動物（生殖発生毒性）	Conley, Justin M; Lambright, Christy S; Evans, Nicola; McCord, James; Strynar, Mark J; Hill, Donna; Medlock-Kakaley, Elizabeth; Wilson, Vickie S; Gray, L Earl Jr	Hexafluoropropylene oxide-dimer acid (HFPO-	2021	Environ Int. 2021 Jan;146:106204. doi: 10.1016/j.envint.2020.106204. Epub 2020 Oct 27.	Hexafluoropropylene oxide dimer acid (HFPO-DA or GenX) is an industrial replacement for the straight-chain perfluoroalkyl substance (PFAS), perfluorooctanoic acid (PFOA). Previously we reported maternal, fetal, and postnatal effects from gestation day (GD) 14-18 oral dosing in Sprague-Dawley rats. Here, we further evaluated the perinatal toxicity of HFPO-DA by orally dosing rat dams with 1-125 mg/kg/d (n = 4 litters per dose) from GD16-20 and with 10-250 mg/kg/d (n = 5) from GD8 - postnatal day (PND) 2. Effects of GD16-20 dosing were similar to those previously reported for GD14-18 dosing and included increased maternal liver weight, altered maternal serum lipid and thyroid hormone concentrations, and altered expression of peroxisome proliferator-activated receptor (PPAR) pathway genes in maternal and fetal livers. Dosing from GD8-PND2 produced similar effects as well as dose-responsive decreased pup birth weight (≥30 mg/kg), increased neonatal mortality (≥62.5 mg/kg), and increased pup liver weight (≥10 mg/kg). Histopathological evaluation of newborn pup livers indicated a marked reduction in glycogen stores and pups were hypoglycemic at birth. Quantitative gene expression analyses of F1 livers revealed significant alterations in genes related to glucose metabolism at birth and on GD20. Maternal serum and liver HFPO-DA concentrations were similar between dosing intervals, indicating rapid clearance, however dams dosed GD8 - PND2 had greater liver weight and gestational weight gain effects at lower doses than GD16-20 dosing, indicating the importance of exposure duration. Comparison of neonatal mortalitydose-response curves between HFPO-DA and previously published perfluorooctane sulfonate (PFOS) data indicated that, based on serum concentration, the potency of these two PFAS are similar in the rat. Overall, HFPO-DA is a developmental toxicant in the rat and the spectrum of adverse effects is consistent with prior PFAS toxicity evaluations, such as PFOS and PFOA.					1				1												1	A	B	ラットを用いてHFPO-DAの肝臓に対する影響を用量依存性なども含めて詳細にて検討した。血中濃度なども調べており、またメカニズムも少し検討しているので、有用と思われる	
631	実験動物（生殖発生毒性）	Conley, Justin M; Lambright, Christy S; Evans, Nicola; Strynar, Mark J; McCord, James; McIntyre, Barry S; Travlos, Gregory S; Cardon, Mary C; Medlock-Kakaley, Elizabeth; Hartig, Phillip C; Wilson, Vickie S; Gray, L Earl Jr	Adverse Maternal, Fetal, and Postnatal Effects	2019	Environ Health Perspect. 2019 Mar;127(3):37008. doi: 10.1289/EHP4372.	BACKGROUND: Hexafluoropropylene oxide dimer acid [(HFPO-DA), GenX] is a member of the per- and polyfluoroalkyl substances (PFAS) chemical class, and elevated levels of HFPO-DA have been detected in surface water, air, and treated drinking water in the United States and Europe. OBJECTIVES: We aimed to characterize the potential maternal and postnatal toxicities of oral HFPO-DA in rats during sexual differentiation. Given that some PFAS activate peroxisome proliferator-activated receptors (PPARs), we sought to assess whether HFPO-DA affects androgen-dependent development or interferes with estrogen, androgen, or glucocorticoid receptor activity. METHODS: Steroid receptor activity was assessed with a suite of in vitro transactivation assays, and Sprague-Dawley rats were used to assess maternal, fetal, and postnatal effects of HFPO-DA exposure. Dams were dosed daily via oral gavage during male reproductive development (gestation days 14-18). We evaluated fetal testes, maternal and fetal livers, maternal serum clinical chemistry, and reproductive development of F1 animals. RESULTS: HFPO-DA exposure resulted in negligible in vitro receptor activity and did not impact testosterone production or expression of genes key to male reproductive development in the fetal testis; however, in vivo exposure during gestation resulted in higher maternal liver weights ([Formula: see text]), lower maternal serum thyroid hormone and lipid profiles ([Formula: see text]), and up-regulated gene expression related to PPAR signaling pathways in maternal and fetal livers ([Formula: see text]). Further, the pilot postnatal study indicated lower femalebody weight and lower weights of male reproductive tissues in F1 animals. CONCLUSIONS: HFPO-DA exposure produced multiple effects that were similar to prior toxicity evaluations on PFAS, such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), but seen as the result of higher oral doses. The mean dam serum concentration from the lowest dose group was 4-fold greater than the maximum serum concentration detected in a worker in an HFPO-DA manufacturing facility. Research is needed to examine the mechanisms and downstream events linked to the adverse effects of PFAS as are mixture-based studies evaluating multiple PFAS.					1				1												1	A	B	ラットを用いてHFPO-DAの発生に対する影響を用量依存性なども含めて詳細にて検討した。その結果、発達毒性物質であること、その有害作用はPFOSやPFOAなど過去の毒性評価と一致したと書かれている。	
632	実験動物（生殖発生毒性）	Das, Kaberi P; Grey, Brian E; Rosen, Mitchell B; Wood, Carmen R; Tatum-Gibbs, Katoria R; Zehr, R Daniel; Strynar, Mark J; Lindstrom, Andrew B; Lau, Christopher	Developmental toxicity of perfluorononanoic ac	2015	Reprod Toxicol. 2015 Jan;51:133-44. doi: 10.1016/j.reprotox.2014.12.012. Epub 2014 Dec 25.	Perfluorononanoic acid (PFNA) is a ubiquitous and persistent environmental contaminant. Although its levels in the environment and in humans are lower than those of perfluorooctane sulfonate (PFOS) or perfluorooctanoic acid (PFOA), a steady trend of increases in the general population in recent years has drawn considerable interest and concern. Previous studies with PFOS and PFOA have indicated developmental toxicity in laboratory rodent models. The current study extends the evaluation of these adverse outcomes to PFNA in mice. PFNA was given to timed-pregnant CD-1 mice by oral gavage daily on gestational day 1-17 at 1, 3, 5 or 10mg/kg; controls received water vehicle. Dams given 10mg/kg PFNA could not carry their pregnancy successfully and effects of this dose group were not followed. Similar to PFOS and PFOA, PFNA at 5mg/kg or lower doses produced hepatomegaly in the pregnant dams, but did not affect the number of implantations, fetal viability, or fetal weight. Mouse pups were born alive and postnatal survival in the 1 and 3mg/kg PFNA groups was not different from that in controls. In contrast, although most of the pups were also born alive in the 5mg/kg PFNA group, 80% of these neonates died in the first 10 days of life. The pattern of PFNA-induced neonatal death differed somewhat from those elicited by PFOS or PFOA. A majority of the PFNA-exposed pups survived a few days longer after birth than those exposed to PFOS or PFOA, which typically died within the first 2 days of postnatal life. Surviving neonates exposed to PFNA exhibited dose-dependent delays in eye opening and onset of puberty. In addition, increasedliver weight seen in PFNA-exposed offspring persisted into adulthood and was likely related to the persistence of the chemical in the tissue. Evaluation of gene expression in fetal and neonatal livers revealed robust activation of peroxisome proliferator-activated receptor-alpha (PPARα) target genes by PFNA that resembled the responses of PFOA. Our results indicate that developmental toxicity of PFNA in mice is comparable to that of PFOS and PFOA, and that these adverse effects are likely common to perfluoroalkyl acids that persist in the body.				1					1				1			1			1		HBGV設定根拠	1	-	-		
633	実験動物（生殖発生毒性）	Chen, Fengjie; Wei, Cuiyun; Chen, Qiuyu; Zhang, Jie; Wang, Ling; Zhou, Zhen; Chen, Minjie; Liang, Yong	Internal concentrations of perfluorobutane sulf	2018	Ecotoxicol Environ Saf. 2018 Aug 30;158:223-229. doi: 10.1016/j.ecoenv.2018.04.032. Epub 2018 Apr 26.	Perfluorobutane sulfonate (PFBS) is considered a less-toxic replacement for perfluorooctane sulfonate (PFOS), with multiple applications in industrial and consumer products. Previous studies comparing their toxicity generally used similar exposure levels, without taking internal concentrations into account. The current study compared the reproductive toxicity of PFOS and PFBS, at similar internal concentrations, to Caenorhabditis elegans (C. elegans). PFBS was much less bioaccumulative than PFOS. The 48-h median lethal concentrations (LC(50)) for PFOS and PFBS were 1.4 μM (95% confidence interval [CI]: 1.1-1.6) and 794 μM (95% CI: 624-1009), respectively. Egg production and brood number of C. elegans decreased markedly following exposure to 0.1 μM PFOS or 1000 or 1500 μM PFBS. Germ-cell apoptosis and production of reactive oxygen species increased significantly following exposure to 2 μM PFOS or 500 or 1000 μM PFBS. Expression of the antioxidant genes sod-3, ctl-2, and gst-4 and the pro-apoptotic genes egl-1 and ced-13 was altered significantly following PFOS and PFBS exposure. These findings indicate that both chemicals exert reproductive toxicity in C. elegans, probably owing to germ-cell apoptosis resulting from elevated levels of reactive oxygen species. The vastly different exposure concentrations of PFBS and PFOS used in this study produced similar internal concentrations, leading to the reproductive toxicities observed.					1				1													C	C		
634	実験動物（生殖発生毒性）	Sant, Karilyn E; Jacobs, Haydee M; Borofski, Katrina A; Moss, Jennifer B; Timme-Laragy, Alicia R	Embryonic exposures to perfluorooctanesulfon	2017	Environ Pollut. 2017 Jan;220(Pt B):807-817. doi: 10.1016/j.envpol.2016.10.057. Epub 2016 Oct 31.	Perfluorooctanesulfonic acid (PFOS) is a ubiquitous environmental contaminant, previously utilized as a non-stick application for consumer products and firefighting foam. It can cross the placenta, and has been repeatedly associated with increased risk for diabetes in epidemiological studies. Here, we sought to establish the hazard posed by embryonic PFOS exposures on the developing pancreas in a model vertebrate embryo, and develop criteria for an adverse outcome pathway (AOP) framework to study the developmental origins of metabolic dysfunction. Zebrafish (Danio rerio) embryos were exposed to 16, 32, or 64 μM PFOS beginning at the mid-blastula transition. We assessed embryo health, size, and islet morphology in Tg(insulin-GFP) embryos at 48, 96 and 168 hpf, and pancreas length in Tg(ptf1a-GFP) embryos at 96 and 168 hpf. QPCR was used to measure gene expression of endocrine and exocrine hormones, digestive peptides, and transcription factors to determine whether these could be used as a predictive measure in an AOP. Embryos exposed to PFOS showed anomalous islet morphology and decreased islet size and pancreas length in a U-shaped dose-response curve, which resemble congenital defects associated with increased risk for diabetes in humans. Expression of genes encoding islet hormones and exocrine digestive peptides followed a similar pattern, as did total larval growth. Our results demonstrate that embryonic PFOS exposures can disrupt pancreatic organogenesis in ways that mimic human congenital defects known to predispose individuals to diabetes; however, future study of the association between these defects andmetabolic dysfunction are needed to establish an improved AOP framework.					1				1													C	C		
635	実験動物（生殖発生毒性）	Stefani, F; Rusconi, M; Valsecchi, S; Marziali, L	Evolutionary ecotoxicology of perfluoralkyl sub	2014	Aquat Toxicol. 2014 Nov;156:41-51. doi: 10.1016/j.aquatox.2014.07.020. Epub 2014 Aug 12.	A multigeneration toxicity test on Chironomus riparius was performed with the aim of investigating the evolutionary consequences of exposure to perfluoralkyl substances (perfluorooctane sulfonic acid, PFOS; perfluorooctanoic acid, PFOA; perfluorobutane sulfonate, PFBS). Six-hundred larvae were bred per treatment and per generation until emergence and egg deposition under a nominal concentration of 10 μg/L of contaminants. Newborn larvae were used to start the next generation. Evolution of genetic variability was evaluated along a total of 10 consecutive generations based on 5 microsatellite loci. Analysis of life-history traits (survival, sex ratio and reproduction) was also carried out. Rapid genetic variability reduction was observed in all treatments, including controls, across generations due to the test conditions. Nevertheless, an increased mutation rate determined a stronger conservation of genetic variability in PFOS and, at minor extent, in PFBS exposed populations compared to controls. No significant effects were induced by exposure to PFOA. Direct mutagenicity or induced stress conditions may be at the base of increased mutation rate, indicating the potential risk of mutational load caused by exposure to PFOS and PFBS. The test provided the opportunity to evaluate the use of approximate Bayesian computation (ABC) and coalescent approaches in evolutionary ecotoxicology. A weak performance was evidenced for ABC, either in terms of bias or dispersion of effective population sizes and of estimates of mutation rate. On the contrary, coalescent simulations proved the sensitivity of traditional genetic endpoints (i.e.heterozygosity and number of alleles) to the alteration of mutation rate, but not to erosion of genetic effective size.					1				1													C	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
636	実験動物（生殖発生毒性）	Butenhoff J.L., Chang S.-C., Ehresman D. J., York R.G.	Evaluation of potential reproductive and develo	2009	Reprod Toxicol. 2009 Jun;27(3-4):331-341. doi: 10.1016/j.reprotox.2009.01.004. Epub 2009 Jan 21.	This study evaluates the potential reproductive and developmental toxicity of perfluorohexanesulfonate (PFHxS), a surfactant found in sera of the general population. In a modified OECD 422 guideline-based design, 15 rats per sex and treatment group (control, 0.3, 1, 3, and 10mg/kg-d) were dosed by gavage with potassium PFHxS (K(+)PFHxS) or vehicle (0.5% carboxymethylcellulose) 14 days prior to cohabitation, during cohabitation, and until the day before sacrifice (21 days of lactation or presumed gestation day 25 (if not pregnant) for females and minimum of 42 days of treatment for males). Offspring were not dosed by gavage but were exposed by placental transfer in utero and potentially exposed via milk. Evaluations were made for reproductive success, clinical signs, body weight, food consumption, estrous cycling, neurobehavioral effects, gross and microscopic anatomy of selected organs, sperm, hematology, clinical pathology, and concentration of PFHxS in serum and liver. Additional three rats per sex per group were added to obtain sera and liver samples for PFHxS concentration determinations during the study. No reproductive or developmental effects were observed. There were no treatment-related effects in dams or offspring. K(+)PFHxS-induced effects noted in parental males included: (1) at all doses, reductions in serum total cholesterol; (2) at 0.3, 3, and 10mg/kg-d, decreased prothrombin time; (3) at 3 and 10mg/kg-d, increased liver-to-body weight and liver-to-brain weight ratios, centrilobular hepatocellular hypertrophy, hyperplasia of thyroid follicular cells, and decreased hematocrit; (4) at 10mg/kg-d, decreased triglycerides and increased albumin, BUN, ALP, Ca(2+), and A/G ratio. Serum and liver concentrations of PFHxS are reported for parents, fetuses, and pups. PFHxS was not a reproductive or developmental toxicant under study conditions.															1		1	1			1	A	A	データを見れていないが、PFHxSの発生毒性を詳細に検討している。ただ、試験条件下では生殖毒性も発達毒性も認められておらず、他の論文データと比較する必要がある。	
637	実験動物（生殖発生毒性）	Feng, Yixing; Shi, Zhimin; Fang, Xuemei; Xu, Muqi; Dai, Jiayin	Perfluorononanoic acid induces apoptosis invo	2009	Toxicol Lett. 2009 Oct 28;190(2):224-30. doi: 10.1016/j.toxlet.2009.07.020. Epub 2009 Jul 29.	Perfluorononanoic acid (PFNA, C9), a synthetic perfluorinated chemical containing nine carbons, accumulates and is biomagnified through food webs. This compound has been detected in the serum of humans and wildlife and has the potential for reproductive interference. Few studies, however, have reported the effects of PFNA exposure on male reproduction. To determine this, male rats were orally dosed for 1, 3 and 5mg/kgday PFNA or with vehicle for 14 days. In the present study, serum testosterone levels were decreased, while estradiol levels were increased dramatically in rats receiving 5mg PFNA/kgday. Spermatogenic cells from rats that received 5mg PFNA/kgday exhibited apoptotic features including crescent chromatin condensation and chromatin margination. Flow cytometric analysis and TUNEL assays revealed a dose-dependent increase of apoptotic cell numbers. In addition, expression of Fas and Bax mRNA levels were upregulated significantly, and Bcl-2 mRNA levels were downregulated markedly in the 3 and 5mg/kgday groups. A dose-dependent increase in levels of active caspase-8 and no significant changes of active caspase-9 were observed. Our results indicate that PFNA exposure can lead to cell apoptosis in rat testis, and this apoptosis was probably associated with the Fas death receptor-dependent apoptotic pathway.				1													1				B	B		
638	実験動物（生殖発生毒性）	Rogers, J. M.; Ellis-Hutchings, R. G.; Grey, B. E.; Zucker, R. M.; Norwood, J., Jr; Grace, C. E.; Gordon, C. J.; Lau, C.	Elevated blood pressure in offspring of rats exp	2014	Toxicol Sci. 2014 Feb;137(2):436-46. doi: 10.1093/toxsci/kft248. Epub 2013 Nov 11.	Adverse intrauterine environments have been associated with increased risk of later cardiovascular disease and hypertension. In an animal model using diverse developmental toxicants, we measured blood pressure (BP), renal nephron endowment, renal glucocorticoid receptor (GR) gene expression, and serum aldosterone in offspring of pregnant Sprague-Dawley rats exposed to dexamethasone (Dex), perfluorooctane sulfonate (PFOS), atrazine, perfluorononanoic acid (PFNA), arsenic or nicotine. BP was assessed by tail cuff photoplethysmography, nephron endowment by confocal microscopy, and renal GR mRNA by qPCR. BP was also measured by telemetry, and corticosterone (CORT) was measured in resting or restrained Dex and atrazine offspring. Treated dams gained less weight during treatment in all groups except arsenic. There were chemical- and sex-specific effects on birth weight, but offspring body weights were similar by weaning. BP was higher in Dex, PFOS, atrazine and PFNA male offspring by 44752 weeks. Female offspring exhibited elevated BP at 10 weeks for PFNA and arsenic, and at 37 weeks for Dex, PFOS and atrazine. Dex, PFOS and atrazine offspring still exhibited elevated BP at 52-65 weeks of age; others did not. Elevated BP was associated with lower nephron counts. Dex, PFOS and atrazine offspring had elevated renal GR gene expression. Elevations in BPwere also observed in Dex and atrazine offspring by radiotelemetry. Atrazine offspring exhibited enhanced CORT response to restraint. Elevated offspring BP was induced by maternal exposure to toxicants. Since all treatments affected maternal gestational weight gain, maternal stress may be a common underlying factor in these observations.				1													1		1		A	C	SDラットを用いてPFOSが血圧に与える影響を見ており、論文のデータを分析する必要があると思われる。	
639	実験動物（生殖発生毒性）	Singh, Shilpi; Singh, Shio Kumar	Chronic exposure to perfluorononanoic acid im	2019	J Appl Toxicol. 2019 Mar;39(3):420-431. doi: 10.1002/jat.3733. Epub 2018 Oct 7.	Perfluoroalkyl acids (PFAAs) are widely used in commercial applications and that they are ubiquitous and persistent in the environment. Perfluorononanoic acid (PFNA), a member of PFAAs, has been detected in human and wildlife. Previous acute exposure studies have shown the adverse effect of PFNA on the testis. The present study was aimed to examine the effect of chronic PFNA exposure, from prepuberty to adulthood, on testicular functions and fertility in Parkes (P) male mice and to investigate the possible mechanism(s) of its action. PFNA (0.2 and 0.5 mg/kg) was orally administered to P male mice for 90 days from prepuberty (postnatal day [PND] 25) to adulthood (PND 114). Histologically, testes in PFNA-treated mice showed non-uniform degenerative changes in the seminiferous tubules. The treatment also had adverse effects on testicular expression of steroidogenic markers, serum levels of cholesterol and testosterone, sperm parameters and on litter size. A marked increase in the level of lipid peroxidation and decrease in the activities of antioxidant enzymes were observed in the testis of PFNA-treated mice compared to controls. Further, a significant decrease in expression of proliferating cell nuclear antigen (PCNA) and in the number of PCNA-positive cells, and an increase in expression of caspase-3 were also noted in PFNA-treated mice testis. In conclusion, the results suggest that chronic exposure to PFNA in male mice interferes with testosterone biosynthesis and causes oxidative stress in the testis, leading to alterations in spermatogenesis, sperm quality and fertility potential.				1													1		1		A	C	マウスの検討であるが、PFNAの慢性曝露はテストステロンの生合成阻害、酸化ストレスを介して、精子形成に影響を与えると書かれており、論文のデータを分析する必要があると思われる。	
640	実験動物（生殖発生毒性）	Wolf, Cynthia J; Zehr, Robert D; Schmid, Judy E; Lau, Christopher; Abbott, Barbara D	Developmental effects of perfluorononanoic Ac	2010	PPAR Res. 2010;2010:282896. doi: 10.1155/2010/282896. Epub 2010 Sep 27.	Perfluorononanoic acid (PFNA) is one of the perfluoroalkyl acids found in the environment and in tissues of humans and wildlife. Prenatal exposure to PFNA negatively impacts survival and development of mice and activates the mouse and human peroxisome proliferator-activated receptor-alpha (PPARα). In the current study, we used PPARα knockout (KO) and 129S1/SvlmJ wild-type (WT) mice to investigate the role of PPARα in mediating PFNA-induced in vivo effects. Pregnant KO and WT mice were dosed orally with water (vehicle control: 10 ml/kg), 0.83, 1.1, 1.5, or 2 mg/kg PFNA on gestational days (GDs) 1-18 (day of sperm plug = GD 0). Maternal weight gain, implantation, litter size, and pup weight at birth were unaffected in either strain. PFNA exposure reduced the number of live pups at birth and survival of offspring to weaning in the 1.1 and 2 mg/kg groups in WT. Eye opening was delayed (mean delay 2.1 days) and pup weight at weaning was reduced in WT pups at 2 mg/kg. These developmental endpoints were not affected in the KO. Relative liver weight was increased in a dose-dependent manner in dams and pups of the WT strain at all dose levels but only slightly increased in the highest dose group in the KO strain. In summary, PFNA altered liver weight of dams and pups, pup survival, body weight, and development in the WT, while only inducing a slight increase in relative liver weight of dams and pups at 2 mg/kg in KO mice. These results suggest that PPARα is an essential mediator of PFNA-induced developmental toxicity in the mouse.				1													1				B	B		
641	実験動物（生殖発生毒性）	Iwai, Hiroyuki; Hoberman, Alan M; Goodrum, Philip E; Mendelsohn, Emma; Anderson, Janet K	Addendum to Iwai and Hoberman (2014)-Reas	2019	Int J Toxicol. 2019 May/Jun;38(3):183-191. doi: 10.1177/1091581819837904. Epub 2019 Apr 14.	This article presents a supplemental data analysis and evaluation of the findings from an oral (gavage) combined developmental and perinatal/postnatal reproduction toxicity study of the ammonium salt of perfluorohexanoic acid (CASRN: 21615-47-4) in Crl: CD-1(ICR) mice. The original study has been cited as supporting a lowest-observed-adverse-effects level of 175 mg/kg/d and no-observed-adverse-effects level of 35 mg/kg/d for developmental effects from perfluorohexanoic acid (PFHxA, CASRN: 307-24-4) in mice. The statistical analysis reported in 2014 was accurate in terms of quantifying statistical significance within phase 2 of the study. However, given the low incidence of findings, the purpose of this article is to extend the analysis and interpretation of findings by pooling the control group information from both phases of the same study, comparing the study findings to the incidence rates for stillbirths and postpartum viability for this species and strain of mouse observed for similar studies conducted by the same laboratory, and evaluating data on the incidence and range of spontaneous eye abnormalities reported in the literature. Based on this supplemental evaluation, the original study supports a NOAEL of 175 mg/kg/d for PFHxA in mice, which is a factor of 5-fold higher than previously reported. Furthermore, to the extent that this study may be considered in the selection of a point of departure for PFHxA in mice, it is noted that 175 mg/kg/d for maternal exposure is an unbounded NOAEL for developmental effects, meaning that the study did not establish a dose at which developmental effects may occur.				1													1				B	D		
642	実験動物（生殖発生毒性）	Singh, Shilpi; Singh, Shio Kumar	Effect of gestational exposure to perfluoronona	2019	J Appl Toxicol. 2019 Dec;39(12):1663-1671. doi: 10.1002/jat.3883. Epub 2019 Aug 6.	Perfluoroalkyl acids (PFAAs) are widely used in commercial products and are found in many goods of daily use. Perfluorononanoic acid (PFNA) is one of the PFAAs that possesses endocrine disrupting properties and we have recently shown that PFNA affects testicular functions in Parkes mice. Exposure to environmental endocrine disruptors during fetal life is believed to affect gonadal development and they might produce reproductive abnormalities in males. Therefore, the present study examined the effect of gestational exposure to PFNA on the testes of neonatal mice offspring. Pregnant Parkes mice were orally administered PFNA (2 and 5 mg/kg body weight) or distilled water from gestational day 12 until parturition. Male pups were killed on postnatal day 3. PFNA treatment decreased testosterone biosynthesis by inhibiting expression of steroidogenic acute regulatory protein, cytochrome P450scc, and 3β- and 17β-hydroxysteroid dehydrogenase; proliferation of testicular cells was also affected in treated mice. Furthermore, a marked decrease in expression of Wilms tumor 1, steroidogenic factor 1 and insulin-like factor 3 was noted in neonatal mice testes, indicating that the PFNA treatment may affect the development of the testis. Moreover, observation of the dose-related expression of anti-müllerian hormone and c-Kit in neonatal mice testes is also suggestive of an interference with gonadal development by PFNA exposure. In conclusion, the results suggest that the gestational exposure to PFNA decreased testosterone biosynthesis and altered the expression of critical factors involved in the development of thetestis, thereby advocating a potential risk of PFNA to male reproductive health.				1													1		1		A	C	マウスで2濃度のみの検討であるが、PFNAの曝露はテストステロンの生合成を阻害し、精巣の発達に影響を与える可能性がある。他にも同様な報告があり、Aと判定した。	
643	実験動物（生殖発生毒性）	Singh, Shilpi; Singh, Shio Kumar	Acute exposure to perfluorononanoic acid in pr	2019	Ecotoxicol Environ Saf. 2019 Nov 15;183:109499. doi: 10.1016/j.ecoenv.2019.109499. Epub 2019 Aug 6.	Perfluoroalkyl acids (PFAAs) are anthropogenic compounds used globally in a variety of commercial products. Perfluorononanoic acid (PFNA), a member of PFAAs, is detected in human blood and this has been reported to cause hepatotoxic, immunotoxic, and developmental and testicular toxic effects in laboratory animals. We have recently shown that the acute exposure to PFNA in prepubertal Parkes (P) mice impairs spermatogenesis by inducing oxidative stress and inhibiting testosterone biosynthesis in the testis. The present study was aimed to examine the effect of acute exposure to PFNA in prepubertal P mice on germ cell dynamics and to understand the possible mechanisms of action of this compound on testicular functions. PFNA (2 and 5 mg/kg body weight) was orally administered to male mice for 14 days from postnatal day 25-38. The treatment caused a decrease in overall germ cell transformation. The results also reveal that impairment in testicular functions in treated mice is associated with alterations in cholesterol and glucose homeostasis; further, an inhibition in expressions of growth hormone receptor (GHR), insulin-like growth factor-1 (IGF-1), insulin-like growth factor-1 receptor (IGF-1R), androgen receptor (AR), phosphorylated mammalian target of rapamycin (p-mTOR) and peroxisome proliferator activated receptor α (PPAR α) in the testis is also implicated in this action. The findings thus suggest involvement of multiple factors which altogether contribute to the alterations in spermatogenic process and testosterone production following acute exposure to PFNA in prepubertal mice.				1													1		1		A	C	642と同じグループでメカニズムを検討した論文。一応、642と同様にAとした。	
644	実験動物（生殖発生毒性）	Singh, Shilpi; Singh, Shio Kumar	Prepubertal exposure to perfluorononanoic aci	2019	Ecotoxicol Environ Saf. 2019 Apr 15;170:590-599. doi: 10.1016/j.ecoenv.2018.12.034. Epub 2018 Dec 18.	Perfluoroalkyl acids (PFAAs) are widely used in industrial and commercial products and possess endocrine disrupting properties. Perfluorononanoic acid (PFNA), one of PFAAs, has been mainly reported to produce testicular toxicity in adult animals. The objective of the present study was to examine the effect of acute exposure of PFNA to prepubertal male Parkes (P) mice on spermatogenesis and testicular steroidogenesis, and to study the possible mechanism(s) of its action. PFNA (2 and 5 mg/kg) was orally administered to male P mice for 14 days from postnatal day 25-38. Histologically, testis in PFNA-treated mice showed non-uniform diverse degenerative changes in the seminiferous tubules; both normal and affected tubules were seen in the same testicular sections. The treatment caused a reduction in intra-testicular and serum testosterone levels accompanied by a decrease in testicular expression of SF1, StAR, CYP11A1, and 3β- and17β-HSD. Further, the activity of antioxidant enzymes and expression of Nrf2 and HO-1 in the testis were markedly decreased, while the level of lipid peroxidation and expression of IKKβ, NF-κB and caspase-3 were significantly increased in testis of PFNA-treated mice. There was also a decrease in PCNA expression and in PCNA-index and an increase in TUNEL-positive germ cells in testes of PFNA-treated mice. In conclusion, the results suggest that PFNA exposure to prepubertal male mice altered antioxidant enzymes activity and Nrf2-HO-1 signaling, leading to oxidative stress and a decrease in testosterone biosynthesis in the testis; these changes, in turn, caused increased apoptosis and decreased proliferation of germcells, thereby suppression of spermatogenesis.				1													1		1		A	C	642と同じグループでメカニズムを検討した論文。一応、642と同様にAとした。	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
645	in vitro（神経毒性）	Liao, Chunyang; Wang, Thanh; Cui, Lin; Zhou, Qunfang; Duan, Shumin; Jiang, Guibin	Changes in synaptic transmission, calcium cur	2009	Environ Sci Technol. 2009 Mar 15;43(6):2099-104. doi: 10.1021/es802985e.	Scientific and public concerns on perfluorinated compounds (PFCs) are increasingly growing because of their environmental persistency, bioaccumulation, and extensive distribution throughout the world. Little is known about the effects of PFCs on neural function and the underlying mechanisms. Recent evidence suggests that the toxicological effects of PFCs are closely correlated with their carbon chain lengths. In this present work, the actions of PFCs with varying chain length on cultured rat hippocampal neurons and possible action patterns were examined. Increases in the frequencies of spontaneous miniature postsynaptic current (mPSC) were commonly found in cultured neurons when perfused with PFCs. The increase of mPSC frequency was in proportion to the carbon chain length, and the potency of perfluorinated carboxylates was less pronounced than that of perfluorinated sulfonates. A comparable but less perceptible trend was also found for the amplitudes of voltage-dependent calcium current (I(Ca)). No regular change in pattern was observed for the effects of PFCs on activation and inactivation kinetics of I(Ca). Furthermore, prolonged treatment of PFCs inhibited the neurite growth of neuronsto various degrees. Comparisons between nonfluorinated and perfluorinated analogues demonstrated thatthefluorination in alkyl chain exerts stronger actions on neurons as compared to the surfactant activity. This study shows that PFCs exhibit adverse effects on cultured neurons to various extents, which is dependent on the carbon chain length and functional group attached to the fully fluorinated alkyl chain.				1						1												B	-		
646	in vitro（神経毒性）	Slotkin, Theodore A; MacKillop, Emiko A; Melnick, Ronald L; Thayer, Kristina A; Seidler, Frederic J	Developmental neurotoxicity of perfluorinated	2008	Environ Health Perspect. 2008 Jun;116(6):716-22. doi: 10.1289/ehp.11253.	BACKGROUND: The widespread detection of perfluoroalkyl acids and their derivatives in wildlife and humans, and their entry into the immature brain, raise increasing concern about whether these agents might be developmental neurotoxicants. OBJECTIVES: We evaluated perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorooctane sulfonamide (PFOSA), and perfluorobutane sulfonate (PFBS) in undifferentiated and differentiating PC12 cells, a neuronotypic line used to characterize neurotoxicity. METHODS: We assessed inhibition of DNA synthesis, deficits in cell numbers and growth, oxidative stress, reduced cell viability, and shifts in differentiation toward or away from the dopamine (DA) and acetylcholine (ACh) neurotransmitter phenotypes. RESULTS: In general, the rank order of adverse effects was PFOSA > PFOS > PFBS approximately PFOA. However, superimposed on this scheme, the various agents differed in their underlying mechanisms and specific outcomes. Notably, PFOS promoted differentiation into the ACh phenotype at the expense of the DA phenotype, PFBS suppressed differentiation of both phenotypes, PFOSA enhanced differentiation of both, and PFOA had little or no effect on phenotypic specification. CONCLUSIONS: These findings indicate that all perfluorinated chemicals are not the same in their impact on neurodevelopment and that it is unlikely that there is one simple, shared mechanism by which they all produce their effects. Our results reinforce the potential for in vitro models to aid in the rapid and cost-effective screening for comparative effects among differentchemicals in the same class and in relation to known developmental neurotoxicants.				1						1												B	-		
647	実験動物（反復投与毒性）	Butenhoff, John L; Bjork, James A; Chang, Shu-Ching; Ehresman, David J; Parker, George A; Das, Kaberi; Lau, Christopher; Lieder, Paul H; van Otterdijk, François M; Wallace, Kendall B	Toxicological evaluation of ammonium perfluor	2012	Reprod Toxicol. 2012 Jul;33(4):513-530. doi: 10.1016/j.reprotox.2011.08.004. Epub 2011 Aug 19.	Sequential 28-day and 90-day oral toxicity studies were performed in male and female rats with ammonium perfluorobutyrate (NH(4)(+)PFBA) at doses up to 150 and 30mg/kg-d, respectively. Ammonium perfluorooctanoate was used as a comparator at a dose of 30mg/kg-d in the 28-day study. Female rats were unaffected by NH(4)(+)PFBA. Effects in males included: increased liver weight, slight to minimal hepatocellular hypertrophy; decreased serum total cholesterol; and reduced serum thyroxin with no change in serum thyrotropin. During recovery, liver weight, histological, and cholesterol effects were resolved. Results of RT-qPCR were consistent with increased transcriptional expression of the xenosensor nuclear receptors PPARα and CAR as well as the thyroid receptor, and decreased expression of Cyp1A1 (Ah receptor-regulated). No observable adverse effect levels (NOAELs) were 6 and >150mg/kg-d for male and female rats in the 28-day study and 6 and >30mg/kg-d in the 90-dat study, respectively.	1					1						1		1		1	HBGV設定根拠	1	-	-		
648	実験動物（反復投与毒性）	Chengelis, Christopher P; Kirkpatrick, Jeannie B; Radovsky, Ann; Shinohara, Motoki	A 90-day repeated dose oral (gavage) toxicity s	2009	Reprod Toxicol. 2009 Jun;27(3-4):342-351. doi: 10.1016/j.reprotox.2009.01.006. Epub 2009 Jan 21.	Possible toxic effects of perfluorohexanoic acid (PFHxA) were evaluated when administered orally by gavage to rats at levels up to 200mg/kg/day for 90 days. Lower body weight gains were noted in the 10, 50 and 200mg/kg/day group males (not dose-responsive) throughout dosing. Other changes included lower red blood cell parameters, higher reticulocyte counts and lower globulin in the 200mg/kg/day group males and females, higher liver enzymes in males at 50 and 200mg/kg/day, lower total protein and higher albumin/globulin ratio, and lower cholesterol, calcium in males at 200mg/kg/day. Minimal centrilobular hepatocellular hypertrophy was present in 200mg/kg/day group males and correlated with higher liver weights and slightly higher peroxisome beta oxidation activity at the end of the dosing period. Based on liver histopathology and liver weight changes, the no-observed-adverse-effect level (NOAEL) for oral administration was 50mg/kg/day for males and 200mg/kg/day for females.		1				1	1				1		1		1		1			1	A	-		
649	実験動物（発がん性）	Klaunig, James E; Shinohara, Motoki; Iwai, Hiroyuki; Chengelis, Christopher P; Kirkpatrick, Jeannie B; Wang, Zemin; Bruner, Richard H	Evaluation of the chronic toxicity and carcinog	2015	Toxicol Pathol. 2015 Feb;43(2):209-20. doi: 10.1177/0192623314530532. Epub 2014 May 28.	Perfluorohexanoic acid (PFHxA), a 6-carbon perfluoroalkyl (C6; CAS # 307-24-4), has been proposed as a replacement for the commonly used 8-carbon perfluoroalkyls: perfluorooctanoic acid and perfluorooctane sulfonate. PFHxA is not currently a commercial product but rather the ultimate degradation product of C6 fluorotelomer used to make C6 fluorotelomer acrylate polymers. It can be expected that, to a greater or lesser extent, the environmental loading of PFHxA will increase, as C6 fluorotelomer acrylate treatments are used and waste is generated. This article reports on a chronic study (duration 104 weeks) that was performed to evaluate the possible toxicologic and carcinogenic effects of PFHxA in gavage (daily gavage, 7 days per week) treated male and female Sprague-Dawley (SD) rats. In the current study, dosage levels of 0, 2.5, 15, and 100 mg/kg/day of PFHxA (males) and 5, 30, and 200 mg/kg/day of PFHxA (females) were selected based on a previous subchronic investigation. No effects on body weights, food consumption, a functional observational battery, or motor activity were observed after exposure to PFHxA. While no difference in survival rates in males was seen, a dose-dependent decrease in survival in PFHxA-treated female rats was observed. Hematology and serum chemistry were unaffected by PFHxA. PFHxA-related histologic changes were noted in the kidneys of the 200-mg/kg/day group females. Finally, there was no evidence that PFHxA was tumorigenic in male or female SD rats at any of the dosage levels examined.		1				1	1				1		1		1		1	HBGV設定根拠	1	-	-		
650	実験動物（反復投与毒性）	Weatherly, Lisa M; Shane, Hillary L; Lukomska, Ewa; Baur, Rachel; Anderson, Stacey E	Systemic toxicity induced by topical applicatio	2021	Food Chem Toxicol. 2021 Oct;156:112528. doi: 10.1016/j.fct.2021.112528. Epub 2021 Aug 30.	Heptafluorobutyric acid (PFBA) is a synthetic chemical belonging to the per- and polyfluoroalkyl substances (PFAS) group that includes over 5000 chemicals incorporated into numerous products. PFBA is a short-chain PFAS (C4) labeled as a safer alternative to legacy PFAS which have been linked to numerous health effects. Despite the high potential for dermal exposure, occupationally and environmentally, dermal exposure studies are lacking. Using a murine model, this study analyzed serum chemistries, histology, immune phenotyping, and gene expression to evaluate the systemic toxicity of sub-chronic dermal PFBA 15-day (15% v/v or 375 mg/kg/dose) or 28-day (3.75-7.5% v/v or 93.8-187.5 mg/kg/dose) exposures. PFBA exposure produced significant increases in liver and kidney weights and altered serum chemistries (all exposure levels). Immune-cell phenotyping identified significant increases in draining lymph node B-cells (15%) and CD11b + cells (3.75-15%) and skin T-cells (3.75-15%) and neutrophils (7.5-15%). Histopathological and gene expression changes were observed in both the liver and skin after dermal PFBA exposure. The findings indicate PFBA induces liver toxicity and alterations of PPAR target genes, suggesting a role of a PPAR pathway. These results demonstrate that sustained dermal exposure to PFBA induces systemic effects and raise concerns of short-chain PFAS being promoted as safer alternatives.	1					1													1	A	-		
651	実験動物（反復、生殖毒性、遺伝毒性）	Loveless, Scott E; Slezak, Brian; Serex, Tessa; Lewis, Joseph; Mukerji, Pushkor; O'Connor, John C; Donner, E Maria; Frame, Steven R; Korzeniowski, Stephen H; Buck, Robert C	Toxicological evaluation of sodium perfluorohe	2009	Toxicology. 2009 Oct 1;264(1-2):32-44. doi: 10.1016/j.tox.2009.07.011. Epub 2009 Jul 24.	Sodium perfluorohexanoate [NaPFHx, F(CF(2))(5)CO(2)Na, CAS#2923-26-4] was evaluated in acute, 90-day subchronic, one-generation reproduction, developmental and in vitro genetic toxicity studies. In the subchronic/one-generation reproduction study, four groups of young adult male and female Crl:CD(SD) rats were administered NaPFHx daily for approximately 90 days by gavage at dosages of 0, 20, 100, or 500 mg/kg. Selected groups of rats were evaluated after 1- and 3-month recovery periods. Rats selected for reproductive evaluations were dosed for approximately 70 days prior to cohabitation, through gestation and lactation, for a total of about 4 months. The subchronic toxicity no observed adverse effect level (NOAEL) was 20mg/(kg day), based on nasal lesions observed at 100 and 500 mg/(kg day). No effects were observed for neurobehavioral endpoints. NaPFHx was a moderate inducer of hepatic peroxisomal beta-oxidation with a no observed effect level (NOEL) of 20 (male rats) and 100mg/(kg day) (female rats). Elevated hepatic beta-oxidation levels were observed following 1-month recovery in male and female rats at 500 mg/(kg day). No NaPFHx-related effects were observed on any reproductive parameters. The P(1) adult rat NOAEL was 20mg/(kg day), based on reduced body weight parameters, whereas the NOAEL for reproductive toxicity was 100 mg/(kg day), based on effects limited to reduced F(1) pup weights. In the developmental study, female rats were dosed via gavage on gestation day (GD) 6-20 with the same doses of NaPFHx administered in the subchronic study. The maternal and developmental toxicity NOAEL was 100 mg/(kg day), based on maternal and fetalbody weight effects at 500 mg/(kg day). NaPFHx is therefore concluded not to present a reproductive or developmental hazard. NaPFHx genotoxicity studies showed no mutations in the bacterial reverse mutation (Ames) assay or chromosome aberrations in human lymphocytes treated with NaPFHx in vitro. The lowest NOAEL from all of the studies was 20mg/(kg day) in the subchronic study based on nasal lesions. Benchmark doses (BMDL10) for nasal lesions were 13 and 21 mg/(kg day) for male and female rats, respectively. The relevance of the nasal lesions to humans is not known.		1				1					1			1			1	HBGV設定根拠	1	-	-		
652	実験動物（反復投与毒性）	Lieder, Paul H; Chang, Shu-Ching; York, Raymond G; Butenhoff, John L	Toxicological evaluation of potassium perfluorc	2009	Toxicology. 2009 Jan 8;255(1-2):45-52. doi: 10.1016/j.tox.2008.10.002. Epub 2008 Oct 17.	Perfluorobutanesulfonate (PFBS) is a surfactant and degradation product of substances synthesized using perfluorobutanesulfonyl fluoride. A 90-day rat oral gavage study has been conducted with potassium PFBS (K+PFBS). Rats were dosed with K+PFBS at doses of 60, 200, and 600mg/kg-day body weight. The following endpoints were evaluated: clinical observations, food consumption, body weight, gross and microscopic pathology, clinical chemistry, and hematology. In addition, functional observation battery and motor activity assessments were made. Histological examination included tissues in control and 600 mg/kg-day groups. Additional histological examinations were performed on nasal cavities and turbinates, stomachs, and kidneys in the 60 and 200 mg/kg-day groups. No treatment-related mortality, body weight, or neurological effects were noted. Chromorhinorrhea (perioral) and urine-stained abdominal fur were observed in males at 600mg/kg-day. Red blood cell counts, hemoglobin, and hematocrit values were reduced in males receiving 200 and 600mg/kg-day; however, there were no adverse histopathological findings in bone marrow. Total protein and albumin were lower in females at 600mg/kg-day. There were no significant changes in clinical chemistry in either sex. All rats appeared normal at sacrifice. Microscopic changes were observed only at the highest dose in the stomach. These changes consisted of hyperplasia with some necrosis of the mucosa with some squamous metaplasia. These effects likely were due to a cumulative direct irritation effect resulting from oral dosing with K+PFBS. Histopathological changes werealso observed in the kidneys. The changes observed were minimal-to-mild hyperplasia of the epithelial cells of the medullary and papillary tubules and the ducts in the inner medullary region. There were no corresponding changes in kidney weights. Clinical chemistry parameters related to kidney function were unchanged. These kidney findings are likely due to a response to high concentration of K+PFBS in tubules and ducts and represent a minimal-to-mild effect. Microscopic changes of an equivocal and uncertain nature were observed in the nasal mucosa and were likely attributable to the route of dosing (oral gavage). The NOAEL for the female rat in this study was 600 mg/kg-day (highest dose of study). The NOAEL for the male rat was 60 mg/kg-day based on hematological effects.				1				1		1			1		1		1	1	1	A	-		
653	実験動物（反復投与毒性）	Caverly Rae, J M; Craig, Lisa; Slone, Theodore W; Frame, Steven R; Buxton, L William; Kennedy, Gerald L	Evaluation of chronic toxicity and carcinogenic	2015	Toxicol Rep. 2015 Jun 30;2:939-949. doi: 10.1016/j.toxrep.2015.06.001. eCollection 2015.	Ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate, developed for use as a polymerization processing aid in the manufacture of fluoropolymers, was tested for its potential chronic toxicity and carcinogenicity in a 2-year oral dosing study in Sprague-Dawley rats. Male rats were given daily doses of either 0, 0.1, 1 or 50 mg/kg; females were given either 0, 1, 50 or 500 mg/kg. Body weights, food consumption and clinical signs were monitored daily; clinical pathology was conducted at designated intervals and animals were given a complete pathological evaluation after 12 months and 24 months of dosing. Normal survival was seen in all groups, no abnormal clinical signs were seen, and body weight gain was reduced only in female rats at 500 mg/kg. Both sexes at the high dose had mild decreases in red cell mass which were somewhat more pronounced in females. Clinical pathology indicative of liver injury was present in males that received 50 mg/kg and correlated with histomorphological liver changes that included both hypertrophic and degenerative/necrotic lesions. Similar histomorphological lesions were seen in the livers of females at 500 mg/kg. Previous shorter term toxicity studies have identified this chemical as a PPARα agonist and the finding of benign tumors of the liver, pancreas and/or testes in males at 50 mg/kg and females at 500 mg/kg is consistent with the rat response to peroxisome proliferators and is of questionable human relevance. Changes in the kidney, tongue, and stomach were observed only at the highest dose of 500 mg/kg in females. The no-observed-adverse-effect-level in this study lies between 1 and50 mg/kg for males and between 50 and 500 mg/kg for females.						1			1			1		1					1	A	-		
654	実験動物（発がん性）	Klaunig, James E; Hocevar, Barbara A; Kamendulis, Lisa M	Mode of Action analysis of perfluorooctanoic a	2012	Reprod Toxicol. 2012 Jul;33(4):410-418. doi: 10.1016/j.reprotox.2011.10.014. Epub 2011 Nov 22.	Perfluorooctanoic acid (PFOA) is an environmentally persistent chemical used in the manufacturing of a wide array of industrial and commercial products. PFOA has been shown to induce tumors of the liver, testis and pancreas (tumor triad) in rats following chronic dietary administration. PFOA belongs to a group of compounds that are known to activate the PPARα receptor. The PPARα activation Mode of Action was initially addressed in 2003 [9] and further refined in subsequent reviews [92-94]. In the intervening time, additional information on PFOA effects as well as a further refinement of the Mode of Action framework warrants a re-examination of this compound for its cancer induction Mode of Action. This review will address the rodent (rat) cancer data and cancer Mode of Action of PFOA for tumors of the liver, testes and pancreas.						1			1			1		1						C	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献リンク（委員①）	文献リンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
655	実験動物（神経毒性）	Zhang, Qian; Liu, Wei; Niu, Qiao; Wang, Yu; Zhao, Huimin; Zhang, Huifang; Song, Jing; Tsuda, Shuji; Saito, Norimitsu	Effects of perfluorooctane sulfonate and its alt	2016	Toxicol Res (Camb). 2016 Jan 7;5(2):539-546. doi: 10.1039/c5tx00184f. eCollection 2016 Mar 1.	With the limited but ongoing usage of perfluorooctane sulfonate (PFOS), the health effects of both PFOS and its alternatives are far from being understood. Long-term potentiation (LTP) was evaluated in rats after exposure to PFOS and its alternatives, aiming to provide some evidence about their potential to affect cognitive ability. Different dosages of PFOS and alternative chemicals, including perfluorohexane sulfonate (PFHxS), perfluorobutane sulfonate (PFBS) and chlorinated polyfluorinated ether sulfonate (Cl-PFAES), were given to rats via acute intracerebroventricular injection. The field excitatory postsynaptic potential (fEPSP) amplitude of the input/output functions, paired-pulse facilitations, and LTP in vivo were recorded. PFOS and its alternatives inhibited LTP in varying degrees, without significant effects on the normal synaptic transmission. In addition, PFHxS and Cl-PFAES exhibited comparable potential to PFOS in disturbing LTP. The results suggested that acute exposure to PFOS and its alternatives impaired the synaptic plasticity by a postsynaptic rather than a presynaptic mechanism. Besides, the fEPSP amplitude of the baseline was reduced by Cl-PFAES but not by other compounds, indicating that Cl-PFAES might act in a different mode. Providing some electrophysiological evidence and the potential mechanism of the neurotoxicity induced by PFOS and its alternatives, the present study addresses further evaluation of their safety and health risks.				1						1											C	-		
656	実験動物（発がん性）	Biegel, L. B.; Hurtt, M. E.; Frame, , S. R.; O'Connor, J. C.; Cook, J. C.	Mechanisms of extrahepatic tumor induction b	2001	Toxicol Sci. 2001 Mar;60(1):44-55. doi: 10.1093/toxsci/60.1.44.	Wyeth-14,643 (WY) and ammonium perfluorooctanoate (C8) belong to a diverse class of compounds which have been shown to produce hepatic peroxisome proliferation in rodents. From previous work, WY, but not C8, has been shown to produce hepatocellular carcinoma in rats, while C8 has been shown to produce Leydig cell adenomas. In addition, based on a review of bioassay data a relationship appears to exist between peroxisome-proliferating compounds and Leydig cell adenoma and pancreatic acinar cell hyperplasia/adenocarcinoma formation. To further investigate the relationship between peroxisome-proliferating compounds and hepatic, Leydig cell, and pancreatic acinar cell tumorigenesis, a 2-year feeding study in male CD rats was initiated to test the hypothesis that peroxisome proliferating compounds induce a tumor triad (liver, Leydig cell, pancreatic acinar cell), and to examine the potential mechanism for the Leydig cell tumors. The study was conducted using 50 ppm WY and 300 ppm C8. The concentration of WY in the diet was decreased to 25 ppm on test day 301 due to increased mortality. In addition to the ad libitum control, a second control was pair-fed to the C8 group. Interim sacrifices were performed at 1- or 3-month intervals. Peroxisome proliferation measured by beta-oxidation activity and cell proliferation were measured in the liver and testis at all time points and in the pancreas beginning at the 9-month time point (cell proliferation only). Serum hormone concentrations (estradiol, testosterone, LH, FSH, and prolactin) were also measured at each time point. Increased relative liver weights and hepatic beta-oxidation activity were observed in both the WY- and C8-treated rats at all time points. In contrast, hepatic cell proliferation was significantly increased only in the WY-treated group. Neither WY nor C8 significantly altered the rate of Leydig cell beta-oxidation or Leydig cell proliferation when compared to the control groups. Moreover, the basal rate of beta-oxidation in Leydig cells was approximately 20 times less than the rate of hepatic beta-oxidation. There were no biologically meaningful differences in serum testosterone, FSH, prolactin, or LH concentrations in the WY- and C8-treated rats when compared to their respective controls. There were, however, significant increases in serum estradiol concentrations in the WY- and C8-treated rats at 1, 3, 6, 9, 15, 18, and 21 months. At 12 months, only the C8-treated rats had elevated serum estradiol concentrations when compared to the pair-fed control. Histopathological evaluation revealed compound-related increases in liver, Leydig cell, and pancreatic acinar cell tumors in both WY- and C8-treated rats. The data support the hypothesis that the peroxisome-proliferating compounds induce the previously described tumor triad. In addition, both C8 and WY produced a sustained increase in serum estradiol concentrations that correlated with the potency of the 2 compounds to induce Leydig cell tumors (i.e., WY caused a more consistent sustained increase in serum estradiol throughout the entire study, and more specifically at the end of the study, than did C8). This study suggests that estradiol may play a role in enhancement of Leydig cell tumors in the rat, and that peroxisome proliferators may induce tumors via a non-LH type mechanism.				1						1				1							C	-		
657	実験動物（刺激性）	Carpenter, C.	FRD-902: Acute Dermal Irritation Study in Rab	2007	Wilmington, DE: E.I. du pont de Nemours and Company.	FRD-902 was evaluated for acute eye irritation potential in 1 young adult New Zealand White rabbit. A skin irritation study was previously conducted. The test substance was not a severe skin irritant or corrosive to the skin. An aliquot of 0.1 mL of test substance was administered to 1 eye of the animal. The treated and control eye remained unwashed following treatment. The conjunctiva, iris, and cornea of the treated eye were evaluated and scored according to a numerical scale approximately 1, 24, and 28 hours following administration of the test substance. Brown and white discoloration of the conjunctival membrane of the treated rabbit eye, which appeared to look like necrosis, was observed at 1, 24, and 28 hours after instillation of the test substance. Corneal opacity (score of 2), iritis (score of 1), conjunctival chemosis (score of 2 or 4), and discharge (score of 2 or 3) were also observed. Fluorescein stain examinations of the treated eye were positive for corneal injury. The rabbit was euthanized the day after treatment for humane reasons. Under the conditions of this study, FRD-902 produced ocular effects in a rabbit which appeared to look like necrosis.				1						1											C	-		
658	実験動物（急性毒性）	Carpenter, C.	FRD-902: Acute Dermal Toxicity Study in Rats	2007	Wilmington, DE: E.I. du pont de Nemours and Company.	A single dose of FRD-902 was applied to the shaved, intact skin of 5 male and 5 female rats at a dose of 5000 mg/kg of body weight. The application site was covered with a semi-occlusive dressing for 24 hours, after which the test substance was removed. The rats were observed for 14 days following application. The rats were necropsied to detect grossly observable evidence of organ or tissue damage at the end of the 15-day test period. No deaths occurred. The rats exhibited no clinical signs of systemic toxicity or body weight loss. No erythema or edema was observed on the test site of male rats. All female rats exhibited erythema (score of 2) but no edema on the test site the day after application of the test substance. No erythema was observed in these rats by 2 days after application. Hyperkeratosis was observed on the test site of 8 rats, and ulceration was observed on the test site of 3 rats during the study. All dermal effects cleared by 13 days after application. No gross lesions were present in the rats at necropsy. Under the conditions of this study, the skin absorption LD50 for FRD-902 was greater than 5000 mg/kg of body weight when applied to the skin of male and female rats for 24 hours.				1						1											C	-		
659	実験動物（刺激性）	Carpenter, C.	FRD-902: Acute Eye Irritation Study in Rabbits	2007	Wilmington, DE: E.I. du pont de Nemours and Company.	FRD-902 was evaluated for acute eye irritation potential in 1 young adult New Zealand White rabbit. A skin irritation study was previously conducted. The test substance was not a severe skin irritant or corrosive to the skin. An aliquot of 0.1 mL of test substance was administered to 1 eye of the animal. The treated and control eye remained unwashed following treatment. The conjunctiva, iris, and cornea of the treated eye were evaluated and scored according to a numerical scale approximately 1, 24, and 28 hours following administration of the test substance. Brown and white discoloration of the conjunctival membrane of the treated rabbit eye, which appeared to look like necrosis, was observed at 1, 24, and 28 hours after instillation of the test substance. Corneal opacity (score of 2), iritis (score of 1), conjunctival chemosis (score of 2 or 4), and discharge (score of 2 or 3) were also observed. Fluorescein stain examinations of the treated eye were positive for corneal injury. The rabbit was euthanized the day after treatment for humane reasons. Under the conditions of this study, FRD-902 produced ocular effects in a rabbit which appeared to look like necrosis.				1						1											C	-		
660	実験動物（急性毒性）	Carpenter, C.	FRD-902: Acute Oral Toxicity Study in Mice - U	2007	Wilmington, DE: E.I. du pont de Nemours and Company.	A single dose of FRD-902 was administered by oral gavage to 1 fasted female mouse at a dose of 175 mg/kg, to 3 fasted female mice at a dose of 550 mg/kg, and to 3 fasted female mice at a dose of 1750 mg/kg. The mice were dosed one at a time at a minimum of 48-hour intervals. The mice were observed for mortality, body weight effects, and clinical signs for up to 14 days after dosing. All mice were necropsied to detect grossly observable evidence of organ or tissue damage. Death occurred in all 3 mice dosed at 1750 mg/kg. No clinical signs were observed in the mouse dosed at 175 mg/kg or in 2 mice dosed at 550 mg/kg. Wet fur was observed on the day of dosing in 1 mouse dosed at 550 mg/kg. One mouse dosed at 1750 mg/kg was found dead on the day of dosing. No clinical signs were observed in this mouse. Another mouse dosed at 1750 mg/kg exhibited lethargy and low posture and was found dead on the day of dosing. The remaining mouse dosed at 1750 mg/kg exhibited lethargy on the day of dosing and was found dead on the day after dosing. No body weight losses occurred in surviving mice after dosing. No test substance-related gross lesions were found in the study. Under the conditions of this study, the estimated oral LD50 for FRD-902 was 1030 mg/kg for female mice. In accordance with the provisions of Directive 67/548/EEC, classification is required based on the results of this study. FRD-902 is classified as harmful and assigned the symbol “Xn” and the risk phrase R22 Harmful if swallowed.				1						1											C	-		
661	実験動物（急性毒性）	Carpenter, C.	FRD-903: Acute Oral Toxicity Study in Rats - U	2008	Wilmington, DE: E.I. du pont de Nemours and Company.	A single dose of diluted FRD-903 was administered by oral gavage to fasted male and female rats. Male rats were dosed at 175 mg/kg (2 rats), 550 mg/kg (4 rats), 1750 mg/kg (6 rats), and 5000 mg/kg (3 rats). Female rats were dosed at 175 mg/kg (1 rat), 550 mg/kg (3 rats), 1750 mg/kg (4 rats), and 5000 mg/kg (1 rat). The rats were dosed 1 at a time at a minimum of 48-hour intervals. The rats were observed for mortality, body weight effects, and clinical signs for up to 14 days after dosing. All rats were necropsied to detect grossly observable evidence of organ or tissue damage. In male rats, death occurred in 1 of 4 rats dosed at 550 mg/kg (sacrificed in extremis on test day 4 following a 23% reduction in body weight), in 2 of 6 rats dosed at 1750 mg/kg (found dead on test day 0 or 1), and in 3 of 3 rats dosed at 5000 mg/kg (found dead on test day 0). No clinical signs of toxicity were observed in the 2 male rats dosed at 175 mg/kg and in 1 surviving male rat dosed at 550 mg/kg. Clinical signs of toxicity were observed for up to 5 days after dosing in the remaining male rats and included lung noise, absent feces, lethargy, not eating, stained fur/skin, wet fur, labored breathing, lethargy, decreased muscle tone, prostrate posture, tremors, clear oral discharge, diarrhea, ataxia, and/or high posture. No biologically relevant body weight losses occurred in surviving male rats. Gross findings were present in 3 rats dosed at 5000 mg/kg, in 4 rats dosed at 1750 mg/kg, and 1 rat dosed at 550 mg/kg. These included stomach discoloration, stomach thick, skin stain, stomach distended with gas, and/or small testes and epididymides. In female rats, death occurred in 3 of 4 rats dosed at 1750 mg/kg (found dead on test day 0 or 1) and in the single rat dosed at 5000 mg/kg (found dead on test day 0). Clinical signs of toxicity were observed up to 3 days after dosing in all female rats except the single rat dosed at 175 mg/kg and included wet fur, stained fur/skin, ataxia, labored breathing, cold to touch, clear ocular or oral discharge, lethargy, lung noise, absent feces, not eating, and/or rubbing face on bottom of cage. No body weight losses occurred in female rats. Gross findings were present in 1 rat dosed at 5000 mg/kg and in 3 rats dosed at 1750 mg/kg. These included stomach discoloration, stomach thick, esophagus fluid, skin wet, and/or mesenteric lymph nodes discoloration. Under the conditions of this study, the estimated oral LD50 for diluted FRD-903 was 1730 mg/kg and 1750 mg/kg for male and female rats, respectively. In accordance with the provisions of Directive 67/548/EEC, the test substance is classified as harmful and assigned the symbol Xn and the risk phrase R22 Harmful if swallowed. According to the Globally Harmonized System (GHS) of classification and labeling of chemicals and under the conditions of this study, the test substance is classified in Category 4.				1						1											C	-		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
662	実験動物（反復投与毒性）	Hadrup, Niels; Pedersen, Mikael; Skov, Kasper; Hansen, Niels Lund; Berthelsen, Line Olrik; Kongsbak, Kristine; Boberg, Julie; Dybdahl, Marianne; Hass, Ulla; Frandsen, Henrik; Vinggaard, Anne Marie	Perfluorononanoic acid in combination with 14	2016	Arch Toxicol. 2016 Mar;90(3):661-75. doi: 10.1007/s00204-015-1452-6. Epub 2015 Jan 15.	Humans are simultaneously exposed to several chemicals that act jointly to induce mixture effects. At doses close to or higher than no-observed adverse effect levels, chemicals usually act additively in experimental studies. However, we are lacking knowledge on the importance of exposure to complex real-world mixtures at more relevant human exposure levels. We hypothesised that adverse mixture effects occur at doses approaching high-end human exposure levels. A mixture (Mix) of 14 chemicals at a combined dose of 2.5 mg/kg bw/day was tested in combination with perfluorononanoic acid (PFNA) at doses of 0.0125 (Low PFNA), 0.25 (Mid PFNA) and 5 (High PFNA) mg/kg bw/day by oral administration for 14 days in juvenile male rats. Indication of a toxicokinetic interaction was found, as simultaneous exposure to PFNA and the Mix caused a 2.8-fold increase in plasma PFNA concentrations at Low PFNA. An increase in testosterone and dihydrotestosterone plasma concentrations was observed for Low PFNA + Mix. This effect was considered non-monotonic, as higher doses did not cause this effect. Reduced LH plasma concentrations together with increased androgen concentrations indicate a disturbed pituitary-testis axis caused by the 15-chemical mixture. Low PFNA by itself increased the corticosterone plasma concentration, an effect which was normalised after simultaneous exposure to Mix. This combined with affected ACTH plasma concentrations and down-regulation of 11β HSD mRNA in livers indicates a disturbed pituitary-adrenal axis. In conclusion, our data suggest that mixtures of environmental chemicals at doses approaching high-end human exposure levelscan cause a hormonal imbalance and disturb steroid hormones and their regulation. These effects may be non-monotonic and were observed at low doses. Whether this reflects a more general phenomenon that should be taken into consideration when predicting human mixture effects or represents a rarer phenomenon remains to be shown.			1											1		1			B	-		
663	実験動物（急性毒性）	Kinney, L A; Chromey, N C; Kennedy, G L Jr	Acute inhalation toxicity of ammonium perfluor	1989	Food Chem Toxicol. 1989 Jul;27(7):465-8. doi: 10.1016/0278-6915(89)90033-1.	Ammonium perfluorononanoate (CAS Registry No. 4149-60-4) is a white powder that can become airborne. Its acute inhalation toxicity in male rats was studied. Male rats were exposed for single 4-hr periods to dust concentrations ranging from 67 to 4600 mg/m3. The LC50 was determined to be 820 mg/m3, with the lowest concentration causing death being 590 mg/m3. Ammonium perfluorononanoate was classified as moderately toxic by the acute inhalation route. Exposure to ammonium perfluorononanoate caused a pronounced increase in liver size. The acute toxicity of ammonium perfluorononanoate appears to be similar to that of its 8-carbon homologue, ammonium perfluorooctanoate, but considerably less than that of the 10-carbon homologue, perfluoro-n-decanoic acid.			1											1					B	-		
664	ヒト（肝毒性）	Nian, M.; Li, Q. Q.; Bloom, M.; Qian, Z. M.; Syberg, K. M.; Vaughn, M. G.; Wang, S. Q.; Wei, Q.; Zeeshan, M.; Gurram, N.; Chu, C.; Wang, J.; Tian, Y. P.; Hu, L. W.; Liu, K. K.; Yang, B. Y.; Liu, R. Q.; Feng, D.; Zeng, X. W.; Dong, G. H.	Liver function biomarkers disorder is associate	2019	Environ Res 172: 8188. doi: 10.1016/j.envres.2019.02.013.	Exposure to chemicals may affect liver enzyme to increase the risk of liver diseases. Perfluoroalkyl acids (PFAAs) are one kind of persistent organic pollutants with hepatotoxic effect in organism. However, data is scarce to characterize the hepatotoxic effects of specific structural PFAA isomers in general population. To address this data gap, we evaluated the association between serum PFAAs concentration and liver function biomarkers in the Isomers of C8 Health Project in China. High performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) was used to measure 18 serum PFAAs, except for linear and branched isomers of PFOA/PFOS, nine perfluorinated carboxylic acids (PFCAs) and two perfluorinated sulfonic acids (PFSAs) were also included, in 1605 adult residents of Shenyang, China. Values for nine serum liver function biomarkers were determined by full-automatic blood biochemical analyzer. Linear regression was used to evaluate associations between PFAAs and continuous liver function biomarkers and logistic regression to assess markers dichotomized per clinical reference intervals. Results indicated that serum PFAAs concentrations were associated with liver biomarker levels suggestive of hepatotoxicity, especially for liver cell injury. For example, a 1 ln-unit increase in total- perfluorooctanoic acid (PFOA) exposure was associated with a 0.074 [95% confidence interval (CI): 3.9%, 11.0%] higher alanine aminotransferase(ALT) level in serum. Interestingly, we observed association between branched PFAA isomers and liver biomarkers. For example, one ln-unit increase in branched perfluorooctane sulfonate (PFOS) isomers exposure was associated with a 0.043 increase in ALT level (95% CI: 1.2%, 7.4%) and a 0.33 increased odds of having abnormal ALT (95% CI: 5.0%, 67.0%). Also, we found that PFNA had positive association with ALT [(6.2%, 0.95 CI: 3.1%, 9.4%) and AST levels (2.5%, 0.95 CI: 0.5%, 4.5%)]. Logistic regression results showed that PFPeA, PFHxA, PFNA, PFDoDA, PFTrDA and PFTeDA had statistically association with abnormal prealbumin. Conclusively, our results support previous studies showing association between PFAAs exposure and liver function biomarkers. We found new evidence that branched PFAAs isomer exposure is associated with the risk of clinically relevant hepatocellular dysfunction.	1	1	1			1	1									1			1		B	A		
665	ヒト（肝毒性）	Zhang, L.; Ren, X. M.; Guo, L. H.	Structure-based investigation on the interactic	2013	Environ Sci Technol. 2013 Oct 1;47(19):11293-301. doi: 10.1021/es4026722. Epub 2013 Sep 20.	Perfluorinated compounds (PFCs) are known to accumulate in liver and induce hepatotoxicity on experimental animals. Liver fatty acid binding protein (L-FABP) is expressed highly in hepatocytes and binds fatty acids. PFCs may bind with FABP and change their ADME and toxicity profile. In the present study, the binding interaction of 17 structurally diverse PFCs with human L-FABP was investigated to assess their potential disruption effect on fatty acid binding. The binding affinity of twelve perfluorinated carboxylic acids (PFCAs), as determined by fluorescence displacement assay, increased significantly with their carbon number from 4 to 11, and decreased slightly when the number was over 11 The three perfluorinated sulfonic acids (PFSAs) displayed comparable affinity, but no binding was detected for the two fluorotelomer alcohols. Circular dichroism results showed that PFC binding induced distinctive structural changes of the protein. Molecular docking revealed that the driving forces for the binding of PFCs with FABP were predominantly hydrophobic and hydrogen-bonding interactions, and the binding geometry was dependent on both the size and rigidity of the PFCs. Based on the binding constant obtained in this work, the possibility of in vivo competitive displacement of fatty acids from FABP by PFCs was estimated.					1			1										1			B	C		
666	ヒト（肝毒性、その他）	Christensen, K. Y.; Raymond, M.; Thompson, B. A.; Anderson, H. A.	Perfluoroalkyl substances in older male anglers	2016	Environ Int. 2016 May;91:312-8. doi: 10.1016/j.envint.2016.03.012. Epub 2016 Mar 19.	Background: Perfluoroalkyl substances (PFAS) are an emerging class of contaminants. Certain PFAS are regulated or voluntarily limited due to concern about environmental persistence and adverse health effects, including thyroid disease and to dyslipidemia. The major source of PFAS exposure in the general population is seafood. Objectives: In this analysis we examine PFAS levels and their determinants, as well as associations between PFAS levels and self-reported health outcomes, in a group of older male anglers in Wisconsin with high fish consumption. Methods: A biomonitoring study of male anglers aged 50 and older living in Wisconsin collected detailed information on fish consumption, demographics and self-reported health outcomes, along with hair and blood samples for biomarker analysis. Sixteen different PFAS were extracted from serum samples. Regression models were used to identify factors (demographic characteristics and fish consumption habits) associated with PFAS biomarker levels in blood, as well as associations between PFAS and self-reported health outcomes, adjusting for potential confounders. Results: Seven PFAS were detected in at least 30% of participants and were used in subsequent analyses (PFDA, PFHpS, PFHxS, PFNA, PFOA, PFOS, PFuDA). The PFAS with the highest levels were PFOS, followed by PFOA, PFHxS and PFNA (medians of 19.0, 2.5, 1.8 and 1.4ng/mL). In general, increasing age was associated with higher PFAS levels, while increasing BMI were associated with lower PFAS levels. Greater alcohol consumption was associated with higher levels of PFHpS, PFHxS and PFOA. Associations with smoking and employment did not show a consistent pattern. Associations between fish consumption and PFAS were generally weak, with the exception of notably higher PFDA and PFHpS with both other locally-caught fish, and restaurant-purchased fish. Regarding associations with health outcomes, PFuDA, PFNA and PFDA were all associated with increased risk of pre-diabetes and/or diabetes. PFHpS was associated with a significantly increased risk of high cholesterol; PFDA and PFuDA also showed notable, though non-significant associations. All PFAS evaluated were associated with lower risk of hypertension although the only significant odds ratio was that for PFNA. There were no associations between any of the PFAS examined and either coronary heart disease, or the grouped outcome of any cardiovascular condition.Conclusions: PFAS are emerging contaminants with widespread exposure, persistence, and potential for adverse health effects. In this study population, demographic patterns may reflect differences in exposure sources, or possibly differences in adsorption and metabolism. PFAS were associated mainly with endocrine related outcomes, with a general trend towards increased risk of glucose intolerance and high cholesterol. Continued research on the risks and benefits of fish consumption is important due to potential exposure to PFAS and noted associations with highly prevalent adverse health outcomes.			1											1					B	A		
667	ヒト（肝毒性、その他）	Gleason, Jessie A; Post, Gloria B; Fagliano, Jerald A	Associations of perfluorinated chemical serum	2015	Environ Res. 2015 Jan;136:8-14. doi: 10.1016/j.envres.2014.10.004. Epub 2014 Nov 19.	BACKGROUND: Perfluorinated chemicals (PFCs) are a group of manmade compounds that are not broken down in the body. Four PFCs (PFHxS, PFOS, PFOA, and PFNA) have been found in the blood of more than 98% of the United States population. OBJECTIVES: Our goal was to assess associations between PFHxS, PFOS, PFOA, and PFNA and uric acid, alanine transferase (ALT), gamma-glutamyl transferase (GGT), asparate aminotransferase (AST), alkaline phosphate (ALP), and total bilirubin in 2007-2008 and 2009-2010 combined National Health and Nutrition Examination Survey (NHANES). METHODS: We used multivariate linear regression and logistic regression adjusted for age, gender, race/ethnicity and BMI group, poverty, smoking, and/or alcohol consumption to estimate associations. Trend analysis was performed. RESULTS: PFHxS was associated with ALT. Each quartile of PFOS was statistically associated with total bilirubin [(Q2: OR=1.44, 95% CI 1.12-1.84), (Q3: OR=1.65, 95% CI 1.25-2.18), and (Q4: OR=1.51, 95% CI 1.06-2.15)], with evidence of an increasing trend (p-value=0.028). PFOA was associated with uric acid, ALT, GGT, and total bilirubin. PFNA was linearly associated with ALT (p-value <0.001), and there was statistically significant increasing trend (p-value=0.042). CONCLUSIONS: Our analysis found evidence of associations of biomarkers of liver function and uric acid with PFHxS, PFOS, PFOA, and PFNA at levels found in the general U.S. population.			1											1	1				B	D		
668	ヒト（肝毒性、その他）	Kang, H.; Lee, H. K.; Moon, H. B.; Kim, S.; Lee, J.; Ha, M.; Hong, S.; Kim, S.; Choi, K.	Perfluoroalkyl acids in serum of Korean childre	2018	Sci Total Environ. 2018 Dec 15;645:958-965. doi: 10.1016/j.scitotenv.2018.07.177. Epub 2018 Jul 20.	Perfluoroalkyl acids (PFAAs) have been widely used in human environment, and their exposure among general population has been frequently reported. However, extent of PFAAs exposure and their potential effects among children are not well characterized. In this study, children of between 3 and 18 years of age (n = 150) were recruited in Seoul and Gyeonggi, Korea, and the serum levels of 16 PFAAs along with lipids and thyroid hormones were measured. Questionnaire survey was conducted for dietary and behavioral characteristics of the children. Among the measured PFAAs, PFOA, PFNA, PFHxS, and PFOS were detected in all the samples, and PFUnDA and PFDA were detected in over 0.75 of the samples. PFOS was detected at the highest concentration with a median of 5.68 ng/mL. PFUnDA was detected at higher levels (median of 0.652 ng/mL) compared to those reported for children in USA. Serum PFAA levels were not different by sex among the children of <10 years of age, but in older children, those of boys are significantly higher than girls. Physiological characteristics like menstruation may explain lower PFAAs levels of the girls. In addition, breastmilk consumption, fish/shellfish consumption, non-stick frying pan use, and waterproof cloth use were identified as potential sources of PFAAs exposure. Serum PFUnDAlevel was positively associated with total cholesterol and low-density lipoprotein level of the children. PFNA was positively associated with free T4 level. High levels of PFUnDA among children and its association with serum lipids warrant replication and confirmation in other populations and/or supports by experimental studies.			1											1					B	B		
669	ヒト（肝毒性）	Lin, Chien-Yu; Lin, Lian-Yu; Chiang, Chih-Kang; Wang, Wei-Jie; Su, Yi-Ning; Hung, Kuan-Yu; Chen, Pau-Chung	Investigation of the associations between low-	2010	Am J Gastroenterol. 2010 Jun;105(6):1354-63. doi: 10.1038/ajg.2009.707. Epub 2009 Dec 15.	OBJECTIVES: Perfluorinated chemicals (PFCs) have been largely used for years in a variety of products worldwide. However, the toxic effect of PFCs on exposure to the liver in the general population has not yet been determined. METHODS: In this study, 2,216 adults (18 years of age or older) were recruited in a National Health and Nutrition Examination Survey (NHANES) in 1999-2000 and 2003-2004 to determine the relationship between serum level of PFCs and the levels of liver enzymes. The data were adjusted for all other confounding variants. RESULTS: After performing mathematical analysis, we determined when serum log-perfluorooctanoic acid (PFOA) increases in one unit, the serum alanine aminotransferase (ALT) concentration (U/l) increases by 1.86 units (95% confidence interval (CI), 1.24-2.48; P=0.005), and the serum log-gamma-glutamyltransferase (GGT) concentration (U/l) is 0.08 unit higher (95% CI, 0.05-0.11; P=0.019). The association between PFOA and liver enzymes was more evident in obese subjects, as well as subjects with insulin resistance and/or metabolic syndromes. When dividing the serum PFOA into quartiles in the fully adjusted models in subjects with a body mass index>or=30 kg/m2, the ALT level trend across the serum PFOA quartiles was significant (P=0.003). CONCLUSIONS: On the basis of these data, we conclude that a higher serum concentration of PFOA may cause liver enzymes to increase abnormally in the general population, particularly in obese individuals. Further studies are warranted to clarify the casual relationship between PFCs and these liver enzymes.			1											1	1				B	C		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
670	ヒト（肝毒性、その他）	Mundt, Diane J; Mundt, Kenneth A; Luippold, Rose S; Schmidt, Michael D; Farr, Craig H	Clinical epidemiological study of employees ex	2007	Occup Environ Med. 2007 Sep;64(9):589-94. doi: 10.1136/oem.2007.032664. Epub 2007 Apr 4.	INTRODUCTION: An epidemiological study was conducted of a perfluorononanoic acid (PFNA) surfactant blend, to investigate whether clinical differences were apparent between employees who were potentially exposed to the surfactant and those who were not exposed. The surfactant blend, which is related to other previously studied perfluorinated materials, is used in the production of some high-performance polymers. METHODS: All 630 individuals employed at a polymer production facility using PFNA (CAS No 72968-38-8) at any time between 1 January 1989 and 1 July 2003 were included in the cohort. Plausibly related laboratory test results were abstracted from annual medical examination records, including liver enzyme function and blood lipids. Detailed work histories, available for all employees, provided the basis for determining exposure category. Thirty two clinical parameters were evaluated by exposure level at five points in time, determined to reflect changes in possible exposure intensity, as well as greatest number of records available. Annual cross-sectional analyses and longitudinal analyses that accounted for multiple measurements per person were conducted separately for men and women, by exposure groups. RESULTS: Differences by exposure group for all laboratory measures, adjusted for age and body mass index, were small and not clinically significant. Although some statistically significant pair-wise differences were observed, these observations were not consistent between men and women, or over the five analysis windows. For the seven outcome variables (liver enzymes and blood lipids) examined in separatelongitudinal models, no significant increase or decrease was observed by unit increase in cumulative exposure intensity score. CONCLUSION: This is the first epidemiological study investigating the possible health effects in humans associated with exposure to PFNA blend. Based on laboratory measures assessed over more than a decade, no adverse clinical effects were detected from occupational exposure to PFNA blend.			1											1						B	D		
671	ヒト（肝毒性、その他）	Nelson, J. W.; Hatch, E. E.; Webster, T. F.	Exposure to Polyfluoroalkyl Chemicals and Cho	2010	Environ Health Perspect. 2010 Feb;118(2):197-202. doi: 10.1289/ehp.0901165.	Background: Polyfluoroalkyl chemicals (PFCs) are used commonly in commercial applications and are detected in humans and the environment worldwide. Concern has been raised that they may disrupt lipid and weight regulation. Objectives: We investigated the relationship between PFC serum concentrations and lipid and weight outcomes in a large publicly available data set. Methods: We analyzed data from the 20032004 National Health and Nutrition Examination Survey (NHANES) for participants 1280 years of age. Using linear regression to control for covariates, we studied the association between serum concentrations of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctane sulfonic acid (PFOS), and perfluorohexane sulfonic acid (PFHxS) and measures of cholesterol, body size, and insulin resistance. Results: We observed a positive association between concentrations of PFOS, PFOA, and PFNA and total and non-high-density cholesterol. We found the opposite for PFHxS. Those in the highest quartile of PFOS exposure had total cholesterol levels 13.4 mg/dL [95% confidence interval (CI), 3.823.0] higher than those in the lowest quartile. For PFOA, PFNA, and PFHxS, effect estimates were 9.8 (95% CI, 0.2 to 19.7), 13.9 (95% CI, 1.925.9), and 7.0 (95% CI, 13.2 to 0.8), respectively. A similar pattern emerged when exposures were modeled continuously. We saw little evidence of a consistent association with body size or insulin resistance. Conclusions: This exploratory cross-sectional study is consistent with other epidemiologic studies in finding a positive association between PFOS and PFOA and cholesterol, despite much lower exposures in NHANES. Results for PFNA and PFHxS are novel, emphasizing the need to study PFCs other than PFOS and PFOA.			1											1		1				B	B		
672	ヒト（肝毒性）	Wang, J.; Zhang, Y.; Zhang, W.; Jin, Y.; Dai, J.	Association of perfluorooctanoic acid with HDL	2012	Environ Sci Technol. 2012 Sep 4;46(17):9274-81. doi: 10.1021/es300906q. Epub 2012 Aug 21.	Perfluoroalkyl chemicals (PFCs) are stable man-made compounds with many industrial and commercial uses. Concern has been raised that they may exert deleterious effects, especially on lipid regulation. We aimed to assess exposure to perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and seven other PFCs in occupational workers from a fluorochemical plant and nearby community residents, and to investigate the association between PFOA and serum biomarkers. Serum biomarkers included not only biochemical parameters, such as lipids and enzymes, but also circulating microRNAs (miRNAs). Samples were analyzed by high-pressure liquid chromatography/tandem mass spectrometry (HPLC-MS/MS). Circulating miRNA levels were detected by quantitative polymerase chain reaction (PCR). Analyses were conducted by correlation and linear regression. We detected PFOS, PFOA, perfluorohexane sulfonate (PFHxS), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) in all samples. The median levels of serum PFOA and PFOS were 284.34 ng/mL and 34.16 ng/mL in residents and 1635.96 ng/mL and 33.46 ng/mL in occupational participants, respectively. To our knowledge, we found for the first time that PFOA was negatively associated with high-density lipoprotein cholesterol (HDL-C) in workers using linear regression after adjusting for potential confounders. Circulating miR-26b and miR-199a-3p were elevated with serum concentration of PFOA. Although the limitations of small samplesize and the cross-sectional nature of the current study constrained causal inferences, the observed associations between PFOA and these serum biomarkers warrant further study.			1											1						B	B		
673	ヒト（肝毒性、その他）	Yang, Q.; Guo, X.; Sun, P.; Chen, Y.; Zhang, W.; Gao, A.	Association of serum levels of perfluoroalkyl su	2018	Sci Total Environ. 2018 Apr 15;621:1542-1549. doi: 10.1016/j.scitotenv.2017.10.074. Epub 2017 Oct 18.	As extensively used chemicals in a variety of consumer products, perfluoroalkyl substances (PFASs) are ubiquitous and could bring significant risk to human health. However, the effect of PFASs on metabolic syndrome (MetS) is not fully understood. In 2015, a preliminary cross-sectional study was undertaken. A total of 148 male subjects including 81 affected by MetS and 67 non-MetS participants as the reference were recruited from Physical Examination Center affiliated to Capital Medical University, China. Serum levels of perfluorohexane sulfonic acid (PFHxS), perfluorooctanoic acid (PFOA) and perfluorononanoic acid (PFNA) were significantly higher in the subjects with MetS. Logistic regression results showed that concentration of PFNA in serum was associated with 10.9-fold [95% confidence interval (CI), 2.00-59.1] increased risk of MetS. Moreover, increased serum PFNA concentrations were associated with high blood pressure [both for systolic and diastolic blood pressure (SBP and DBP); odds ratio (OR) 7.52 (95%CI, 1.34-42.1) for SBP and 7.27 (95%CI, 1.17-45.1) for DBP], hypertriglyceridemia [13.2 (95%CI, 2.34-74.2)] and obesity [13.3 (95%CI, 2.38-74.4)], respectively. After adjustment by age in logistic regression models, serum levels of PFOA were associated with 29.4-fold (95%CI, 2.90-299.7) increased risk of MetS. Increased PFOA levels were also correlated with MetS [29.4 (95%CI, 2.9-299.7)], SBP [10.8 (95%CI,1.31-90.0)], hypertriglyceridemia [16.6 (95%CI, 1.92-147.1)], and obesity [46.7 (95%CI, 4.47-487.7)] with adjustment for age. This study suggests bodily retention of PFASs and its association with MetS. Further clinical and animal studies are warranted to clarify the putative causal relationship.			1											1						B	B		
674	ヒト（肝毒性）	Zeng, Xiao-Wen; Qian, Zhengmin; Emo, Brett; Vaughn, Michael; Bao, Jia; Qin, Xiao-Di; Zhu, Yu; Li, Jie; Lee, Yungling Leo; Dong, Guang-Hui	Association between perfluoroalkyl chemicals a	2015	Sci Total Environ. 2015 Apr 15;512-513:364-370. doi: 10.1016/j.scitotenv.2015.01.042. Epub 2015 Jan 30.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs), as well as polymers of PFASs, have been widely used in commercial applications and have been detected in humans and the environment. Previous epidemiological studies have shown associations between particular PFAS chemicals and serum lipid concentrations in adults, particularly perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). There exists, however, limited information concerning the effect of PFASs have on serum lipids among children. In the present cross-sectional study, 225 Taiwanese children (12-15 years of age) were recruited to determine the relationship between serum level PFASs and lipid concentration. Results showed that eight out of ten particular PFASs were detected in the serum of >94% of the participants. Serum PFOS and perfluorotetradecanoic acid (PFTA) levels were at an order of magnitude higher than the other PFASs, with arithmetical means of 32.4 and 30.7 ng/ml in boys and 34.2 and 27.4 ng/ml in girls, respectively. However, the variation in serum PFTA concentration was quite large. Following covariate adjustment, linear regression models revealed that PFOS, PFOA, and perfluorononanoic acid (PFNA) were positively associated with total cholesterol (TC), low-density lipoprotein (LDL) and triglycerides (TG), particularly for PFOS and PFTA. Quartile analysis, with the lowest exposure quartile as a reference, yielded associations between serum PFTA and elevations in TC (p=0.002) and LDL (p=0.004). Though not statistically significant, high-density lipoprotein (HDL) appeared to decrease linearly across quartiles for PFOS and PFOA exposure. Inconclusion, a significant association was observed between serum PFASs and lipid level in Taiwanese children. These findings for PFTA are novel, and emphasize the need to investigate the exposure route and toxicological evidence of PFASs beyond PFOS and PFOA.			1	1										1						B	B		
675	ヒト（肝毒性）	Bassler, John; Ducatman, Alan; Elliott, Meenal; Wen, Sijin; Wahlang, Banrida; Barnett, John; Cave, Matthew C	Environmental perfluoroalkyl acid exposures ar	2019	Environ Pollut. 2019 Apr;247:1055-1063. doi: 10.1016/j.envpol.2019.01.064. Epub 2019 Jan 18.	Exposures to perfluoroalkyl substances (PFAS) including perfluoroalkyl acids (PFAAs) are associated with increased liver enzymes in cohort studies including the C8 Health Study. In animal models, PFAAs disrupt hepatic lipid metabolism and induce apoptosis to cause nonalcoholic fatty liver disease (NAFLD). PFAAs are immunotoxic and inhibit pro-inflammatory cytokine release from stimulated leukocytes in vitro. This cross-sectional study tests the hypothesis that environmental PFAAs are associated with increased hepatocyte apoptosis and decreased pro-inflammatory cytokines in serum. Biomarkers previously associated with PFAS exposures and/or NAFLD were evaluated as secondary endpoints. Two hundred adult C8 Health Study participants were included. Measured serum biomarkers included: perfluorohexane sulfonate (PFHxS); perfluorooctanoic acid (PFOA); perfluorooctane sulfonate (PFOS); perfluorononanoic acid (PFNA); cytokeratin 18 M30 (CK18 M30, hepatocyte apoptosis); adipocytokines; insulin; and cleaved complement 3 (C3a). Confounder-adjusted linear regression models determined associations between PFAS and disease biomarkers with cut-offs determined by classification and regression tree analysis. CK18 M30 was positively associated with PFHxS (β = 0.889, p = 0.042); PFOA (β = 2.1, p = 0.005); and PFNA (β = 0.567, p = 0.03). Tumor necrosis factor α (TNF α) was inversely associated with PFHxS (β = -0.799, p = 0.001); PFOA (β = - 1.242, p = 0.001); and PFOS (β = -0.704, p < 0.001). Interleukin 8 was inversely associated with PFOS and PFNA. PFAAs were also associated with sexually dimorphic adipocytokine and C3a responses. Overall, PFAA exposures were associated with the novel combination of increased biomarkers of hepatocyte apoptosis and decreased serum TNF α. These data support previous findings from cohorts and experimental systems that PFAAs may cause liver injury while downregulated some aspects of the immune response. Further studies of PFAAs in NAFLD are warranted and should evaluate sex differences.adipocytokine and C3a responses. Overall, PFAA exposures were associated with the novel combination of increased biomarkers of hepatocyte apoptosis and decreased serum TNF α. These data support previous findings from cohorts and experimental systems that PFAAs may cause liver injury while downregulated some aspects of the immune response. Further studies of PFAAs in NAFLD are warranted and should evaluate sex differences.			1											1						B	D		
676	ヒト（肝毒性）	Rantakokko, P.; Männistö, V.; Airaksinen, R.; Koponen, J.; Viluksela, M.; Kiviranta, H.; Pihlajamäki, J.	Persistent organic pollutants and non-alcoholi	2015	Environ Health. 2015 Sep 29;14:79. doi: 10.1186/s12940-015-0066-z.	Background: In animal experiments persistent organic pollutants (POPs) cause hepatosteatosis. In epidemiological studies POPs have positive associations with serum markers of nonalcoholic fatty liver disease (NAFLD) and together with obesity synergistic association with insulin resistance. Because insulin resistance and obesity are critical in NAFLD pathogenesis, we investigated the association of serum pollutant levels with liver histology and alanine aminotransferase (ALT) in morbidly obese. Methods: Liver biopsies were from 161 participants of the Kuopio Obesity Surgery Study (KOBS) who underwent bariatric surgery 2005-2011. Liver histology was categorized as normal, steatosis and non-alcoholic steatohepatitis (NASH). Liver phenotype at baseline and ALT at baseline and 12 months post-surgery were correlated to serum POP concentrations at respective time points. As lipophilic POPs concentrate to smaller fat volume during weight loss, serum levels before and 12 months after bariatric surgery were compared. Results: Baseline serum concentration of PCB-118, β-HCH and several PFAAs had an inverse association with lobular inflammation possibly due to changes in bile acid metabolism. ALT had negative associations with many POPs at baseline that turned positive at 12 months after major clinical improvements. There was an interaction between some POPs and sex at 12 months, and in stratified data positive associations were observed mainly in females but not in males. Conclusions: We found a negative association between serum concentrations of PCB-118, β-HCH and several PFAAs with lobular inflammation at baseline. Positive POPs-ATL associations at 12 months among women suggest that increased POP concentrations may decrease the degree of liver recovery.			1	1										1						B	D		

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							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
677	ヒト（肝毒性）	Salihovic, S.; Stubleski, J.; Kärrman, A.; Larsson, A.; Fall, T.; Lind, L.; Lind, P. M.	Changes in markers of liver function in relation	2018	Environ Int. 2018 Aug;117:196-203. doi: 10.1016/j.envint.2018.04.052. Epub 2018 May 10.	Background: While it is known that perfluoroalkyl substances (PFASs) induce liver toxicity in experimental studies, the evidence of an association in humans is inconsistent. Objective: The main aim of the present study was to examine the association of PFAS concentrations and markers of liver function using panel data. Methods: We investigated 1002 individuals from Sweden (50% women) at ages 70, 75 and 80 in 2001-2014. Eight PFASs were measured in plasma using isotope dilution ultra-performance liquid chromatography/tandem mass spectrometry (UPLC-MS/MS). Bilirubin and hepatic enzymes alanine aminotransferase (ALT), alkaline phosphatase (ALP), and γ-glutamyltransferase (GGT) were determined in serum using an immunoassay methodology. Mixed-effects linear regression models were used to examine the relationship between the changes in markers of liver function and changes in PFAS levels. Results: The changes in majority of PFAS concentrations were positively associated with the changes in activity of ALT, ALP, and GGT and inversely associated with the changes in circulating bilirubin after adjustment for gender and the time-updated covariates LDL- and HDL-cholesterol, serum triglycerides, BMI, statin use, smoking, fasting glucose levels and correction for multiple testing. For example, changes in perfluorononanoic acid (PFNA) were associated with the changes liver function markers βBILIRUBIN = -1.56, 95% confidence interval (CI) -1.93 to -1.19, βALT = 0.04, 95% CI 0.03-0.06, and βALP = 0.11, 95% CI 0.06-0.15. Conclusion: Our longitudinal assessment established associations between changes in markers of liver function and changes in plasma PFAS concentrations. These findings suggest a relationship between low-dose background PFAS exposure and altered liver function in the general population.			1													1			B	B		
678	ヒト（腎毒性）	Wang, J.; Zeng, X. W.; Bloom, M. S.; Qian, Z.; Hinyard, L. J.; Belue, R.; Lin, S.; Wang, S. Q.; Tian, Y. P.; Yang, M.; Chu, C.; Gurram, N.; Hu, L. W.; Liu, K. K.; Yang, B. Y.; Feng, D.; Liu, R. Q.; Dong, G. H.	Renal function and isomers of perfluorooctano	2019	Chemosphere 218: 1042-1049. doi: 10.1016/j.chemosphere.2018.11.191.	Perfluoroalkyl substances (PFASs) are widely-utilized synthetic chemicals commonly found in industrial and consumer products. Previous studies have examined associations between PFASs and renal function, yet the results are mixed. Moreover, evidence on the associations of isomers of PFASs with renal function in population from high polluted areas is scant. To help to address this data gap, we used high performance liquid chromatography-mass spectrometry to measure serum isomers of perfluorooctanoate (PFOA), perfluorooctanesulfonate (PFOS), and other PFASs from 1612 adults residing in Shenyang, China, and characterized their associations with estimated glomerular filtration rate (eGFR) and chronic kidney disease (CKD). Results showed that after adjusted for multiple confounding factors, most of the higher fluorinated PFASs, except for PFOA and PFDA, were negatively associated with eGFR and positively associated with CKD. Compared with linear PFOS (n-PFOS), branched PFOS isomers (Br-PFOS) were more strongly associated with eGFR (Br-PFOS; β = -1.22, 95%CI: 2.02, -0.42; p = 0.003 vs. n-PFOS; β = -0.16, 95%CI: 0.98, 0.65; p = 0.691) and CKD (Br-PFOS; OR = 1.27; 0.95 CI: 1.02, 1.58; p = 0.037 vs. n-PFOS; OR = 0.98; 0.95 CI: 0.80, 1.20; p = 0.834). In conclusion, branched PFOS isomers were negatively associated with renal function whereas their linear counterparts were not. Given widespread exposure to PFASs, potential nephrotoxic effects are of great publichealth concern, Furthermore, longitudinal research on the potential nephrotoxic effects of PFASs isomers will be necessary to more definitively assess the risk.	1					1	1												B	B		
679	ヒト（腎毒性）	Watkins, D. J.; Josson, J.; Elston, B.; Bartell, S. M.; Shin, H. M.; Vieira, V. M.; Savitz, D. A.; Fletcher, T.; Wellenius, G. A.	Exposure to perfluoroalkyl acids and markers o	2013	Environ Health Perspect 121: 625630. doi: 10.1289/ehp.1205838.	Background: Serum levels of perfluorooctanoic acid (PFOA) have been associated with decreased renal function in cross-sectional analyses, but the direction of the association is unclear. Objectives: We examined the association of measured and model-predicted serum PFOA concentrations with estimated glomerular filtration rate (eGFR), a marker of kidney function, in a highly exposed population (median serum PFOA, 28.3 ng/mL). Methods: We measured serum creatinine, PFOA, perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS) and calculated eGFR in 9,660 children 1 to < 18 years of age at study enrollment. We predicted concurrent and historical serum PFOA concentrations using a validated environmental, exposure, and pharmacokinetic model based on individual residential histories, and used linear regression to estimate the association between eGFR and measured and predicted serum PFOA concentrations. We hypothesized that predicted serum PFOA levels would be less susceptible to reverse causation than measured levels. Results: An interquartile range increase in measured serum PFOA concentrations [IQR ln(PFOA) = 1.63] was associated with a decrease in eGFR of 0.75 mL/min/1.73 m(2) (95% CI: -1.41, -0.10; p = 0.02). Measured serum levels of PFOS, PFNA, and PFHxS were also cross-sectionally associated with decreased eGFR. In contrast, predicted serum PFOA concentrations at the time of enrollment were not associated with eGFR (-0.10; 95% CI: -0.80, 0.60; p = 0.78). Additionally, predicted serum PFOA levels at birth and during the first ten years of life were not related to eGFR. Conclusions: Our findings suggest that the cross-sectional association between eGFR and serum PFOA observed in this and prior studies may be a consequence of, rather than a cause of, decreased kidney function.	1		1			1								1		1			B	B		
680	ヒト（腎毒性）	Qin, X. D.; Qian, Z.; Vaughn, M. G.; Huang, J.; Ward, P.; Zeng, X. W.; Zhou, Y.; Zhu, Y.; Yuan, P.; Li, M.; Bai, Z.; Paul, G.; Hao, Y. T.; Chen, W.; Chen, P. C.; Dong, G. H.; Lee, Y. L.	Positive associations of serum perfluoroalkyl s	2016	Environ Pollut 212: 519-524. doi: 10.1016/j.envpol.2016.02.050	To investigate the risk of hyperuricemia in relation to Perfluoroalkyl substances (PFASs) in children from Taiwan, 225 Taiwanese children aged 12-15 years were recruited from 2009 to 2010 Linear and logistic regression models were employed to examine the influence of PFASs on serum uric acid levels. Findings revealed that eight of ten PFASs analyses were detected in >94% of the participants' serum samples. Multivariate linear regression models revealed that perfluorooctanic acid (PFOA) was positively associated with serum uric acid levels (β = 0.1463, p < 0.05). Of all the PFASs analyses, only PFOA showed a significant effect on elevated levels of hyperuricemia (aOR = 2.16, 95%CI: 1.29-3.61). When stratified by gender, the association between serum PFOA and uric acid levels was only evident among boys (aOR = 2.76, 95%CI: 1.37-5.56). In conclusion, PFOA was found to be associated with elevated serum levels of uric acid in Taiwanese children, especially boys. Further research is needed to elucidate these links.				1				1						1		1			B	B		
681	ヒト（腎毒性）	Kataria, A.; Trachtman, H.; Malaga-Dieguez, L.; Trasande, L.	Association between perfluoroalkyl acids and k	2015	Environ Health. 2015 Nov 21;14:89. doi: 10.1186/s12940-015-0077-9.	Background: Perfluoroalkyl acids are synthetic compounds widely used in industrial and commercial applications. Laboratory studies suggest that these persistent and bioaccumulative chemicals produce oxidant stress and damage glomerular endothelial cells, raising concern regarding the impact of these compounds on renal function. Methods: We performed cross-sectional analyses of data 1960 participants aged 12-19 years of the 2003-2010 National Health and Nutrition Examination Surveys. PFAA exposure was assessed using levels of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid, and perfluorohexane sulfonic acid. Primary study outcomes were estimated glomerular filtration rate (eGFR) and serum uric acid. Results: While adjusting for demographics, cotinine, prehypertension, insulin resistance, body mass index, and hypercholesterolemia, adolescents in the highest PFOA and PFOS quartile had a lower eGFR, 6.84 mL/min/1.73 m(2) (95% CI: 2.19 to 11.48) and 9.69 mL/min/1.73 m(2) (95 % CI: -4.59 to 14.78), respectively, compared to the lowest quartile. Highest PFOA and PFOS quartiles were also associated with 0.21 mg/dL (95% CI: 0.056 to 0.37) and 0.19 mg/dL (95% CI: 0.032 to 0.34) increases in uric acid, respectively. Conclusions: PFAAs are associated with a reduction in kidney function and increased uric acid levels in otherwise healthy adolescents. Reverse causation and residual confounding could explain the results. Our study results confirm and amplify previous findings, though longitudinal studies examining prenatal and childhood biomarkers in relationship with robust measures of childhood renal function are needed.				1											1		1			B	B		
682	ヒト（免疫毒性）	Grandjean, Philippe; Timmermann, Clara Amalie Gade; Kruse, Marie; Nielsen, Flemming; Vinholt, Pernille Just; Boding, Lasse; Heilmann, Carsten; Mølbak, Kåre	Severity of COVID-19 at elevated exposure to p	2020	PLoS One. 2020 Dec 31;15(12):e0244815. doi: 10.1371/journal.pone.0244815. eCollection 2020.	BACKGROUND: The course of coronavirus disease 2019 (COVID-19) seems to be aggravated by air pollution, and some industrial chemicals, such as the perfluorinated alkylate substances (PFASs), are immunotoxic and may contribute to an association with disease severity. METHODS: From Danish biobanks, we obtained plasma samples from 323 subjects aged 30-70 years with known SARS-CoV-2 infection. The PFAS concentrations measured at the background exposures included five PFASs known to be immunotoxic. Register data was obtained to classify disease status, other health information, and demographic variables. We used ordered logistic regression analyses to determine associations between PFAS concentrations and disease outcome. RESULTS: Plasma-PFAS concentrations were higher in males, in subjects with Western European background, and tended to increase with age, but were not associated with the presence of chronic disease. Of the study population, 108 (33%) had not been hospitalized, and of those hospitalized, 53 (16%) had been in intensive care or were deceased. Among the five PFASs considered, perfluorobutanoic acid (PFBA) showed an unadjusted odds ratio (OR) of 2.19 (95% confidence interval, CI, 1.39-3.46) for increasing severities of the disease. Among those hospitalized, the fully adjusted OR for getting into intensive care or expiring was 5.18 (1.29, 20.72) when based on plasma samples obtained at the time of diagnosis or up to one week before. CONCLUSIONS: Measures of individual exposures to immunotoxic PFASs included short-chain PFBA known to accumulate in the lungs. Elevated plasma-PFBAconcentrations were associated with an increased risk of a more severe course of COVID-19. Given the low background exposure levels in this study, the role of exposure to PFASs in COVID-19 needs to be ascertained in populations with elevated exposures.	1					1													B	D		
683	ヒト（免疫毒性）	Dong, G. H.; Tung, K. Y.; Tsai, C. H.; Liu, M. M.; Wang, D.; Liu, W.; Jin, Y. H.; Hsieh, W. S.; Lee, Y. L.; Chen, P. C.	Serum polyfluoroalkyl concentrations, asthma	2013	Environ Health Perspect 121: 507-513, 513e501-508. doi: 10.1289/ehp.1205351	Background: Perfluorinated compounds (PFCs) are ubiquitous pollutants. Experimental data suggest that they may be associated with adverse health outcomes, including asthma. However, there is little supporting epidemiological evidence. Methods: A total of 231 asthmatic children and 225 nonasthmatic controls, all from northern Taiwan, were recruited in the Genetic and Biomarkers study for Childhood Asthma. Structure questionnaires were administered by face-to-face interview. Serum concentrations of 11 PFCs and levels of immunological markers were also measured. Associations of PFC quartiles with concentrations of immunological markers and asthma outcomes were estimated using multivariable regression models. Results: Nine PFCs were detectable in most children (≥ 84.4%), of which perfluorooctane sulfonate (PFOS) was the most abundant (median serum concentrations of 33.9 ng/mL in asthmatics and 28.9 ng/mL in controls). Adjusted odds ratios for asthma among those with the highest versus lowest quartile of PFC exposure ranged from 1.81 (95% CI: 1.02, 3.23) for the perfluorododecanoic acid (PFDoA) to 4.05 (95% CI: 2.21, 7.42) for perfluorooctanic acid (PFOA). PFOS, PFOA, and subsets of the other PFCs were positively associated with serum IgE concentrations, absolute eosinophil counts (AEC), eosinophilic cationic protein (ECP) concentrations, and asthma severity scores among asthmatics. Conclusions: This study suggests an association between PFC exposure and juvenile asthma. Because of widespread exposure to these chemicals, these findings may be of potential public health concern.		1	1	1			1	1		1				1	1	1			B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
684	ヒト（免疫毒性）	Qin, X. D.; Qian, Z. M.; Dharmage, S. C.; Perret, J.; Geiger, S. D.; Rigdon, S. E.; Howard, S.; Zeng, X. W.; Hu, L. W.; Yang, B. Y.; Zhou, Y.; Li, M.; Xu, S. L.; Bao, W. W.; Zhang, Y. Z.; Yuan, P.; Wang, J.; Zhang, C.; Tian, Y. P.; Nian, M.; Xiao, X.; Chen, W.; Lee, Y. L.; Dong, G. H.	Association of perfluoroalkyl substances expos	2017	Environ Res. 2017 May;155:15-21. doi: 10.1016/j.envres.2017.01.025. Epub 2017 Feb 4.	Previous studies have demonstrated associations between serum levels of perfluoroalkyl substances (PFASs) and asthma or asthma related-biomarkers. However, no studies have reported a possible relationship between PFASs exposure and lung function among children. The objective of the present study is to test the association between PFASs exposure and lung function in children from a high exposure area by using a cross-sectional case-control study, which included 132 asthmatic children and 168 non-asthmatic controls recruited from 2009 to 2010 in the Genetic and Biomarkers study for Childhood Asthma. Structured questionnaires were administered face-to-face. Lung function was measured by spirometry. Linear regression models were used to examine the influence of PFASs on lung function. The results showed that asthmatics in our study had significantly higher serum PFAS concentrations than healthy controls. Logistic regression models showed a positive association between PFASs and asthma, with adjusted odds ratios (ORs) ranging from 0.99 (95% confidence interval [CI]: 0.80-1.21) to 2.76 (95% CI: 1.82-4.17). Linear regression modeling showed serum PFASs levels were significantly negatively associated with three pulmonary function measurements (forced vital capacity: FVC; forced expiratory volume in 1s: FEV1; forced expiratory flow 25-75%: FEF25-75) among children with asthma, the adjusted coefficients between lung function and PFASsexposure ranged from -0.055 (95%CI: -0.1 to -0.010) for FVC and perfluorooctane sulfonate (PFOS) to -0.223 (95%CI: -0.4 to -0.045) for FEF25-75 and perfluorooctanoic acid (PFOA). PFASs were not, however, significantly associated with pulmonary function among children without asthma. In conclusion, this study suggests that serum PFASs are associated with decreased lung function among children with asthma.		1					1	1							1		1				B	B		
685	ヒト（免疫毒性）	Chen, Q.; Huang, R.; Hua, L.; Guo, Y.; Huang, L.; Zhao, Y.; Wang, X.; Zhang, J.	Prenatal exposure to perfluoroalkyl and polyflu	2018	Environ Health 17: 1-12. doi: 10.1186/s12940-018-0352-7	Background: Perfluoroalkyl and polyfluoroalkyl substances (PFASs) have been reported to suppress immune function. However, previous studies on prenatal exposure to PFASs and allergic disorders in offspring provided inconsistent results. We aimed to examine the association between prenatal exposure to PFASs and childhood atopic dermatitis (AD) in offspring up to 24 months of age. Methods: A prospective birth cohort study involving 1056 pregnant women was conducted in two hospitals in Shanghai from 2012 to 2015. Prenatal information was collected by an interview with the women and from medical records. Fetal umbilical cord blood was collected at birth. Cord blood plasma PFASs were measured. Children were followed at 6, 12 and 24 months and information on the development of AD was recorded. AD was diagnosed by 2 dermatologists independently based on the questionnaires. Multiple logistic regression was used to compute odds ratio (OR) and corresponding 95% confidence interval (CI) for the association between AD and each PFASs, adjusting for potential confounders. Results: A total of 687 children completed a 2-year follow-up visit and had PFASs measurement. AD was diagnosed in 173 (25.2%) children during the first 24 months. In female children, a log-unit increase in perfluorooctanoic acid (PFOA) was associated with a 2.1-fold increase in AD risk (AOR 2.07, 95% CI 1.13-3.80) after adjusting for potential confounders. The corresponding risk was 2.22 (1.07-4.58) for perfluorononanoic acid (PFNA). The highest PFOA quartile was significantly associated with AD (2.52, 1.12-5.68) compared with the lowest quartile. The highest quartile of PFNA, perfluorodecanoic acid (PFDA) and perfluorohexane sulfonic acid (PFHxS) were associated with AD with AOR (95% CI) being 2.14 (0.97-4.74), 2.14 (1.00-4.57), and 2.30 (1.03-5.15), respectively. Additionally, the second quartile of perfluorododecanoic acid (PFDoA) was associated with a 3.2-fold increase in AD risk (3.24, 1.44-7.27). However, no significant associations were found in male children. Conclusions: Prenatal exposure to PFOA, PFDA, PFDoA and PFHxS significantly increased the risk of childhood AD in female children during the first 24 months of life. In addition, the associations between AD with prenatal exposure to PFNA were close to statistical significance.				1			1								1					1	B	A		
686	ヒト（免疫毒性）	Zhou, Y.; Bao, W. W.; Qian, Z. M.; Dee Geiger, S.; Parrish, K. L.; Yang, B. Y.; Lee, Y. L.; Dong, G. H.	Perfluoroalkyl substance exposure and urine C	2017	Environ Res 159: 158-163. doi: 10.1016/j.envres.2017.08.005	Background: Studies have reported an association between serum perfluoroalkyl substances (PFASs) and asthma. However, few studies have examined the possible associations between PFASs and the 16-kDa club cell secretory protein (Clara) (CC16) level, a prominent biomarker of asthma, among adolescents. Methods: We recruited a total of 231 asthmatic children and 225 non-asthmatic controls in the Genetic and Biomarkers study for Childhood Asthma (GBCA) in northern Taiwan from 2009 to 2010. Structured questionnaires were administered by face-to-face interview. Urine CC16 was determined by an enzyme-link immunoassay kit. Multiple general linear models were employed to examine the associations between PFASs and urinary CC16 levels. Results: Asthmatic participants had significantly higher serum PFAS concentrations overall than the healthy controls. After adjusting for confounding factors, urinary CC16 was significantly, negatively associated with PFASs, especially PFOS, PFOA, PFDA and PFNA, and especially among males, as follows: PFOS (β = -0.003, 95% confidence interval [CI]: -0.004, -0.002), PFOA (β = -0.045, 95% CI: -0.086, -0.004), and PFHxA (β = -0.310, 95% CI: -0.455, -0.165) among asthmatic boys, and PFDA (β = -0.126, 95%CI: -0.241, -0.012) and PFNA (β = -0.329, 95% CI: -0.526, -0.132) among non-asthmatic boys. Among girls, PFDA (β = -0.088, 95% CI: -0.172, -0.004), was the only PFAS significantly associated with CC16. Significant interaction effects ($p < 0.15$) on CC16 levels were found between asthma and PFOS, PFOA, PFBS and PFHxA in all participants. Conclusion: Our overall results showed that serum PFASs were significantly, inversely associated with CC16 levels. Associations were stronger among males.				1			1			1										B	B		
687	ヒト（免疫毒性）	Zhu, Y.; Qin, X. D.; Zeng, X. W.; Paul, G.; Morawska, L.; Su, M. W.; Tsai, C. H.; Wang, S. Q.; Lee, Y. L.; Dong, G. H.	Associations of serum perfluoroalkyl acid levels	2016	Sci Total Environ 559: 166-173. doi: 10.1016/j.scitotenv.2016.03.187	Perfluoroalkyl acids (PFAAs) are a group of common chemicals that ubiquitously exist in wildlife and humans. Experimental data suggest that they may alter T-lymphocyte functioning in situ by preferentially enhancing the development of T-helper 2 (TH2)- and inhibiting TH1-lymphocyte development and might increase allergic inflammation, but few human studies have been conducted. To evaluate the association between serum PFAAs concentrations and T-lymphocyte-related immunological markers of asthma in children, and further to assess whether gender modified this association, 231 asthmatic children and 225 non-asthmatic control children from Northern Taiwan were recruited into the Genetic and Biomarker study for Childhood Asthma. Serum concentrations of ten PFAAs and levels of TH1 [interferon (IFN)- γ, interleukin (IL)-2] and TH2 (IL-4 and IL-5) cytokines were measured. The results showed that asthmatics had significantly higher serum PFAAs concentrations compared with the healthy controls. When stratified by gender, a greater number of significant associations between PFAAs and asthma outcomes were found in males than in females. Among males, adjusted odds ratios for asthma among those with the highest versus lowest quartile of PFAAs exposure ranged from 2.59 (95% CI: 1.14, 5.87) for the perfluorobutanesulfonate (PFBS) to 4.38 (95% CI: 2.02, 9.50) for perfluorooctanesulfonate (PFOS); and serum PFAAs wereassociated positively with TH2 cytokines and inversely with TH1 cytokines among male asthmatics. Among females, no significant associations between PFAAs and TH2 cytokines could be detected. In conclusion, increased serum PFAAs levels may promote TH cell dysregulation and alter the availability of key TH1 and TH2 cytokines, ultimately contributing to the development of asthma that may differentially impact males to a greater degree than females. These results have potential relevance in asthma prevention.				1			1		1						1	1				B	B		
688	ヒト（免疫毒性）	Dalsager, L.; Christensen, N.; Husby, S.; Kyhl, H.; Nielsen, F.; Høst, A.; Grandjean, P.; Jensen, T. K.	Association between prenatal exposure to perf	2016	Environ Int. 2016 Nov;96:58-64. doi: 10.1016/j.envint.2016.08.026. Epub 2016 Sep 5.	Introduction: Perfluorinated alkylated substances (PFAS) are persistent industrial chemicals that have resulted in global environmental exposures. Previous epidemiological studies have reported possible effects on the immune system after developmental PFAS exposure, but the possible impact on childhood infectious disease is unclear. Objectives: To investigate the association between prenatal exposure to PFAS and symptoms of infections at age 1-4years. Methods: The Odense Child Cohort is an on-going prospective study on children's health, where serum concentrations of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), perfluorodecanoic acid (PFDA) and perfluorononanoic acid (PFNA) were measured in 649 pregnant women before gestational week 16. Of these women, 359 reported on symptoms of infection in their child every two weeks for a one-year period. The association between prenatal exposure to PFAS and the symptoms was estimated using a logistic regression model and a negative binomial regression model. For the latter, the outcome was reported as an incidence rate-ratio (IRR), and all models were adjusted for maternal age, educational level, parity and child age. Results: On average, the children experienced symptoms of infection 23% of the time during one year. PFOS exposure in the high tertile compared to the low tertile was associated with a statistically significant increased proportion of days with fever (IRR: 1.65 (95% CI: 1.24, 2.18), P-trend<0.001) and an increased odds of experiencing days with fever above the median (OR: 2.35 (95% CI: 1.31, 4.11). The latter tendency was also apparent for PFOA (OR: 1.97 (95% CI: 1.07, 3.62). Further, higher concentrations of PFOS and PFOA tended to increase the number of episodes of co-occurrence of fever and coughing and fever and nasal discharge during the one-year study period. Conclusion: We found a positive association between prenatal exposure to PFOS and PFOA and the prevalence of fever, which may be a sensitive marker of infection. This finding is in agreement with an immunotoxic effect of prenatal exposure to PFAS. The wider implications for childhood infectious disease deserve attention.				1					1						1		1			B	B		
689	ヒト（免疫毒性）	Granum, B.; Haug, L. S.; Namork, E.; Stølevik, S. B.; Thomsen, C.; Aaberge, I. S.; van Loveren, H.; Løvik, M.; Nygaard, U. C.	Pre-natal exposure to perfluoroalkyl substance	2013	J Immunotoxicol. 2013 Oct-Dec;10(4):373-9. doi: 10.3109/1547691X.2012.755580. Epub 2013 Jan 25.	Abstract Perfluoroalkyl substances (PFAS) are suggested to have immunosuppressive effects; exposure in utero and in the first years of life is of special concern as fetuses and small children are highly vulnerable to toxicant exposure. The objective of this study was to investigate the effect of pre-natal exposure to PFAS on responses to pediatric vaccines and immune-related health outcomes in children up to 3 years of age. In the prospective birth-cohort BraMat, a sub-cohort of the Norwegian Mother and Child Cohort Study (MoBa), pregnant women from Oslo and Akershus, Norway, were recruited during 2007-2008. Three annual questionnaire-based follow-ups were performed. Blood samples were collected from the mothers at the time of delivery and from the children at the age of 3 years. As a measure of pre-natal exposure to PFAS, the concentrations of perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS) were determined in maternal blood from 99 BraMat participants. Main outcome measures were anti-vaccine antibody levels, common infectious diseases and allergy- and asthma-related health outcomes in the children up to the age of 3 years. There was an inverse association between the level of anti-rubella antibodies in the children's serum at age 3 years and theconcentrations of the four PFAS. Furthermore, there was a positive association between the maternal concentrations of PFOA and PFNA and the number of episodes of common cold for the children, and between PFOA and PFHxS and the number of episodes of gastroenteritis. No associations were found between maternal PFAS concentrations and the allergy- and asthma-related health outcomes investigated. The results indicate that pre-natal exposure to PFAS may be associated with immunosuppression in early childhood.				1					1						1	1	1			B	D		
690	ヒト（免疫毒性）	Buser, M. C.; Scinicariello, F.	Perfluoroalkyl substances and food allergies in	2016	Environ Int. 2016 Mar;88:74-79. doi: 10.1016/j.envint.2015.12.020. Epub 2015 Dec 23.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are a class of organic compounds that are persistent in the environment due to their stable carbon-fluorine backbone, which is not susceptible to degradation. Research suggests these chemicals may exert an immunotoxic effect. The aim of this study is to investigate the associations between four PFASs - perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) - with food sensitization and food allergies in adolescent participants (ages 12-19years) in the National Health and Nutrition Examination Survey (NHANES) 2005-2006 and 2007-2010, respectively. We performed multivariate logistic regression to analyze the association between individual PFASs with food sensitization (defined as having at least 1 food-specific IgE level≥0.35kU/L) in NHANES 2005-2006 and food allergies (self-reported) in NHANES 2007-2010. Serum PFOA, PFOS, and PFHxS were statistically significantly associated with higher odds to have self-reported food allergies in NHANES 2007-2010. When using IgE levels as a marker of food sensitization, we found that serum PFNA was inversely associated with food sensitization (NHANES 2005-2006). In conclusion, we found that serum levels of PFASs were associated with higher odds to have self-reported food allergies. Conversely, adolescents with higher serum PFNA were less likely to be sensitizedto food allergens. These results, along with previous studies, warrant further investigation, such as well-designed longitudinal studies.				1											1	1				B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
691	ヒト（免疫毒性）	Goudarzi, H.; Miyashita, C.; Okada, E.; Kashino, I.; Kobayashi, S.; Chen, C. J.; Ito, S.; Araki, A.; Matsuura, H.; Ito, Y. M.; Kishi, R.	Effects of prenatal exposure to perfluoroalkyl a	2016	Environ Int. 2016 Sep;94:124-132. doi: 10.1016/j.envint.2016.05.020. Epub 2016 May 26.	Perfluoroalkyl acids (PFAAs) are ubiquitous chemicals extremely resistant and widespread throughout the environment, frequently being detected in human blood samples. Animal studies have revealed that exposure to PFAAs results in immunotoxicity. However, the association between PFAAs, especially long-chain PFAAs, and allergies in humans is not well established. We examined whether prenatal exposure to PFAAs is associated with allergic diseases among 4-year-old children in a large-scale prospective birth cohort in Hokkaido, Japan. In total, 1558 mother-child pairs were included in this study and prenatal levels of eleven PFAAs were measured in maternal plasma samples obtained between 28 and 32weeks of pregnancy by using ultra-performance liquid chromatography-tandem mass spectrometry. Participant demographic and characteristic information were obtained from self-administered pre- and postnatal questionnaires and medical birth records. Infant allergies were assessed using the Japanese version of the International Study of Asthma and Allergies in Childhood (ISAAC) Phase Three questionnaire, which was administered 4years post-delivery. Symptoms included eczema, wheezing and rhinoconjunctivitis with a prevalence of 19.0%, 18.7%, and 5.4%, respectively. Associations of PFAA quartiles with allergic outcomes were examined using logistic models. Adjusted odds ratios (ORs) in the 4th quartile vs. 1st quartile (Q4 vs. Q1) for total allergic diseases (including at least oneallergic outcome) significantly decreased for perfluorododecanoic acid (PFDoDa) (Q4 vs. Q1 OR: 0.621; 95 confidence interval (CI): 0.454, 0.847) and perfluorotridecanoic acid (PFTrDA) (Q4 vs. Q1 OR: 0.712; 0.95 CI: 0.524, 0.966) in all children. We obtained similar results when examining the association between PFAAs and eczema. The adjusted OR (Q4 vs. Q1) for wheezing in relation to higher maternal PFHxS levels was 0.728 (95% CI: 0.497, 1.06) in all children. In conclusion, prenatal exposure to long-chain PFAAs, such as PFDoDa and PFTrDA may have an immunosuppressive effect on allergic diseases in 4-year-old children.			1												1		1			1		B	A		
692	ヒト（免疫毒性）	Grandjean, Philippe; Andersen, Elisabeth Wreford; Budtz-Jø rgensen, Esben; Nielsen, Flemming; Mølbak, Kåre; Weihe, Pal; Heilmann, Carsten	Serum vaccine antibody concentrations in child	2012	JAMA. 2012 Jan 25;307(4):391-7. doi: 10.1001/jama.2011.2034.	CONTEXT: Perfluorinated compounds (PFCs) have emerged as important food contaminants. They cause immune suppression in a rodent model at serum concentrations similar to those occurring in the US population, but adverse health effects of PFC exposure are poorly understood. OBJECTIVE: To determine whether PFC exposure is associated with antibody response to childhood vaccinations. DESIGN, SETTING, AND PARTICIPANTS: Prospective study of a birth cohort from the National Hospital in the Faroe Islands. A total of 656 consecutive singleton births were recruited during 1997-2000, [corrected] and 587 participated in follow-up through 2008. MAIN OUTCOME MEASURES: Serum antibody concentrations against tetanus and diphtheria toxoids at ages 5 and 7 years. RESULTS: Similar to results of prior studies in the United States, the PFCs with the highest serum concentrations were perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Among PFCs in maternal pregnancy serum, PFOS showed the strongest negative correlations with antibody concentrations at age 5 years, for which a 2-fold greater concentration of exposure was associated with a difference of -39% (95% CI, -55% to -17%) in the diphtheria antibody concentration. PFCs in the child's serum at age 5 years showed uniformly negative associations with antibody levels, especially at age 7 years, except that the tetanus antibody level following PFOS exposure was not statistically significant. In a structural equation model, a 2-fold greater concentration of major PFCs in child serum was associated with a difference of -49% (95% CI, -67% to -23%) inthe overall antibody concentration. A 2-fold increase in PFOS and PFOA concentrations at age 5 years was associated with odds ratios between 2.38 (95% CI, 0.89 to 6.35) and 4.20 (95% CI, 1.54 to 11.44) for falling below a clinically protective level of 0.1 IU/mL for tetanus and diphtheria antibodies at age 7 years. CONCLUSION: Elevated exposures to PFCs were associated with reduced humoral immune response to routine childhood immunizations in children aged 5 and 7 years.			1												1		1					B	D		
693	ヒト（免疫毒性）	Grandjean, P.; Heilmann, C.; Weihe, P.; Nielsen, F.; Mogensen, U. B.; Budtz-Jø rgensen, E.	Serum vaccine antibody concentrations in ado	2017	Environ Health Perspect. 2017 Jul 26;125(7):077018. doi: 10.1289/E	Background: Postnatal exposure to perfluorinated alkylate substances (PFASs) is associated with lower serum concentrations of specific antibodies against certain childhood vaccines at 7 y. Objectives: We prospectively followed a Faroese birth cohort to determine these associations at 13 y. Methods: In 516 subjects (79% of eligible cohort members) who were 13 years old, serum concentrations of PFASs and of antibodies against diphtheria and tetanus were measured and were compared with data from the previous examination at 7 y. Multiple regression analyses and structural equation models were applied to determine the association between postnatal PFAS exposures and antibody concentrations. Results: Serum concentrations of PFASs and antibodies generally declined from 7 y to 13 y. However, 68 subjects had visited the emergency room and had likely received a vaccination booster, and a total of 202 children showed higher vaccine antibody concentrations at 13 y than at 7 y. Therefore, separate analyses were conducted after exclusion of these two subgroups. Diphtheria antibody concentrations decreased at elevated PFAS concentrations at 13 y and 7 y; the associations were statistically significant for perfluorodecanoate (PFDA) at 7 y and for perfluorooctanoate (PFOA) at 13 y, both suggesting a decrease by ~25% for each doubling of exposure. Structural equation models showed that a doubling in PFAS exposure at 7 y was associated with losses in diphtheria antibody concentrations at 13 y of 10–30% for the five PFASs. Few associations were observed for anti-tetanus concentrations. Conclusions: These results are in accord with previous findings of PFAS immunotoxicity at current exposure levels.			1												1		1					B	D		
694	ヒト（免疫毒性）	Humblet, Olivier; Diaz-Ramirez, Ledif Grisell; Balmes, John R; Pinney, Susan M; Hiatt, Robert A	Perfluoroalkyl chemicals and asthma among ch	2014	Environ Health Perspect. 2014 Oct;122(10):1129-33. doi: 10.1289/ehp.1306606. Epub 2014 Jun 6.	BACKGROUND: Perfluoroalkyl chemicals (PFCs) are a family of commonly used industrial chemicals whose persistence and ubiquity in human blood samples has led to concern about possible toxicity. Several animal studies and one recent human study have suggested a link between exposure to PFCs and asthma, although few epidemiologic studies have been conducted. OBJECTIVES: We investigated children's PFC serum concentrations and their associations with asthma-related outcomes. METHODS: We evaluated the association between serum concentrations of eight PFCs, including perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS), with self-reported lifetime asthma, recent wheezing, and current asthma using data from participants 12-19 years of age from the 1999-2000 and 2003-2008 National Health and Nutrition Examination Surveys. RESULTS: In multivariable-adjusted models, PFOA was associated with higher odds of ever having received a diagnosis of asthma [odds ratio (OR) = 1.18; 95% CI: 1.01, 1.39 for a doubling in PFOA], whereas for PFOS there were inverse relationships with both asthma and wheezing (OR = 0.88; 95% CI: 0.74, 1.04, and OR = 0.83; 95% CI: 0.67, 1.02, respectively). The associations were attenuated after accounting for sampling weights. No associations were seen between the other PFCs and any outcome. CONCLUSIONS: This cross-sectional study provides some evidence for associations between exposure to PFCs and asthma-related outcomes in children. The evidence is inconsistent, however, and prospective studies are needed.			1												1	1					B	B		
695	ヒト（免疫毒性）	Kielsen, Katrine; Shamim, Zaiba; Ryder, Lars P; Nielsen, Flemming; Grandjean, Philippe; Budtz-Jørgensen, Esben; Heilmann, Carsten	Antibody response to booster vaccination with	2016	J Immunotoxicol. 2016;13(2):270-3. doi: 10.3109/1547691X.2015.1067259. Epub 2015 Jul 16.	Recent studies suggest that exposure to perfluorinated alkylate substances (PFASs) may induce immunosuppression in humans and animal models. In this exploratory study, 12 healthy adult volunteers were recruited. With each subject, serum-PFAS concentrations were measured and their antibody responses prospectively followed for 30 days after a booster vaccination with diphtheria and tetanus. The results indicated that serum-PFAS concentrations were positively correlated and positively associated with age and male sex. The specific antibody concentrations in serum were increased from Day 4 to Day 10 post-booster, after which a constant concentration was reached. Serum PFAS concentrations showed significant negative associations with the rate of increase in the antibody responses. Interestingly, this effect was particularly strong for the longer-chain PFASs. All significant associations remained significant after adjustment for sex and age. Although the study involved a small number of subjects, these findings of a PFAS-associated reduction of the early humoral immune response to booster vaccination in healthy adults supported previous findings of PFAS immunosuppression in larger cohorts. Furthermore, the results suggested that cellular mechanisms right after antigen exposure should be investigated more closely to identify possible mechanisms of immunosuppression from PFAS.			1												1	1	1				B	D		
696	ヒト（免疫毒性）	Okada, Emiko; Sasaki, Seiko; Kashino, Ikuko; Matsuura, Hideyuki; Miyashita, Chihiro; Kobayashi, Sumitaka; Itoh, Kumiko; Ikeno, Tamiko; Tamakoshi, Akiko; Kishi, Reiko	Prenatal exposure to perfluoroalkyl acids and a	2014	Environ Int. 2014 Apr;65:127-34. doi: 10.1016/j.envint.2014.01.007. Epub 2014 Jan 29.	Perfluoroalkyl acids (PFAAs) are persistent organic pollutants that are detected in humans worldwide. Laboratory animal studies have shown that PFAAs are associated with immunotoxic effects. However, epidemiological studies investigating the role of PFAAs, in particular PFAAs with longer chains than perfluorooctanoic acid, are scarce. We investigated associations between prenatal exposure to PFAAs, including long-chain compounds, and infant allergic diseases at 12 and 24months in a large study population. The participants included mothers and their infants who enrolled in the Hokkaido Study on Environment and Children's Health 2003-2009. Eleven PFAAs were measured in maternal plasma taken at 28-32weeks of gestation using ultra-performance liquid chromatography coupled to triple quadrupole tandem mass spectrometry. Characteristics of participants and information on infant allergic diseases were obtained from self-administered questionnaires and medical records. At 24months, the adjusted odds ratio (OR) (first vs. fourth quartiles) for eczema in association with higher maternal perfluorotridecanoic acid (PFTrDA) levels was 0.62 (95% confidence interval (CI) 0.45, 0.86). After stratification by gender, the adjusted ORs in female infants from mothers with higher maternal perfluoroundecanoic acid (PFUnDA) and PFTrDA levels were also statistically significant (PFUnDA: OR=0.50; 95% CI, 0.30, 0.81; PFTrDA: OR=0.39; 95% CI, 0.23, 0.64). Our findings suggest that lower prenatal exposure to PFTrDA may decrease the risk of developing eczema in early childhood, only in female infants.			1												1	1	1				B	D		
697	ヒト（免疫毒性）	Stein, C. R.; Ge, Y.; Wolff, M. S.; Ye, X.; Calafat, A. M.; Kraus, T.; Moran, T. M.	Perfluoroalkyl substance serum concentrations	2016	Environ Res. 2016 Aug;149:171-178. doi: 10.1016/j.envres.2016.05.020. Epub 2016 May 18.	Perfluoroalkyl substances (PFAS) were shown to be immunotoxic in laboratory animals. There is some epidemiological evidence that PFAS exposure is inversely associated with vaccine-induced antibody concentration. We examined immune response to vaccination with FluMist intranasal live attenuated influenza vaccine in relation to four PFAS (perfluorooctanoate, perfluorononanoate, perfluorooctane sulfonate, perfluorohexane sulfonate) serum concentrations among 78 healthy adults vaccinated during the 2010-2011 influenza season. We measured anti-A H1N1 antibody response and cytokine and chemokine concentrations in serum pre-vaccination, 3 days post-vaccination, and 30 days post-vaccination. We measured cytokine, chemokine, and mucosal IgA concentration in nasal secretions 3 days post-vaccination and 30 days post-vaccination. Adults with higher PFAS concentrations were more likely to seroconvert after FluMist vaccination as compared to adults with lower PFAS concentrations. The associations, however, were imprecise and few participants seroconverted as measured either by hemagglutination inhibition -0.09 or immunohistochemical staining (25%). We observed no readily discernable or consistent pattern between PFAS concentration and baseline cytokine, chemokine, or mucosal IgA concentration, or between PFAS concentration and change in these immune markers between baseline and FluMist-response states. The results of this study do not support a reduced immune response to FluMist vaccination among healthy adults in relation to serum PFAS concentration.Given the study's many limitations, however, it does not rule out impaired vaccine response to other vaccines or vaccine components in either children or adults.			1												1	1	1				B	B		
698	ヒト（免疫毒性）	Stein, Cheryl R; McGovern, Kathleen J; Pajak, Ashley M; Maglione, Paul J; Wolff, Mary S	Perfluoroalkyl and polyfluoroalkyl substances a	2016	Pediatr Res. 2016 Feb;79(2):348-57. doi: 10.1038/pr.2015.213. Epub 2015 Oct 22.	BACKGROUND: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are immunotoxic in laboratory studies. Human studies of immune effects are inconsistent. Using the US National Health and Nutrition Examination Survey (NHANES), we examined PFAS serum concentration and indicators of prevalent immune function among 12-19-y-old children. METHODS: In this cross-sectional study, we examined PFAS serum concentration in relation to measles, mumps, and rubella antibody concentrations in NHANES 1999-2000 and 2003-2004 (n = 1,191) and to allergic conditions and allergic sensitization in NHANES 2005-2006 (n = 640). RESULTS: In adjusted, survey-weighted models, a doubling of perfluorooctane sulfonate (PFOS) concentration among seropositive children was associated with a 13.3% (95% confidence interval (CI): -19.9, -6.2) decrease in rubella antibody concentration and a 5.9% decrease in mumps antibody concentration (95% CI: -9.9, -1.6). We observed no adverse association between exposure and current allergic conditions, including asthma. Children with higher PFOS concentration were less likely to be sensitized to any allergen (odds ratio (OR): 0.74; 95% CI: 0.58, 0.95). CONCLUSION: Increased exposure to several PFAS was associated with lower levels to mumps and rubella antibody concentrations, especially among seropositive individuals. These lower antibody concentrations may indicate a less robust response to vaccination or greater waning of vaccine-derived immunity over time.			1												1	1	1				B	D		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
699	ヒト（免疫毒性）	Wang, I-Jen; Hsieh, Wu-Shiun; Chen, Chia-Yang; Fletcher, Tony; Lien, Guang-Wen; Chiang, Hung-Lung; Chiang, Chow-Feng; Wu, Trong-Neng; Chen, Pau-Chung	The effect of prenatal perfluorinated chemicals	2011	Environ Res. 2011 Aug;111(6):785-91. doi: 10.1016/j.envres.2011.04.006. Epub 2011 May 23.	BACKGROUND: The role of perfluorinated compounds (PFCs) in the immune system and allergic diseases is not well-known. This study examined the effects of pre-natal exposure to PFCs on immunoglobulin E (IgE) levels and atopic dermatitis (AD). METHODS: In Taiwan Birth Panel cohort study, newborns with cord blood and peri-natal factors (i.e. birth body weight, weeks of gestation, and type of delivery) gathered at birth were evaluated. At the age of 2 years, information on the development of AD, environmental exposures, and serum total IgE were collected. The AD and non-AD children were compared for the concentration of cord blood serum PFCs measured by Ultra-performance liquid chromatography/triple-quadrupole mass (UPLC-MS/MS). Correlations among cord blood IgE, serum total IgE at 2 years of age, and cord blood PFC levels were made. RESULTS: Of 244 children who completed the follow-up and specimen collections, 43 (17.6%) developed AD. Concentrations of cord blood serum perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) were median (range) 1.71 (0.75-17.40), 5.50 (0.11-48.36), 2.30 (0.38-63.87), and 0.035 (0.035-0.420)ng/mL, respectively. PFOA and PFOS levels positively correlated with cord blood IgE levels (per ln-unit: β=0.134 KU/l, p=0.047 for PFOA; β=0.161 KU/l, p=0.017 for PFOS). Analyses stratified by gender revealed that PFOA and PFOS levels positively correlated with cord blood IgE levels only in boys (per ln-unit: β=0.206 KU/l, p=0.025 for PFOA; β=0.175 KU/l, p=0.053 for PFOS). When dividing cord blood serum PFCs intoquartiles in the fully adjusted models, AD had no significant association with PFOS. CONCLUSIONS: Pre-natal PFOA and PFOS exposures positively correlated with cord blood IgE levels.			1													1		1			B	D		
700	ヒト（免疫毒性）	Abraham, K.; Mielke, H.; Fromme, H.; Völkel, W.; Menzel, J.; Peiser, M.; Zepp, F.; Willich, S. N.; Weikert, C.	Internal exposure to perfluoroalkyl substances	2020	Arch Toxicol. 2020 Jun;94(6):2131-2147. doi: 10.1007/s00204-020-02715-4. Epub 2020 Mar 29.	Perfluoroalkyl substances (PFASs) are a complex group of man-made chemicals with high stability and mobility leading to ubiquitous environmental contamination and accumulation in the food chain. In human serum/plasma samples, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are the lead compounds. They are immunotoxic in experimental animals, and epidemiological studies provided evidence of a diminished production of vaccine antibodies in young children. However, information on children of the first year of age is missing but relevant, as they have a relatively high exposure if breastfed, and may have a higher susceptibility as their immune system is developing. In a cross-sectional study with 101 healthy 1-year-old children, internal levels of persistent organic pollutants and a broad panel of biological parameters were investigated at the end of the 1990s. Additional analysis of PFASs resulted in plasma levels (mean ± SD) of PFOA and PFOS of 3.8 ± 1.1 and 6.8 ± 3.4 µg/L, respectively, in the 21 formula-fed children, and of 16.8 ± 6.6 and 15.2 ± 6.9 µg/L in the 80 children exclusively breastfed for at least 4 months. The study revealed significant associations between levels of PFOA, but not of PFOS, and adjusted levels of vaccine antibodies against Haemophilus influenza type b (Hib, r = 0.32), tetanus (r = 0.25) and diphtheria (r = 0.23), with no observed adverse effectconcentrations (NOAECs) determined by fitting a knee' function of 12.2, 16.9 and 16.2 µg/L, respectively. The effect size (means for PFOA quintiles Q1 vs. Q5) was quantified to be - 86, - 54 and - 53%, respectively. Furthermore, levels of PFOA were inversely associated with the interferon gamma (IFNγ) production of ex-vivo lymphocytes after stimulation with tetanus and diphtheria toxoid, with an effect size of - 64 and - 59% (means Q1 vs. Q5), respectively. The study revealed no influence of PFOA and PFOS on infections during the first year of life and on levels of cholesterol. Our results confirmed the negative associations of PFAS levels and parameters of immune response observed in other epidemiological studies, with high consistency as well as comparable NOAECs and effects sizes for the three vaccine antibodies investigated, but for PFOA only. Due to reduction of background levels of PFASs during the last 20 years, children in Germany nowadays breastfed for a long duration are for the most part not expected to reach PFOA levels at the end of the breastfeeding period above the NOAECs determined.		1	1	1												1		1	HBGV設定根拠	1	-	-		
701	ヒト（免疫毒性）	Ait Bamai, Y.; Goudarzi, H.; Araki, A.; Okada, E.; Kashino, I.; Miyashita, C.; Kishi, R.	Effect of prenatal exposure to per- and polyflu	2020	Environ Int. 2020 Oct;143:105979. doi: 10.1016/j.envint.2020.105979. Epub 2020 Jul 24.	Per- and polyfluoroalkyl substances (PFAS) are widely used bio-accumulative chemicals in many industrial and household products. Experimental studies reported that exposure to PFAS results in immunotoxicity. We have previously reported that prenatal exposure to PFAS decreased the risk of allergies, while it increased the risk of infectious diseases at ages 2 and 4 years. However, it remains unclear whether the adverse effects of PFAS on allergies and infectious diseases continue until a reliable age of diagnosing allergies. This study aimed at investigating the effects of prenatal exposure to PFAS on the prevalence of allergies and infectious diseases in children up to age 7, from the Hokkaido Study. Among mother-child pairs enrolled in the Hokkaido study and followed up until the age of 7 years, 2689 participants with maternal PFAS, 1st trimester of pregnancy and 7-year-old questionnaire survey data were included in this study. Eleven PFAS in the 3rd-trimester plasma were measured using ultra-performance liquid chromatography coupled to triple quadrupole tandem mass spectrometry. Wheeze, rhino-conjunctivitis, and eczema were defined using the International Study of Asthma and Allergies on Childhood (ISAAC) questionnaire. History childhood infectious diseases diagnosed by a doctor was assessed by a mother-reported questionnaire at child's age 7 The relative risk ofchildhood allergies was calculated by generalized estimating equation models. The odds ratio of an episode of infectious diseases was calculated by logistic regression analysis, adjusted for potential confounders. The prevalence of various allergies and infectious diseases was: wheeze, 11.9%; rhino-conjunctivitis, 11.3%; eczema, 21.0%; chickenpox, 61.5%; otitis media, 55.7%; pneumonia, 30.6%; and respiratory syncytial virus infection, 16.8%. Prenatal exposure to perfluorooctanoic acid, perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) was inversely associated with rhino-conjunctivitis, while that for perfluorooctanoate (PFOA), perfluorooctane sulfonate, PFUnDA, perfluorododecanoic acid (PFDoDA), and perfluorotridecanoic acid was inversely associated with eczema. For infectious diseases, PFDA and PFDoDA were associated with increased risk of pneumonia and PFOA was associated with increased risk of RSV infection among children not having any siblings (only-one-child). Our results corroborate the hypothesis on immunosuppressive and immunomodulating effects of PFAS on allergies and infectious diseases in children. These effects observed previously at 2 and 4 years continued until the age of 7 years. However, additional studies assessing inflammatory biomarkers along with ISAAC questionnaires, doctor-diagnosed allergies, and longer follow-ups are necessary to better assess the effects of exposure to chemicals on human immune outcomes.			1	1													1			1	B	A		
702	ヒト（免疫毒性）	Dalsager, L.; Christensen, N.; Halekoh, U.; Timmermann, C. A. G.; Nielsen, F.; Kyhl, H. B.; Husby, S.; Grandjean, P.; Jensen, T. K.; Andersen, H. R.	Exposure to perfluoroalkyl substances during f	2021	Environ Int. 2021 Apr;149:106395. doi: 10.1016/j.envint.2021.106395. Epub 2021 Jan 25.	Introduction: The immunosuppressive properties of PFASs are widely recognized. Early-life exposure to PFAS has been linked to reduced immune response to childhood vaccinations and increased rates of common infectious diseases, but implications for hospitalizations are unclear. Objectives: To investigate the association between maternal serum concentrations of five PFASs during pregnancy and the child's rate of hospitalization due to common infectious diseases between birth and 4 years of age. Methods: Serum samples from first trimester pregnant women from the Odense Child Cohort (OCC) collected in 2010-2012 were analyzed for concentrations of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and three other PFASs. Data on child hospitalizations with an ICD-10 code for infectious disease was obtained from the Danish National Patient Register. The following were identified: upper respiratory tract infections (URTI), lower respiratory tract infections (LRTI), gastrointestinal infections (GI), and other infections. The Andersen-Gill Cox proportional hazard model for recurrent events was used to investigate the association between PFAS exposure and hospitalizations. The resulting estimates were hazard ratios (HRs), which express the relative change in the instantaneous risk of hospitalization with a doubling in maternal PFAS concentration. Results: A total of 1,503 mother-child pairs were included, and 26% of the children were hospitalized at least once for infectious disease. A doubling in maternal PFOS concentration was associated with a 23% increase in the risk of hospitalization due to any infection (HR: 1.23 (95% CI: 1.05, 1.44). There was indication of an interaction between child sex and PFOS (p = 0.07) and PFDA (p = 0.06), although in opposite directions. Further, every doubling of PFOA or PFOS increased the risk of LRTI by 27% (HR: 1.27 (1.01, 1.59)) and 54% (HR: 1.54 (1.11, 2.15)), respectively. Similar tendencies were seen for URTI and the group of other infections. For GIs, the opposite pattern of association was seen as HR's were consistently below 1 (PFOA, HR: 0.55 (0.32, 0.95)). Discussion: We found an association between PFOS and the overall risk of infectious disease, and between PFOS and PFOA exposures and the risk of LRTI's. These results are in agreement with previous findings from the OCC, in which maternal PFOS and PFOA concentrations were positively associated with the number of days that the children experienced fever, thereby suggesting that PFOS and PFOA may affect the prevalence of both mild and more severe infectious diseases even in a rather low-exposed population.			1													1				B	B		
703	ヒト（免疫毒性）	Grandjean, P.	Serum vaccine antibody concentrations in chil	2012	JAMA. 2012 Jan 25; 307(4): 391–397. doi: 10.1001/jama.2011.2034	Context Perfluorinated compounds (PFCs) have emerged as important food contaminants. They cause immune suppression in a rodent model at serum concentrations similar to those occurring in the US population, but adverse health effects of PFC exposure are poorly understood. Objective To determine whether PFC exposure is associated with antibody response to childhood vaccinations. Design, Setting, and Participants Prospective study of a birth cohort from the National Hospital in the Faroe Islands. A total of 656 consecutive singleton births were recruited during 1997-2000, and 587 participated in follow-up through 2008. Main Outcome Measures Serum antibody concentrations against tetanus and diphtheria toxoids at ages 5 and 7 years. Results Similar to results of prior studies in the United States, the PFCs with the highest serum concentrations were perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Among PFCs in maternal pregnancy serum, PFOS showed the strongest negative correlations with antibody concentrations at age 5 years, for which a 2-fold greater concentration of exposure was associated with a difference of −39% (95% CI, −55% to −17%) in the diphtheria antibody concentration. PFCs in the child's serum at age 5 years showed uniformly negative associations with antibody levels, especially at age 7 years, except that the tetanus antibody level following PFOS exposure was not statistically significant. In a structural equation model, a 2-fold greater concentration of major PFCs in child serum was associated with a difference of −49% (95% CI, −67% to −23%) in the overall antibody concentration. A 2-fold increase in PFOS and PFOA concentrations at age 5 years was associated with odds ratios between 2.38 (95% CI, 0.89 to 6.35) and 4.20 (95% CI, 1.54 to 11.44) for falling below a clinically protective level of 0.1 IU/mL for tetanus and diphtheria antibodies at age 7 years.			1													1		No. 692と重複		B	D		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
704	ヒト（免疫毒性）	Huang, H.; Yu, K.; Zeng, X.; Chen, Q.; Liu, Q.; Zhao, Y.; Zhang, J.; Zhang, X.; Huang, L.	Association between prenatal exposure to perf	2020	Environ Res. 2020 Dec;191:110156. doi: 10.1016/j.envres.2020.110156. Epub 2020 Aug 30.	Background: Prenatal exposure to perfluoroalkyl substances (PFAS) is considered to affect adversely the immune function. However, the effect of prenatal PFAS exposure on respiratory tract infections (RTIs) in children is unclear. Thus, we evaluated whether cord blood PFAS levels were associated with RTI in the first 5 years of life. Methods: The Shanghai Prenatal Cohort is an on-going birth cohort, which included all the mothers during pregnancy. Children were followed by paediatricians once a year after birth. The levels of 10 PFAS in cord blood were tested using liquid chromatography-mass spectrometry. RTIs were diagnosed based on face-to-face interviews with the parents and review of medical records. Immunoglobulin G (IgG) and immunoglobulin E (IgE) levels, as biomarkers of humoral immunity, were assessed using enzyme-linked immunosorbent assay at age 5 years. Multivariable logistic and linear regression models were applied to study the association between prenatal PFAS exposure and RTIs. Results: A total of 743 children completed the follow-up, 344 of them had detail information of cord blood PFAS, IgG, and IgE concentrations. Eight PFAS were detected in more than 90% of the cord blood samples, except for perfluoroheptanoic acid (PFHpA) and perfluorooctane sulfonamide (FOSA). During the 5-year follow-up period, the frequency of RTIs increased with age, reaching a peak at age 4. Moreover, 20.6% of the children were diagnosed with recurrent RTIs. Children with recurrent RTIs had higher prenatal perfluorobutane sulfonic acid (PFBS) concentration. Higher prenatal PFBS concentration was positively associated with total RTI frequency (β = 6.05, 95% CI [0.84, 11.26]) in first 5 years of life and negatively associated with IgG level (β = -0.82, 95% CI [-1.67, -0.01]) at age 5. Conclusions: Children with higher prenatal PFBS were more vulnerable to RTIs in early life, which may be attributed to immunosuppression of IgG production. These findings need to be further verified in larger prospective studies.			1	1													1				B	B		
705	ヒト（免疫毒性）	Impinen, A.; Longnecker, M. P.; Nygaard, U. C.; London, S. J.; Ferguson, K. K.; Haug, L. S.; Granum, B.	Maternal levels of perfluoroalkyl substances (F	2019	Environ Int. 2019 Mar;124:462-472. doi: 10.1016/j.envint.2018.12.041. Epub 2019 Jan 23.	Introduction: Prenatal exposure to perfluoroalkyl substances (PFASs) has been inconsistently associated with asthma and allergic diseases and increased number of infections in early childhood. We examined the association of PFASs measured in pregnancy with childhood asthma, allergies and common infectious diseases in a prospective pregnancy cohort followed to age 7 years. Material and methods: Six PFASs (out of 19 measured) with at least 80% of measurements above the limit of quantification (LOQ) in maternal plasma during pregnancy in two subcohorts of the Norwegian Mother and Child Cohort Study (MoBa) were analyzed in relation to health outcomes: perfluorooctane sulfonic acid (PFOS), acid (PFOA), perfluorohexane sulfonic acid (PFHxS), perfluorononanoic acid (PFNA), perfluoroundecanoic acid (PFUnDA), and perfluoroheptane sulfonic acid (PFHpS). Follow-up questionnaires were completed at 3 years by 1270 women and at 7 years by 972 women among the 1943 with pregnancy questionnaire and PFAS measures. Health outcomes included parent reports of child's symptoms or doctor diagnosed asthma and allergic conditions at age 7 years and parent-reported frequency of various infections at 3 and 7 years of age. Logistic and Poisson regression were used. The false discovery rate was controlled at 5%. Sensitivity analyses on gender were performed. Results: Among the allergy and asthma outcomes, a statistically significant inverse association was seen between PFUnDA concentrations and ever having atopic eczema in girls. PFUnDA also tended to be inversely associated with both wheeze and asthma. For infections from 0 to 3 and 6 to 7 years, 11 significant positive associations were seen between PFASs and airways infections (bronchitis/pneumonia, throat infection, pseudocroup), ear infection and gastric flu/diarrhea; whereas 6 inverse associations were seen for pseudocroup, ear infections and urinary tract infections. The majority of the findings with respect to infectious diseases were found in girls only. Discussion: With the exception of an inverse association between PFUnDA and eczema, and a tendency of a similar association for wheeze and asthma, maternal PFAS levels during pregnancy showed little association with asthma or allergy related outcomes. Findings from the present study suggest immunosuppressive effects of PFASs on airways infections, such as bronchitis/pneumonia and throat infections, as well as diarrhea/gastric flu. Our results indicate a possible role of gender in the PFAS-health outcome associations.			1														1	1			B	B		
706	ヒト（免疫毒性）	Kvalem, H. E.; Nygaard, U. C.; Lødrup Carlsen, K. C.; Carlsen, K. H.; Haug, L. S.; Granum, B.	Perfluoroalkyl substances, airways infections, a	2020	Environ Int. 2020 Jan;134:105259. doi: 10.1016/j.envint.2019.105259. Epub 2019 Nov 13.	Introduction: Exposure to perfluoroalkyl substances (PFASs) has been inconsistently associated with asthma, allergic diseases and airways infections in early childhood. The aim of the study was, therefore, to investigate the effect of childhood exposure to PFASs on asthma and allergy related outcomes and on airways infections before and during puberty using the prospective birth cohort Environment and Childhood Asthma (ECA) Study. Aspects of gender, exposure period and study design (cross-sectional and longitudinal) were also taken into consideration. Material and methods: Included in the study was 378 participants with PFAS measurements at age 10 years and follow-up data at ages 10 years (cross sectional data) and 16 years (longitudinal data). Eight PFASs with at least 70% of measurements above the limit of quantification (LOQ) in the child's serum were included in the present study: perfluoroheptanoate (PFHpA), perfluorooctanoate (PFOA), perfluorononanoate (PFNA), perfluorodecanoate (PFDA), perfluoroundecanoate (PFUnDA), perfluorohexane sulfonate (PFHxS), perfluoroheptane sulfonate (PFHpS) and perfluorooctane sulfonate (PFOS). The PFAS levels were converted into interquartile range (IQR). In addition, perfluorooctane sulfonamide (PFOSA) detected in 60% of the samples, was recoded into "not detected /detected". Binomial, multinomial and linear regression were used, followed by Bonferroni adjustment to correct for multiple comparisons. Sensitivity analyses evaluating the effect of extreme PFAS values and gender were performed. Results: In the cross sectional data at 10 years a positive statistically significant association was seen between PFHpA and asthma in girls. In the longitudinal data, PFNA, PFDA and PFUnDA were inversely associated with atopic dermatitis (AD) in girls and with PFHxS in all participants and in boys. Further, PFNA and PFHpS were positively associated with rhinitis in girls and with PFOA in all participants. There seems to be a suggestive pattern of increased risk of allergic sensitisation in all participants and a decreased risk in boys, but due to different results in main and sensitivity analyses these findings should be interpreted with caution. No associations were found between PFASs and lung function. For airways infections and longitudinal data, PFDA was inversely associated with common cold, while positive association was found for PFHpA, PFOA, PFHpS and PFOS and lower respiratory tract infections (LRTI). Discussion and conclusion: Our results lend further support for an immunosuppressive effect of PFASs on AD and LRTI. Gender seems to be important for some exposure-health associations. No clear pattern in exposure-health associations was observed with regard to exposure period or study design, with the exception of asthma where significant findings have mostly been reported in cross-sectional studies.			1														1			1	B	A		
707	ヒト（免疫毒性）	Timmermann, C. A. G.; Jensen, K. J.; Nielsen, F.; Budtz-Jørgensen, E.; van Der Klis, F.; Benn, C. S.; Grandjean, P.; Fisker, A. B.	Serum Perfluoroalkyl Substances, Vaccine Res	2020	Environ Health Perspect. 2020 Aug;128(8):87002. doi: 10.1289/EHP6517. Epub 2020 Aug 10.	Background: Perfluoroalkyl substances (PFAS) are a group of widely used persistent chemicals with suspected immunotoxic effects. Objectives: The present study aimed to examine the association between infant PFAS exposure and antibody responses to measles vaccination as well as morbidity in a low-income country. Methods: In a randomized controlled trial, children from Guinea-Bissau, West Africa, were followed from inclusion (4-7 months of age) through 2 years of age. Half the children received two measles vaccinations (at inclusion and at 9 months of age), and the other half received only one (at 9 months of age). In a subset of 237 children, six PFAS were quantified in serum at inclusion, and measles antibody concentrations were assessed at inclusion and at approximately 9 months and 2 years of age. At inclusion and at the 9-month visit, mothers were interviewed about infant morbidity. Results: All but one child had detectable serum concentrations of all six PFAS, although levels were lower than seen elsewhere. A doubling in perfluorooctane sulfonic acid (PFOS) and perfluorodecanoic acid (PFDA) were associated with 21% (95% CI: 2, 37%) and 25% (95% CI: 1, 43%), respectively, lower measles antibody concentrations at the 9-month visit among the children who had received a measles vaccine at inclusion. Elevated serum PFAS concentrations were also associated with reduced prevaccination measles antibody concentrations and increased morbidity. Discussion: The present study documents that PFAS exposure has reached West Africa and that infants show PFAS-associated increases in morbidity and decreases in measles-specific antibody concentrations before and after vaccination. These findings support the evidence on PFAS immunotoxicity at comparatively low serum concentrations.			1														1			1	B	A		
708	ヒト（免疫毒性）	Zeng X-W, Bloom MS, Dharmage SC, Lodge CJ, Chen D, Li S, Guo Y, Roponen M, Jalava P, Hirvonen M-R, Ma H, Hao Y-T, Chen W, Fu C and Dong G-H.	Prenatal exposure to perfluoroalkyl substances	2019	Sci Total Environ. 2019 May 1:663:60-67. doi: 10.1016/j.scitotenv.2019.01.325. Epub 2019 Jan 26.	Background: Perfluoroalkyl substances (PFASs) are synthetic chemicals widely used in industry and for commercial products. Their immunomodulatory effects are a growing health concern in children. Hand, Foot and Mouth Disease (HFMD) is a common childhood viral infection, and increased incidence of which has parallel the rise in PFAS exposure in the Asia-Pacific region. Objective: We conducted the first study to assess whether prenatal exposure to PFAS was associated with a reduction in HFMD virus antibodies in infants. Methods: We enrolled 201 mother-infant pairs from the Guangzhou Birth Cohort Study from July to October 2013. High performance liquid chromatography-mass spectrometry was employed to determine concentrations of specific PFAS isomers in cord blood. Neutralizing antibodies titers were measured against two HFMD viruses, enterovirus 71 (EV71) and coxsackievirus A 16 (CA16), in cord blood serum and blood serum at three months of age. Results: Higher umbilical cord blood PFAS concentrations were associated with lower EV71 and CA16 antibody concentrations. A doubling in the composite sum of cord blood PFASs in three month old infants was associated with significant increase in the risk of HFMD antibody concentration below clinical protection level (≥1:8 titers) for CA16 (odds ratio, OR: 2.74 [95% confidence interval (CI): 1.33, 5.61] and for EV71 (OR = 4.55, 95% CI: 1.45, 4.28). This association was higher in boys at three months of age for CA16. Conclusions: Our findings suggest that cord blood PFAS exposure is associated with lower HFMD antibody in infancy. Given the widespread nature of PFAS exposures and the high global incidence of HFMD globally, these findings have substantial public health implications and therefore, these associations need to be replicated in a larger study to more definitively address the risk.																	1				B	D		
709	ヒト（免疫毒性）	Budtz-Jørgensen, E.; Grandjean, P.	Application of benchmark analysis for mixed co	2018	PLoS ONE. 2018 Oct 19;13(10):e0205388. doi: 10.1371/journal.pone.0205388. eCollection 2018.	Background: Developmental exposure to perfluorinated alkylate substances (PFASs) is associated with deficient IgG antibody responses to childhood vaccines. As this immunotoxicity outcome may represent a critical effect, calculation of benchmark dose (BMD) results would be useful for defining protective limits of exposure. However, exposures to the major PFASs that are associated with this adverse effect are interrelated, and mutually adjusted BMD results would be desirable. Methods: We carried out BMD calculations on prospective data from two prospective birth cohort studies from the Faroe Islands with a total of 1,146 children. Exposure data included serum concentrations of five major PFASs at birth and at age 5 years and, as outcome parameters, the serum concentrations of specific IgG antibodies against tetanus and diphtheria at ages 5 and 7. We calculated the BMDs and their lower confidence bounds (BMDLs) and included mutual adjustment for five major PFASs. BMD and BMDL were expressed in terms of the serum concentration of the PFASs. Results: The BMDLs for the immunotoxicants were of similar magnitude before and after adjustment. As compared to linear dose-response models, the PFASs showed lower results for a piecewise linear model, which also provided a slightly better fit. Weaker associations with the antibody outcomes were observed after adjustments due to the correlation between the PFASs. However, while the adjustments resulted in elevated BMD results and p values, the BMDL values were not materially changed. Conclusions: Adjustment for co-exposure to a related immunotoxicant increased both the BMD values and their standard errors, though affected the BMDL values only to a negligible extent. Thus, when correlated toxicants appear to affect the same outcome and none of them is known a priori to be solely responsible, all exposures may be considered responsible in BMD calculations. Our BMDL results, both before and after adjustment are generally below current exposure levels and therefore suggest that all five perfluorinated substances should attract regulatory attention, at least until additional evidence shows otherwise.			1														1				B	B		

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
710	ヒト（免疫毒性）	Grandjean, P.; Heilmann, C.; Weihe, P.; Nielsen, F.; Mogensen, U. B.; Timmermann, A.; Budtz-Jørgensen, E.	Estimated exposures to perfluorinated compou	2017	J Immunotoxicol. 2017 Dec;14(1):188-195. doi: 10.1080/1547691X.2017.1360968.	Perfluorinated alkylate substances (PFASs) are highly persistent and may cause immunotoxic effects. PFAS-associated attenuated antibody responses to childhood vaccines may be affected by PFAS exposures during infancy, where breastfeeding adds to PFAS exposures. Of 490 members of a Faroese birth cohort, 275 and 349 participated in clinical examinations and provided blood samples at ages 18 months and 5 years. PFAS concentrations were measured at birth and at the clinical examinations. Using information on duration of breastfeeding, serum-PFAS concentration profiles during infancy were estimated. As outcomes, serum concentrations of antibodies against tetanus and diphtheria vaccines were determined at age 5 Data from a previous cohort born eight years earlier were available for pooled analyses. Pre-natal exposure showed inverse associations with the antibody concentrations five years later, with decreases by up to about 0.2 for each two-fold higher exposure, while associations for serum concentrations at ages 18 months and 5 years were weaker. Modeling of serum-PFAS concentration showed levels for age 18 months that were similar to those measured. Concentrations estimated for ages 3 and 6 months showed the strongest inverse associations with antibody concentrations at age 5 years, particularly for tetanus. Joint analyses showed statistically significant decreases in tetanus antibody concentrations by 19-29% at age 5 for eachdoubling of the PFAS exposure in early infancy. These findings support the notion that the developing adaptive immune system is particularly vulnerable to immunotoxicity during infancy. This vulnerability appears to be the greatest during the first 6 months after birth, where PFAS exposures are affected by breast-feeding.			1														1				B	D		
711	ヒト（免疫毒性）	Manzano-Salgado, C. B.; Granum, B.; Lopez-Espinosa, M. J.; Ballester, F.; Iñiguez, C.; Gascón, M.; Martínez, D.; Guxens, M.; Basterretxea, M.; Zabaleta, C.; Schettgen, T.; Sunyer, J.; Vrijheid, M.; Casas, M.	Prenatal exposure to perfluoroalkyl substances	2019	Int J Hyg Environ Health. 2019 Jul;222(6):945-954. doi: 10.1016/j.ijheh.2019.06.005. Epub 2019 Jun 28.	Background: Prenatal exposure to perfluoroalkyl substances (PFASs) has been associated with impaired immune and respiratory health during childhood but the evidence is inconsistent and limited for lung function. We studied the association between prenatal PFASs exposure and immune and respiratory health, including lung function, up to age 7 years in the Spanish INMA birth cohort study. Methods: We assessed four PFASs in maternal plasma samples collected during the 1st trimester of pregnancy (years: 2003-2008): perfluorohexane sulfonate (PFHxS), perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), and perfluorononanoate (PFNA). Mothers reported the occurrence (yes/no) of lower respiratory tract infections, wheezing, asthma, and eczema in the previous 12 months at 1.5 and 4 years of the child (n = 1188) and at 7 years (n = 1071). At ages 4 (n = 503) and 7 (n = 992) years lung function was assessed using spirometry tests. Results: The most abundant PFASs were PFOS and PFOA (geometric means: 5.80 and 2.31 ng/mL, respectively). The relative risk of asthma during childhood per each doubling in PFNA concentration was 0.74 (95 CI%: 0.57, 0.96). The relative risk of eczema during childhood per every doubling in PFOS concentration was 0.86 (95 CI%: 0.75, 0.98). Higher PFOA concentrations were associated with lower forced vital capacity and lower forced expiratory volume in 1 s z-scores at 4 years [β (95 CI %): -0.17 (-0.34, -0.01) and -0.13 (-0.29, 0.03), respectively], but not at 7 years. Conclusion: This longitudinal study suggests that different PFASs may affect the developing immune and respiratory systems differently. Prenatal exposure to PFNA and PFOS may be associated with reduced risk of respiratory and immune outcomes, particularly asthma and eczema whereas exposure to PFOA may be associated with reduced lung function in young children. These mixed results need to be replicated in follow-up studies at later ages.			1														1				B	B		
712	ヒト（免疫毒性）	Timmermann, C. A.; Budtz-Jørgensen, E.; Jensen, T. K.; Osuna, C. E.; Petersen, M. S.; Steuerwald, U.; Nielsen, F.; Poulsen, L. K.; Weihe, P.; Grandjean, P.	Association between perfluoroalkyl substance	2017	J Immunotoxicol. 2017 Dec;14(1):39-49. doi: 10.1080/1547691X.2016.1254306. Epub 2017 Jan 16.	Perfluoroalkyl substances (PFASs) are highly persistent chemicals that might be associated with asthma and allergy, but the associations remain unclear. Therefore, this study examined whether pre- and postnatal PFAS exposure was associated with childhood asthma and allergy. Measles, mumps, and rubella (MMR) vaccination in early life may have a protective effect against asthma and allergy, and MMR vaccination is therefore taken into account when evaluating these associations. In a cohort of Faroese children whose mothers were recruited during pregnancy, serum concentrations of five PFASs - Perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) - were measured at three timepoints (maternal serum in pregnancy week 34-36 and child serum at ages 5 and 13 years) and their association with immunoglobulin E (IgE) (cord blood and at age 7 years) and asthma/allergic diseases (questionnaires at ages 5 and 13 years and skin prick test at age 13 years) was determined. A total of 559 children were included in the analyses. Interactions with MMR vaccination were evaluated. Among 22 MMR-unvaccinated children, higher levels of the five PFASs at age 5 years were associated with increased odds of asthma at ages 5 and 13The associations were reversed among MMR-vaccinated children. Prenatal PFAS exposure was not associated with childhood asthma or allergic diseases regardless of MMR vaccination status. In conclusion, PFAS exposure at age 5 was associated with increased risk of asthma among a small subgroup of MMR-unvaccinated children but not among MMR-vaccinated children. While PFAS exposure may impact immune system functions, this study suggests that MMR vaccination might be a potential effect-modifier.			1														1				B	B		
713	ヒト（脂質代謝）	Fu, Yaning; Wang, Tieyu; Fu, Quanliang; Wang, Pei; Lu, Yonglong	Associations between serum concentrations of	2014	Ecotoxicol Environ Saf. 2014 Aug;106:246-52. doi: 10.1016/j.ecoenv.2014.04.039. Epub 2014 May 23.	Perfluoroalkyl acids (PFAAs) have been used in a variety of products for many years and have been detected worldwide in human serum. Previous studies have suggested the potential effects of PFAAs on serum lipids. To investigate the associations between serum concentrations of PFAAs and serum lipid levels, 133 participants were randomly selected from the people coming for health check-up in Yuanyang Red Cross Hospital of Henan, China. Linear regression analysis revealed that perfluoro-octanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA), with a median concentration of 1.43, 0.37, and 0.19 ng/mL, respectively, were positively associated with total cholesterol (TC). Those in the highest quartile of PFOA exposure had ln-TC levels 0.24 mmol/L higher than those in the lowest quartile. For PFNA and PFDA, effect estimates were 0.25 and 0.16 mmol/L, respectively. A positive association between high-density lipoprotein cholesterol (HDLC) and PFDA was found, and there was a 0.18 mmol/L increase of HDLC for the top PFDA quartile compared with the lowest quartile. PFOA and PFNA were positively associated with low-density lipoprotein cholesterol (LDLC). Ln-LDLC levels of people in both top PFOA and PFNA quartiles were 0.33 mmol/L higher than those in the lowest quartiles. Logistic regression analysis indicated that increased PFOA and PFOS quartiles were positively associated with an increased risk of abnormal TC and LDLC when controlling for no confounding factors.	1					1	1							1			1			B	C	China, 対象者133人, 年齢中央値30歳 Outcome: TC, TG, HDLC, LDLC LOD未満はLOD/2で置換 PFAA濃度は四分位値を使用 covariatesの選択方法は不明 PFNAおよびPFNA濃度と脂質マーカーとの間には関連なし	
714	ヒト（脂質代謝）	Zeng, X. W.; Qian, Z.; Emo, B.; Vaughn, M.; Bao, J.; Qin, X. D.; Zhu, Y.; Li, J.; Lee, Y. L.; Dong, G. H.	Association of polyfluoroalkyl chemical exposu	2015	Sci Total Environ. 2015 Apr 15:512-513:364-370. doi: 10.1016/j.scitotenv.2015.01.042. Epub 2015 Jan 30.	Perfluoroalkyl and polyfluoroalkyl substances (PFASs), as well as polymers of PFASs, have been widely used in commercial applications and have been detected in humans and the environment. Previous epidemiological studies have shown associations between particular PFAS chemicals and serum lipid concentrations in adults, particularly perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). There exists, however, limited information concerning the effect of PFASs have on serum lipids among children. In the present cross-sectional study, 225 Taiwanese children (12-15 years of age) were recruited to determine the relationship between serum level PFASs and lipid concentration. Results showed that eight out of ten particular PFASs were detected in the serum of >94% of the participants. Serum PFOS and perfluorotetradecanoic acid (PFTA) levels were at an order of magnitude higher than the other PFASs, with arithmetical means of 32.4 and 30.7 ng/ml in boys and 34.2 and 27.4 ng/ml in girls, respectively. However, the variation in serum PFTA concentration was quite large. Following covariate adjustment, linear regression models revealed that PFOS, PFOA, and perfluorononanoic acid (PFNA) were positively associated with total cholesterol (TC), low-density lipoprotein (LDL) and triglycerides (TG), particularly for PFOS and PFTA. Quartile analysis, with the lowest exposure quartile as a reference,yielded associations between serum PFTA and elevations in TC (p=0.002) and LDL (p=0.004). Though not statistically significant, high-density lipoprotein (HDL) appeared to decrease linearly across quartiles for PFOS and PFOA exposure. In conclusion, a significant association was observed between serum PFASs and lipid level in Taiwanese children. These findings for PFTA are novel, and emphasize the need to investigate the exposure route and toxicological evidence of PFASs beyond PFOS and PFOA.			1	1			1	1		1						1				B	B	Taiwan, 225人, 12-15歳 Outcome: TC, TG, HDLC, LDLC, TC/HDL LOQの算出方法や、LOQ未満の値の対応は不明 PFAS濃度はln変換および四分位群 共変量の選択方法は不明 PFBSとPFNAが1μg/l増加するとTCが19.3/12.9 mg/dl増加、PFNAが1μg/l増加するとLDLが9.63 mg/dl増加、PFNAが1μg/l増加するとTGが23.0 mg/dl増加、PFHxAは関連なし	
715	ヒト（代謝）	Zhang, T.; Zhang, B.; Bai, X.; Yao, Y.; Wang, L.; Shu, Y.; Kannan, K.; Huang, X.; Sun, H.	Health status of elderly people living near e-wa	2019	Environ Sci Technol Lett 6: 133140. doi: 10.1021/acs.estlett.9b00085	The elderly people living near electronic waste (e-waste) dismantling sites are susceptible to elevated chemical exposure, which is acerbated by hypometabolism and diminished immune tolerance. In this study, paired serum and urine samples collected from 1025 elderly people (≥60 years old) living near e-waste dismantling sites (n = 800) and reference areas (n = 225) in South China were analyzed for markers of health status and chemical exposures. Our results indicated that among all the health indicators fasting blood glucose (FBG) and urinary clinical markers were significantly higher in e-waste areas than in the reference area. Sixteen legacy perfluoroalkyl substances (PFASs) were determined in serum samples of elderly individuals living near e-waste dismantling areas (n = 171) and a reference area (n = 50). Serum PFASs concentrations in individuals from e-waste dismantling areas were significantly higher ($p < 0.05$) than those from the reference area, which indicated that e-waste dismantling activities are a source of exposure to PFASs. Association between PFASs exposure and personal health history showed that body mass index (BMI) was significantly positively ($p < 0.05$) associated with serum PFHxA, PFHpA, PFOA, and PFNA concentrations. Negative associations between FBG and serum PFUnDA ($r = -0.160$, $p < 0.05$)and PFTeDA ($r = -0.157$, $p < 0.05$) were also found. Our results suggest that PFASs exposure is associated with adverse health outcomes in elderly population living around e-waste dismantling sites.			1				1													C	B	China, e-waste area, 221人（50人ref）, 60歳以上 Outcome: BMI, fasting blood glucose, urinary clinical marker, liver function examination, TC, TG LOQ未満の値はLOQ/2で置換（中央値やGMの計算のため） PFAS濃度はlog変換 共変量なし？→相関や二群比較 相関は0.3未満で関連なしと考えるべき ⇒不明な情報が多いので除外して良いのではと思います	
716	ヒト（脂質代謝）	Chen, Q.; Zhang, X.; Zhao, Y.; Lu, W.; Wu, J.; Zhao, S.; Zhang, J.; Huang, L.	Prenatal exposure to perfluorobutanesulfonic a	2019	Chemosphere. 2019 Jul:226:17-23. doi: 10.1016/j.chemosphere.2019.03.095. Epub 2019 Mar 19.	Background: Several per- and polyfluoroalkyl substances (PFAS) have been phased out due to their adverse effects, and replaced by the short-chain perfluorobutanesulfonic acid (PFBS). However, the long-term impacts of PFBS on human health are unknown. Objective: We aimed to investigate the association between prenatal exposure to PFAS, especially PFBS and childhood adiposity at 5 years of age. Methods: We conducted a prospective birth cohort study involving 1,140 pregnant women from 2012 to 2017 in Shanghai. Fetal umbilical cord blood was collected at birth. A total of 404 children (196 girls) completed the adiposity measurements using a bioelectrical impedance analysis method and cord plasma PFAS measurements using LC-MS/MS. Multivariable linear models after adjustment for potential confounders were used to evaluate the associations between PFAS and childhood adiposity. Results: The median concentration of PFAS in the cord plasma ranged from 0.05 (PFBS) to 6.74 ng/mL (PFOA). Results of multivariable linear regression found that in girls, PFBS had a significant positive association with waist circumference and waist to height ratio (P-values < 0.05). Girls in the highest tertile of PFBS concentrations had more fat mass, as well as higher body fat percentage, waist circumference, and waist to height ratio compared to those in the lowest tertile. However, girls in the second tertile of PFDoA had lower body fat percentage, waist circumference and fat mass. Conclusions: Adiposity at 5 years of age shows a positive association with prenatal exposure to PFBS in girls. These findings need to be further verified in larger prospective studies.				1				1		1										B	B	China, Shanghai Prenatal Cohort, 404人, 5歳 Outcome: 脂肪量, 体脂肪率, BMI, 腹囲, 腹囲/身長比 臍帯血中PFAS濃度、DLの算出方法は不明、DL未満の値は検量線の一番下/2を置換（複数の記載？） PFAS濃度はlog10変換したものと、三分位値を使用 共演量は既報を元に選択 PFBS濃度と、腹囲、脂肪量、体脂肪率、腹囲/身長比で正の関連（但し、三分位に分けたときにはリニアな関連は見られず）	
717	ヒト（代謝）	Braun, J. M.; Chen, A.; Romano, M. E.; Calafat, A. M.; Webster, G. M.; Yolton, K.; Lanphear, B. P.	Prenatal perfluoroalkyl substance exposure an	2016	Obesity (Silver Spring). 2016 Jan;24(1):231-7. doi: 10.1002/oby.21258. Epub 2015 Nov 11.	Objective: To examine relationships between prenatal perfluoroalkyl substance (PFAS) exposure and adiposity in children born to women who lived downstream from a fluoropolymer manufacturing plant. Methods: Data are from a prospective cohort in Cincinnati, Ohio (HOME Study). Perfluorooctanoic (PFOA), perfluorooctane sulfonic (PFOS), perfluorononanoic (PFNA), and perfluorohexane sulfonic (PFHxS) acids were measured in prenatal serum samples. Differences were measured in body mass index z-scores (BMI), waist circumference, and body fat at 8 years of age (n = 204) and BMI between 2-8 years of age (n = 285) according to PFAS concentrations. Results: Children born to women in the top two PFOA terciles had greater adiposity at 8 years than children in the 1st tercile. For example, waist circumference (cm) was higher among children in the 2nd (4.3; 95% CI: 1.7, 6.9) and 3rd tercile (2.2; 95% CI: -0.5, 4.9) compared to children in the 1st tercile. Children in the top two PFOA terciles also had greater BMI gains from 2 to 8 years compared to children in the 1st tercile ($P < 0.05$). PFOS, PFNA, and PFHxS were not associated with adiposity. Conclusions: In this cohort, higher prenatal serum PFOA concentrations were associated with greater adiposity at 8 years and a more rapid increase in BMI between 2-8 years.			1													1	1			B	C	USA, HOME study, 204人, 平均8.1歳 Outcome: BMI-zscore, 腹囲, 脂肪量 母体血中PFAS, LODの算出方法やLOD未満の置換方法は不明 PFAS濃度はln変換 共変量はDAGを用いて選択 PFNAとの関連はなし	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
718	ヒト（代謝）	Cardenas, A.; Gold, D. R.; Hauser, R.; Kleinman, K. P.; Hivert, M. F.; Calafat, A. M.; Ye, X.; Webster, T. F.; Horton, E. S.; Oken, E.	Plasma concentrations of per- and polyfluoroa	2017	Environ Health Perspect. 2017 Oct 2;125(10):107001. doi: 10.1289/EHP1612.	Background: Several per- and polyfluoroalkyl substances (PFAS) are ubiquitous anthropogenic pollutants almost universally detected in humans. Experimental evidence indicates that PFAS alter glucose metabolism and insulin secretion. However, epidemiological studies have yielded inconsistent results. Objective: We sought to examine associations between plasma PFAS concentrations, glycemic indicators, and diabetes incidence among high-risk adults. Methods: Within the Diabetes Prevention Program (DPP), a trial for the prevention of type 2 diabetes among high-risk individuals, we quantified baseline plasma concentrations of nine PFAS among 957 participants randomized to a lifestyle intervention or placebo. We evaluated adjusted associations for plasma PFAS concentrations with diabetes incidence and key glycemic indicators measured at baseline and annually over up to 4.6 y. Results: Plasma PFAS concentrations were similar to those reported in the U.S. population in 1999-2000. At baseline, in cross-sectional analysis, a doubling in plasma perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) concentrations was associated with higher homeostatic model assessment of insulin resistance (HOMA-IR) [βPFOS=0.39; 95% confidence interval (CI): 0.13, 0.66; βPFOA=0.64; 95% CI: 0.34, 0.94], β-cell function (HOMA-β) (βPFOS=9.62; 95% CI: 1.55, 17.70; βPFOA=15.93; 95% CI: 6.78, 25.08), fasting proinsulin (βPFOS=1.37 pM; 95% CI: 0.50, 2.25; βPFOA=1.71 pM; 95% CI: 0.72, 2.71), and glycated hemoglobin (HbA1c) (βPFOS=0.03%; 95% CI: 0.002, 0.07; βPFOA=0.04%; 95% CI: 0.001, 0.07). There was no strong evidence of associations between plasma PFAS concentrations and diabetes incidence or prospective changes in glycemic indicators during the follow-up period. Conclusions: At baseline, several PFAS were cross-sectionally associated with small differences in markers of insulin secretion and β-cell function. However, there was limited evidence suggesting that PFAS concentrations are associated with diabetes incidence or changes in glycemic indicators during the follow-up period.			1											1		1					B	C	USA, Diabetes Prevention Program study, 957人, 25歳以上 1996年-1999年のサンプリング Outcome: HOMA-IR, Fast insulin, 30-min insulin, Fast proinsulin, HOMA-b, Corrected insulin response, Insulinogenic index, Fast glucose, 30-min glucose, 2-h glucose, HbA1c, Adiponectin, BMI LODの算出方法は不明、LOD未満の値はLOD/√2で置換 PFAS濃度はlog2変換 共変量の選択方法は不明 PFNAとの関連はなし	
719	ヒト（代謝）	Conway, B.; Innes, K. E.; Long, D.	Perfluoroalkyl substances and beta cell deficie	2016	J Diabetes Complications. 2016 Aug;30(6):993-8. doi: 10.1016/j.jdiacomp.2016.05.001. Epub 2016 May 4.	Aims: Perfluoroalkyl substances (PFAS) are synthetic hydrocarbons shown to preserve pancreatic islet cell viability and reduce islet cell hypoxia and apoptosis. We investigated the relationship of serum PFAS with diabetes, and whether this varied by diabetes type. Methods: 6,460 individuals with and 60,439 without diabetes from the C8 Health Project, were categorized into three groups: type 1 (n=820), type 2 (n=4,291), or uncategorized diabetes (n=1,349, missing data on diabetes type or diabetes based on blood sugar at study entry). Four PFAS were investigated: perfluorohexane sulfonate (PFHxS), perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), and perfluorononanoic acid (PFNA). Results: PFAS levels were significantly lower in those with diabetes, and lowest in those with type 1 diabetes. In age and sex adjusted analyses, ORs (CI) for type 1, type 2, and uncategorized diabetes compared to no diabetes were 0.59 (0.54-0.64), 0.74 (0.71-0.77), 0.84 (0.78-0.90), respectively for PFHxS; 0.69 (0.65-0.74), 0.87 (0.89-0.91), 0.92 (0.88-0.97), respectively for PFOA; 0.65 (0.61-0.70), 0.86 (0.82-0.90), 0.93 (0.86-1.03), respectively for PFOS; and 0.65 (0.57-0.74), 0.94 (0.88-1.00), 0.95 (0.85-1.06), respectively for PFNA. Further adjustment for eGFR and other covariates did not eliminate these inverse associations. Conclusions: PFAS levels were negatively associated with diabetes. This inverse relationship was strongest for type 1 diabetes, suggesting the relationship with serum PFAS may vary with the severity of islet cell deficiency.			1											1							B	B	USA, C8 Health Project, 1型糖尿病820人, 2型糖尿病4291人, 型不明1349人, 非糖尿病60436人, 平均約50歳（非糖尿病38歳） Outcome: 糖尿病 LODの算出方法およびLOD未満の値の扱いについては不明 PFAS濃度はln変換 共変量の選択にDAGは使用せず PFNAとの関連はなし	
720	ヒト（代謝）	Fleisch, A. F.; Rifas-Shiman, S. L.; Mora, A. M.; Calafat, A. M.; Ye, X.; Luttmann-Gibson, H.; Gillman, M. W.; Oken, E.; Sagiv, S. K.	Early-life exposure to perfluoroalkyl substance	2017	Environ Health Perspect. 2017 Mar;125(3):481-487. doi: 10.1289/EHP303. Epub 2016 Sep 2.	Background: Perfluoroalkyl substances (PFASs) are synthetic chemicals that may persist in the environment and in humans. There is a possible association between early-life PFAS exposure and metabolic dysfunction in later life, but data are limited. Methods: We studied 665 mother-child pairs in Project Viva, a Boston, Massachusetts-area cohort recruited 1999-2002. We quantified concentrations of PFASs [perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoate (PFNA), perfluorohexane sulfonate (PFHxS), and perfluorodecanoate (PFDeA)] in maternal plasma collected at the first prenatal visit (median, 9.6 weeks gestation) and in child plasma from the mid-childhood research visit (median, 7.7 years). We assessed leptin, adiponectin, and homeostatic model assessment of insulin resistance (HOMA-IR) in mid-childhood. We fit covariate-adjusted linear regression models and conducted stratified analyses by child sex. Results: Children with higher PFAS concentrations had lower HOMA-IR [e.g., -10.1% (95% CI: -17.3, -2.3) per interquartile range increment in PFOA]. This inverse association between child PFAS and HOMA-IR was more pronounced in females [e.g., PFOA: -15.6% (95% CI: -25.4, -4.6) vs. -6.1% (95% CI: -16.2, 5.2) for males]. Child PFAS plasma concentrations were not associated with leptin or adiponectin. Prenatal PFAS plasma concentrations were not associated with leptin, adiponectin, or HOMA-IR in offspring. Conclusions: We found no evidence for an adverse effect of early-life PFAS exposure on metabolic function in mid-childhood. In fact, children with higher PFAS concentrations had lower insulin resistance. Citation: Fleisch AF, Rifas-Shiman SL, Mora AM, Calafat AM, Ye X, Luttmann-Gibson H, Gillman MW, Oken E, Sagiv SK. 2017. Early-life exposure to perfluoroalkyl substances and childhood metabolic function.			1											1		1					B	B	USA, Project Viva, 665人, 中央値32.5歳（母）、7.7歳（子） 1999年-2002年に母サンプリング Outcome: レプチン, アディポネクチン, HOMA-IR 母子血漿中PFASを測定、LODの算出方法は不明、LOD未満の値はLOD/√2で置換 PFAS濃度は、IQR値および四分位群を使用 共変量の選択は既報を参照 子どもの心血管代謝バイオマーカーと母親血中PFNAとの関連はなし、子の血中PFNAとHOME-IRと間に負の関連（各四分位群で約-26%減）	
721	ヒト（代謝）	Halldorsson, Thorhallur I; Rytter, Dorte; Haug, Line Småstuen; Bech, Bodil Hammer; Danielsen, Inge; Becher, Georg; Henriksen, Tine Brink; Olsen, Sjurdur F	Prenatal exposure to perfluorooctanoate and r	2012	Environ Health Perspect. 2012 May;120(5):668-73. doi: 10.1289/ehp.1104034. Epub 2012 Feb 3.	BACKGROUND: Perfluoroalkyl acids are persistent compounds used in various industrial -applications. Of these compounds, perfluorooctanoate (PFOA) is currently detected in humans worldwide. A recent study on low-dose developmental exposure to PFOA in mice reported increased weight and elevated biomarkers of adiposity in postpubertal female offspring. OBJECTIVE: We examined whether the findings of increased weight in postpubertal female mice could be replicated in humans. METHODS: A prospective cohort of 665 Danish pregnant women was recruited in 1988-1989 with offspring follow-up at 20 years. PFOA was measured in serum from gestational week 30. Offspring body mass index (BMI) and waist circumference were recorded at follow-up (n = 665), and biomarkers of adiposity were quantified in a subset (n = 422) of participants. RESULTS: After adjusting for covariates, including maternal pre-pregnancy BMI, smoking, education, and birth weight, in utero exposure to PFOA was positively associated with anthropometry at 20 years in female but not male offspring. Adjusted relative risks comparing the highest with lowest quartile (median: 5.8 vs. 2.3 ng/mL) of maternal PFOA concentration were 3.1 [95% confidence interval (CI): 1.4, 6.9] for overweight or obese (BMI ≥ 25 kg/m2) and 3.0 (95% CI: 1.3, 6.8) for waist circumference > 88 cm among female offspring. This corresponded to estimated increases of 1.6 kg/m2 (95% CI: 0.6, 2.6) and 4.3 cm (95% CI: 1.4, 7.3) in average BMI and waist circumference, respectively. In addition, maternal PFOA concentrations were positively associated with serum insulin and leptin levels and inversely associated withadiponectin levels in female offspring. Similar associations were observed for males, although point estimates were less precise because of fewer observations. Maternal perfluorooctane sulfonate (PFOS), perfluorooctane sulfonamide (PFOSA), and perfluorononanoate (PFNA) concentrations were not independently associated with offspring anthropometry at 20 years. CONCLUSIONS: Our findings on the effects of low-dose developmental exposures to PFOA are in line with experimental results suggesting obesogenic effects in female offspring at 20 years of age.			1											1		1					B	B	Denmark, Danish birth cohort, 665人, 子20歳時 1988年-1989年に母サンプリング Outcome: adiponectine, レプチン, インスリン, BMI, 腹囲 母体血中PFAA濃度、LOQの算出方法およびLOD未満の値への対応は不明 PFAS濃度は四分位群を使用 共変量の選択は既報を参照、欠測値はMIで補完 PFNAとの関連はなし	
722	ヒト（代謝）	Hartman, T. J.; Calafat, A. M.; Holmes, A. K.; Marcus, M.; Northstone, K.; Flanders, W. D.; Kato, K.; Taylor, E. V.	Prenatal exposure to perfluoroalkyl substances	2017	Child Obes. 2017 Jun;13(3):222-230. doi: 10.1089/chi.2016.0126. Epub 2017 Jan 27.	Background: Perfluoroalkyl substances (PFASs) are used in surface coatings that resist stains, grease, and water. Methods: The association between in utero PFAS exposure and girls' body fatness at age 9 was analyzed in The Avon Longitudinal Study of Parents and Children (UK). Maternal serum [median 15 weeks: interquartile range (IQR) 10 and 28 weeks of gestation] was analyzed for perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA). Body composition was measured by dual X-ray emission absorptiometry, and percent total body fat (%BF) was calculated. Associations between PFASs and body fatness were modeled by multivariable linear regression. Results: Among 359 girls, median (IQR) %BF was 27.5 (IQR 21.7-34.6). Median (IQR) concentrations (all ng/mL) were 3.7 (2.9-4.8) for PFOA, 19.8 (15.0-25.3) for PFOS, 1.6 (1.3-2.2) for PFHxS, and 0.5 (0.4-0.7) for PFNA. Maternal PFAS concentrations were not significantly associated with daughters' total %BF overall. Mothers' educational status modified associations for PFOA and PFOS with %BF (P-interactions: 0.005 and 0.02, respectively). %BF was higher [1.4%; 95% confidence interval (95% CI): 0.3 to 2.5] for each one unit (ng/mL) higher PFOA among girls with mothers in the middle education group, but lower (-0.6%; 95% CI: -1.12 to -0.04) for the corresponding comparison among girls with mothers with the highest education. %BF was lower (-0.2%; 95% CI: -0.3 to -0.1) for each one unit higher PFOS among girls with the most educated mothers. Conclusions: Prenatal exposure to PFOA and PFOS was associated with girls' %BF within some strata of maternal education status. PFHxS and PFNA were not associated with %BF.			1											1		1					B	B	UK, ALSPAC, 359人（女子）, 9歳 1991年-1992年に母サンプリング Outcome: body fat, trunk fat, BMI, 腹囲 母体血中PFAS濃度、LODの算出方法およびLOD未満の値への対応は不明 モデルの中のPFAS濃度の対数変換は不明 共変量の選択方法は不明 教育レベル低の群で母体血中PFNA濃度が1ng/ml増加するとbody fatが12.73%増加（しかしリニアな関連はなし）	
723	ヒト（代謝）	He, X.; Liu, Y.; Xu, B.; Gu, L.; Tang, W.	PFOA is associated with diabetes and metabol	2018	Sci Total Environ. 2018 Jun 1;625:566-574. doi: 10.1016/j.scitotenv.2017.12.186. Epub 2017 Dec 30.	Exposure to perfluoroalkyl substances (PFAS) is associated with a range of adverse health effects. However, it remains unclear whether PFAS at environmentally relevant exposure levels are related to diabetes and metabolite concentrations in adults. Using cross-sectional data from 7904 adults (age≥20years) in the 2003-2012 National Health and Nutrition Examination Survey (NHANES), we examined the association of PFAS with the prevalence of diabetes and metabolite concentrations. A multivariate logistic regression was applied to investigate the associations of diabetes prevalence with serum perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS) and perfluorononanoate (PFNA) levels. A multivariate generalised linear regression was further performed to investigate the associations between PFAS exposure and some metabolites. We identified a strong positive association between serum PFOA and diabetes prevalence in men with an adjusted model (OR: 2.66, 0.95 CI: 1.63-4.35; P for trend=0.001). No significant association between serum PFOA and diabetes prevalence was observed in women (OR: 1.47, 0.95 CI: 0.88-2.46; P for trend=0.737). Furthermore, diabetes was not related to PFOS, PFHxS and PFNA, regardless of gender. In the gender-stratified generalised linear models, men and women with the highest PFOA levels demonstrated a 0.0143 (95% CI: 0.62%-2.34%) and a 0.0107 (95% CI: 0.27%-1.97%) greater increase in serumtotal cholesterol (P for trend=0.006 and 0.001) compared to those with the lowest PFOA levels. There were no significant associations between serum PFOA and other metabolites. These results provide epidemiological evidence that environment-related levels of serum PFOA may be positively associated with the prevalence of diabetes in men and with total cholesterol in adults. Further clinical and animal studies are urgently needed to elucidate putative causal relationships and shed light on the potential mode of action involved.			1											1							B	B	USA, NHANES, 7904人, 平均約50歳 Outcome: 糖尿病, 糖代謝マーカー（fasting plasma glucose, fasting insulin levels, HOMA-IR），脂質代謝マーカー（TC, TG, HDL-C, LDL-C），血圧 LODはNHANES方式で算出、LOD未満はLOD/√2で置換 PFAS濃度は四分位群を使用 共変量の選択は既報を参照 血中PFNA濃度との関連はなし	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
724	ヒト（代謝）	Jensen, R. C.; Glintborg, D.; Timmermann, C. A. G.; Nielsen, F.; Kyhl, H. B.; Andersen, H. R.; Grandjean, P.; Jensen, T. K.; Andersen, M.	Perfluoroalkyl substances and glycemic status	2018	Environ Int. 2018 Jul;116:101-107. doi: 10.1016/j.envint.2018.04.010. Epub 2018 Apr 13.	Background: Perfluoroalkyl substances (PFASs) are persistent chemicals with suspected endocrine disrupting abilities applied in consumer products. PFASs have potentially modulating effects on glucose homeostasis. Insulin resistance prevails during third trimester of pregnancy, and this challenge of glucose homeostasis may reveal putative effects of PFAS concentrations on glycemic status. Objective: To investigate associations between five serum PFASs and glucose-related outcomes in pregnant Danish women based on their risk of gestational diabetes mellitus (GDM). Methods: In the prospective Odense Child Cohort serum concentrations of five PFASs - perfluorohexane sulfonic acid (PFHxS), perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) - were measured at median gestational week (GW) 11 in pregnant women. An oral glucose tolerance test (OGTT) was performed at GW 28. The statistical analysis was conducted among 158 women with high GDM risk and 160 women with low GDM risk matched by gestational age. Multiple linear regression models were performed to estimate associations between PFAS concentrations and glucose, insulin, C-peptide, homeostatic model of assessment of insulin resistance (HOMA-IR) and beta cell function (HOMA-%β), and insulin sensitivity (Matsuda index) during the 2-h OGTT. Results: In women with high risk for GDM, a two-fold increase in PFHxS concentration was significantly associated with increased fasting glucose, fasting insulin and HOMA-IR after adjusting for age, parity, educational level and pre-pregnancy BMI. Adjusting for the same confounders, a doubling in PFNA concentration was associated with higher fasting insulin and HOMA-%β. In women with low GDM risk, no associations were found between PFAS concentrations and glucose-related outcomes. Conclusion: PFHxS and PFNA concentrations were associated with impaired glycemic status in metabolically vulnerable pregnant women and might further enhance the risk of developing GDM.			1											1						B	B	Denmark, Odense Child Cohort, 318人, 平均約30歳 Outcome: 2-h OGTT data (including plasma glucose, serum insulin, and serum C-peptide), HOMA-IR, HOMA-%β, Insulin sensitivity from the OGTT LOQの算出方法、LOD未満はLOD/√2で置換 PFAS濃度はln変換 共変量はDAGを用いて選択 高糖尿病リスク群における血中PFNAとfasting insulin(12%), HOMA%b(12%)と正の関連	
725	ヒト（代謝）	Karlsen, M.; Grandjean, P.; Weihe, P.; Steuerwald, U.; Oulhote, Y.; Valvi, D.	Early-life exposures to persistent organic pollu	2017	Reprod Toxicol. 2017 Mar;68:145-153. doi: 10.1016/j.reprotox.2016.08.002. Epub 2016 Aug 3.	Current knowledge on obesogenic effects of persistent organic pollutants (POPs) is equivocal. We therefore evaluated the associations between early-life POP exposures and body mass index (BMI) in 444 Faroese children born in 2007-2009. POPs were measured in maternal 2-week postpartum serum and child age-5 serum. Linear regression and generalised linear models assessed the associations with continuous and dichotomous BMI z-scores, respectively, at ages 18 months and/or 5 years. Maternal serum concentrations of HCB, PFOS and PFOA were associated with increased BMI z-scores and/or overweight risk (i.e. BMI z-score≥85th WHO percentile). No clear association was found for maternal serum-PCBs, p,p'-DDE, PFHxS, PFNA and PFDA. In cross-sectional analyses, we observed a pattern of inverse associations between child serum-POPs and BMI z-scores at age 5, perhaps due to reverse causation that requires attention in future prospective analyses. Findings in this recent cohort support a role of maternal exposure to endocrine disruptors in the childhood obesity epidemic.			1											1			1			B	B	Denmark, Faroe study, 444組の母子, 子18か月と5歳時 Outcome: BMI z-score、過体重 LODの算出方法は不明（既報にあり？）, LOD未満の値はLOD/2で置換 PFAS濃度はlog10変換 共変量はDAGを用いて選択しているが、単変量解析？でPFNAとBMIと関連が見られた（10%以上の変動）変数を追加している 母親血中PFNA濃度との関連は無し	
726	ヒト（代謝）	Lin, C. Y.; Chen, P. C.; Lin, Y. C.; Lin, L. Y.	Association among serum perfluoroalkyl chemi	2009	Diabetes Care. 2009 Apr;32(4):702-7. doi: 10.2337/dc08-1816. Epub 2008 Dec 29.	Objective: Perfluoroalkyl chemicals (PFCs) have been used worldwide in a variety of consumer products. The effect of PFCs on glucose homeostasis is not known. Research design and methods: We examined 474 adolescents and 969 adults with reliable serum measures of metabolic syndrome profile from the National Health and Nutrition Examination Survey 1999-2000 and 2003-2004. Results: In adolescents, increased serum perfluorononanoic acid (PFNA) concentrations were associated with hyperglycemia (odds ratio [OR] 3.16 [95% CI 1.39-7.16], P < 0.05). Increased serum PFNA concentrations also have favorable associations with serum HDL cholesterol (0.67 [0.45-0.99], P < 0.05). Overall, increased serum PFNA concentrations were inversely correlated with the prevalence of the metabolic syndrome (0.37 [0.21-0.64], P < 0.005). In adults, increased serum perfluorooctanoic acid concentrations were significantly associated with increased beta-cell function (beta coefficient 0.07 +/- 0.03, P < 0.05). Increased serum perfluorooctane sulfate (PFOS) concentrations were associated with increased blood insulin (0.14 +/- 0.05, P < 0.01), homeostasis model assessment of insulin resistance (0.14 +/- 0.05, P < 0.01), and beta-cell function (0.15 +/- 0.05, P < 0.01). Serum PFOS concentrations were also unfavorably correlated with serum HDL cholesterol (OR 1.61 [95% CI 1.15-2.26], P < 0.05). Conclusions: Serum PFCs were associated with glucose homeostasis and indicators of metabolic syndrome. Further clinical and animal studies are warranted to clarify putative causal relationships.			1											1			1			1	B	A	USA, NHANES, 1443名, 平均15.5歳（青年）46.2歳（成人） 1999-2000年, 2003-2004年のサンプリング Outcome: glucose, insulin, HOME-IR, b-cell function/metabolic: syndrome, waist, glucose, HDL, TG LODの計算方法は不明（算出していない？検出率不明）、LOD未満の値への対応は不明 PFAS濃度はlog変換 共変量の選択方法は不明 血中PFNA濃度が1単位増加すると、青年のinsulinとb-cell functionが低下、メタボな青年のglucoseが増加およびHDLが低下 ⇒解析等で記載が不十分な点があり、解釈に注意が必要	
727	ヒト（代謝）	Lind, L.; Zethelius, B.; Salihovic, S.; van Bavel, B.; Lind, P. M.	Circulating levels of perfluoroalkyl substances	2014	Diabetologia. 2014 Mar;57(3):473-9. doi: 10.1007/s00125-013-3126-3. Epub 2013 Dec 14.	Aims/hypothesis: Several environmental contaminants, such as polychlorinated biphenyls, dioxins, bisphenol A and phthalates, have been linked to diabetes. We therefore investigated whether other kinds of contaminants, perfluoroalkyl substances (PFAS), also called perfluorinated compounds (PFCs), are also associated with diabetes. Methods: The Prospective Investigation of the Vasculature in Uppsala Seniors (PIVUS) study investigated 1,016 men and women aged 70 years. Seven PFAS were detected in almost all participant sera by ultra-high performance liquid chromatograph/tandem mass spectrometry. Diabetes was defined as use of hypoglycaemic agents or fasting glucose >7.0 mmol/l. Results: 114 people had diabetes. In the linear analysis, no significant relationships were seen between the seven PFAS and prevalent diabetes. However, inclusion of the quadratic terms of the PFAS revealed a significant non-linear relationship between perfluorononanoic acid (PFNA) and diabetes, even after adjusting for multiple confounders (OR 1.96, 95% CI 1.19, 3.22, p = 0.008 for the linear term and OR 1.25, 95% CI 1.08, 1.44, p = 0.002 for the quadratic term). Perfluorooctanoic acid (PFOA) also showed such a relationship (p = 0.01). PFOA was related to the proinsulin/insulin ratio (a marker of insulin secretion), but none of the PFAS was related to the HOMA-IR (a marker of insulin resistance) following adjustment for multiple confounders. Conclusions/interpretation: PFNA was related to prevalent diabetes in a non-monotonic fashion in this cross-sectional study, supporting the view that this perfluoroalkyl substance might influence glucose metabolism in humans at the level of exposure seen in the general elderly population.			1											1			1			1	B	A	Sweden, PIVUS study, 1016名, 70歳 2001-2004年にサンプリング Outcome: 糖尿病, proinsulin/insulin ratio, HOMA-IR LOD算出方法およびLOD未満の値への対応は不明（検出率不明） PFAS濃度はln変換 共変量の選択方法は不明 血中PFNA濃度と糖尿病有無との間に正の関連（linear/non-linear文中の記載のみ）	
728	ヒト（代謝）	Liu, G.; Dhana, K.; Furtado, J. D.; Rood, J.; Zong, G.; Liang, L.; Qi, L.; Bray, G. A.; DeJonge, L.; Coull, B.; Grandjean, P.; Sun, Q.	Perfluoroalkyl substances and changes in body	2018	PLoS Med. 2018 Feb 13;15(2):e1002502. doi: 10.1371/journal.pmed.1002502. eCollection 2018 Feb.	Background: The potential endocrine-disrupting effects of perfluoroalkyl substances (PFASs) have been demonstrated in animal studies, but whether PFASs may interfere with body weight regulation in humans is largely unknown. This study aimed to examine the associations of PFAS exposure with changes in body weight and resting metabolic rate (RMR) in a diet-induced weight-loss setting. Methods and findings: In the 2-year POUNDS Lost randomized clinical trial based in Boston, Massachusetts, and Baton Rouge, Louisiana, that examined the effects of energy-restricted diets on weight changes, baseline plasma concentrations of major PFASs were measured among 621 overweight and obese participants aged 30-70 years. Body weight was measured at baseline and 6, 12, 18, and 24 months. RMR and other metabolic parameters, including glucose, lipids, thyroid hormones, and leptin, were measured at baseline and 6 and 24 months. Participants lost an average of 6.4 kg of body weight during the first 6 months (weight-loss period) and subsequently regained an average of 2.7 kg of body weight during the period of 6-24 months (weight regain period). After multivariate adjustment, baseline PFAS concentrations were not significantly associated with concurrent body weight or weight loss during the first 6 months. In contrast, higher baseline levels of PFASs were significantly associated with a greater weight regain, primarily in women. In women, comparing the highest to the lowest tertiles of PFAS concentrations, the multivariate-adjusted mean weight regain (SE) was 4.0 (0.8) versus 2.1 (0.9) kg for perfluorooctanesulfonic acid (PFOS) (Ptrend = 0.01); 4.3 (0.9) versus 2.2 (0.8) kg for perfluorooctanoic acid (PFOA) (Ptrend = 0.007); 4.7 (0.9) versus 2.5 (0.9) kg for perfluorononanoic acid (PFNA) (Ptrend = 0.006); 4.9 (0.9) versus 2.7 (0.8) kg for perfluorohexanesulfonic acid (PFHxS) (Ptrend = 0.009); and 4.2 (0.8) versus 2.5 (0.9) kg for perfluorodecanoic acid (PFDA) (Ptrend = 0.03). When further adjusted for changes in body weight or thyroid hormones during the first 6 months, results remained similar. Moreover, higher baseline plasma PFAS concentrations, especially for PFOS and PFNA, were significantly associated with greater decline in RMR during the weight-loss period and less increase in RMR during the weight regain period in both men and women. Limitations of the study include the possibility of unmeasured or residual confounding by socioeconomic and psychosocial factors, as well as possible relapse to the usual diet prior to randomization, which could have been rich in foods contaminated by PFASs through food packaging and also dense in energy. Conclusions: In this diet-induced weight-loss trial, higher baseline plasma PFAS concentrations were associated with a greater weight regain, especially in women, possibly explained by a slower regression of RMR levels. These data illustrate a potential novel pathway through which PFASs interfere with human body weight regulation and metabolism. The possible impact of environmental chemicals on the obesity epidemic therefore deserves attention.			1											1						B	C	USA, 2-year POUNDS Lost randormised clinical trial, 過体重や肥満621人, 30-70歳 Outcome: change of body weight and RMR 6, 12, 18, 24か月目に調査（血液とRMRは初回空腹時採取の血液、6, 24ヶ月目に採取） LODの計算方法は不明（検出率100%） PFAS濃度はlog10変換／三分位群で使用 共変量の選択方法は不明 血中PFNA濃度が分位群が上がることに6-24か月の体重変動が増加（特に女性）、6ヶ月目までのRMR減少と6ヶ月目以降のRMR増加量の低下と関連あり	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
729	ヒト（代謝）	Manzano-Salgado, C. B.; Casas, M.; Lopez-Espinosa, M. J.; Ballester, F.; Iñiguez, C.; Martinez, D.; Romaguera, D.; Fernández-Barrés, S.; Santa-Marina, L.; Basterretxea, M.; Schettgen, T.; Valvi, D.; Vioque, J.; Sunyer, J.; Vrijheid, M.	Prenatal exposure to perfluoroalkyl substances	2017	Environ Health Perspect. 2017 Nov;108:278-284. doi: 10.1016/j.envint.2017.09.006.	Background: Perfluoroalkyl substances (PFAS) may affect body mass index (BMI) and other components of cardiometabolic (CM) risk during childhood, but evidence is scarce and inconsistent. Objectives: We estimated associations between prenatal PFAS exposures and outcomes relevant to cardiometabolic risk, including a composite CM-risk score. Methods: We measured perfluorohexanesulfonic acid (PFHxS), perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA) in maternal plasma (first trimester). We assessed weight gain from birth until 6 mo. At 4 and 7 y, we calculated the age- and sex-specific z-scores for BMI, waist circumference (WC), and blood pressure (BP) (n≈1,000). At age 4, we calculated the age-, sex-, and region-specific z-scores for cholesterol, triglycerides (TGs), high-density (HDL-C), and low-density lipoprotein cholesterol (LDL-C) (n=627). At age 4, we calculated a CM-risk score (n=386) as the sum of the individual age-, sex-, and region-specific z-scores for WC, BP, HDL-C, and TGs. We used the average between the negative of HDL-C z-score and TGs z-score to give similar weight to lipids and the other components in the score. A higher score indicates a higher cardiometabolic risk at age 4. Results: PFOS and PFOA were the most abundant PFAS (geometric mean: 5.80 and 2.32 ng/mL, respectively). In general, prenatal PFAS concentrations were not associated with individual outcomes or the combined CM-risk score. Exceptions were positive associations between prenatal PFHxS and TGs z-score [for a doubling of exposure, β =0.11; 95% confidence interval (CI): 0.01, 0.21], and between PFNA and the CM-risk score (β =0.60; 95% CI: 0.04, 1.16). There was not clear or consistent evidence of modification by sex. Conclusions: We observed little or no evidence of associations between low prenatal PFAS exposures and outcomes related to cardiometabolic risk in a cohort of Spanish children followed from birth until 7 y.			1											1		1			B	B	Spain. INMA birth cohort study, 1154 (6m), 1230 (4y), 1086 (7y) 2003-2008年にリクルート Outcome: weight gain z-score (6m), BMI/WC/BP/TC/HDL/LDL/TG z-score, CM-risk (4y), BMI/WC/BP z-score (7y) LOQ未満の値はMIで補完 PFAS濃度はlog2変換 共変量は先行研究を参照、欠測値はMIで補完 母親血中PFNA濃度と関連なし	
730	ヒト（代謝）	Monroy, R.; Morrison, K.; Teo, K.; Atkinson, S.; Kubwabo, C.; Stewart, B.; Foster, W. G.	Serum levels of perfluoroalkyl compounds in hu	2008	Environ Res. 2008 Sep;108(1):56-62. doi: 10.1016/j.envres.2008.06.001. Epub 2008 Jul 22.	Perfluoroalkyl compounds (PFCs) are end-stage metabolic products from industrial flourochemicals used in the manufacture of plastics, textiles, and electronics that are widely distributed in the environment. The objective of the present study was to quantify exposure to perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorodecanoic acid (PFDeA), perfluorohexane sulfonate (PFHxS), perfluoroheptanoic acid (PFHpA), and perfluorononanoic acid (PFNA) in serum samples collected from pregnant women and the umbilical cord at delivery. Pregnant women (n=101) presenting for second trimester ultrasound were recruited and PFC residue levels were quantified in maternal serum at 24-28 weeks of pregnancy, at delivery, and in umbilical cord blood (UCB; n=105) by liquid chromatography-mass spectrometry. Paired t-test and multiple regression analysis were performed to determine the relationship between the concentrations of each analyte at different sample collection time points. PFOA and PFOS were detectable in all serum samples analyzed including the UCB. PFOS serum levels (mean+/-S.D.) were significantly higher (p<0.001) in second trimester maternal serum (18.1+/-10.9 ng/mL) than maternal serum levels at delivery (16.2+/-10.4 ng/mL), which were higher than the levels found in UCB (7.3+/-5.8 ng/mL; p<0.001). PFHxS was quantifiable in 46/101 -0.455 maternal and 21/105 -0.2 UCB samples with a mean concentration of 4.05+/-12.3 and 5.05+/-12.9 ng/mL, respectively. Therewas no association between serum PFCs at any time point studied and birth weight. Taken together our data demonstrate that although there is widespread exposure to PFCs during development, these exposures do not affect birth weight.			1											1					C	C	妊娠中、出産時、臍帯血中のPFNA濃度の比較と、出生体重との関連を報告した論文であり、非該当と判断	
731	ヒト（代謝）	Mora, A. M.; Oken, E.; Rifas-Shiman, S. L.; Webster, T. F.; Gillman, M. W.; Calafat, A. M.; Ye, X.; Sagiv, S. K.	Prenatal exposure to perfluoroalkyl substances	2017	Environ Health Perspect. 2017 Mar;125(3):467-473. doi: 10.1289/EHP246. Epub 2016 Jun 28.	Background: Few studies have examined whether prenatal exposure to perfluoroalkyl substances (PFASs) is associated with childhood adiposity. Objective: We examined associations of prenatal exposure to PFASs with adiposity in early and mid-childhood. Methods: We measured plasma PFAS concentrations in 1,645 pregnant women (median, 9.6 weeks gestation) enrolled in Project Viva, a prospective pre-birth cohort study in Massachusetts (USA), between 1999 and 2002. We assessed overall and central adiposity in 1,006 children in early childhood (median, 3.2 years) and 876 in mid-childhood (median, 7.7 years) using anthropometric and dual X-ray absorptiometry (DXA) measurements. We fitted multivariable linear regression models to estimate exposure-outcome associations and evaluated effect modification by child sex. Results: Median (25-75th percentiles) prenatal plasma perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA) concentrations in children assessed in early childhood were 5.6 (4.1-7.7), 24.8 (18.4-33.9), 2.4 (1.6-3.8), and 0.6 (0.5-0.9) ng/mL, respectively. Among girls, each interquartile range increment of prenatal PFOA concentrations was associated with 0.21 kg/m2 (95% CI: -0.05, 0.48) higher body mass index, 0.76 mm (95% CI: -0.17, 1.70) higher sum of subscapular and triceps skinfold thickness, and 0.17 kg/m2 (95% CI: -0.02, 0.36) higher DXA total fat mass index in mid-childhood. Similar associations were observed for PFOS, PFHxS, and PFNA. We observed null associations for boys and early-childhood adiposity measures. Conclusions: In this cohort, prenatal exposure to PFASs was associated with small increases in adiposity measurements in mid-childhood, but only among girls. Citation: Mora AM, Oken E, Rifas-Shiman SL, Webster TF, Gillman MW, Calafat AM, Ye X, Sagiv SK. 2017. Prenatal exposure to perfluoroalkyl substances and adiposity in early and mid-childhood.			1											1		1			B	B	USA, Project Viva, 1006(ave 3.2y)/876(7.7y) 1999-2002年にリクルート Outcome: BMI (z-score), WC, WHtR, skinfold thickness (3.2y) + fat mass, fat-free mass index, trunk fat mass (7.7y) LODの計算方法は不明（既報にある？）, LOD未満の値はLOD/√2で置換 PFAS濃度はIQRごとの増加を見た 共変量の選択は既報参照＋DAGで選ばれた物＋二群比較でPFAS濃度と関連があったもの？、欠測値はMIで補完 7.7歳時の母親血中PFNA濃度とBMI（女子）、skinfold thickness（全体、女子）、Subscapular-to-triceps skinfold thickness ratio（全体、女子）で正の関連	
732	ヒト（代謝）	Starling, A. P.; Adgate, J. L.; Hamman, R. F.; Kechris, K.; Calafat, A. M.; Ye, X.; Dabelea, D.	Perfluoroalkyl substances during pregnancy ar	2017	Environ Health Perspect. 2017 Jun 26;125(6):067016. doi: 10.1289/EHP641.	Background: Certain perfluoroalkyl and polyfluoroalkyl substances (PFAS) are widespread, persistent environmental contaminants. Prenatal PFAS exposure has been associated with lower birth weight; however, impacts on body composition and factors responsible for this association are unknown. Objectives: We aimed to estimate associations between maternal PFAS concentrations and offspring weight and adiposity at birth, and secondarily to estimate associations between PFAS concentrations and maternal glucose and lipids, and to evaluate the potential for these nutrients to mediate associations between PFAS and neonatal outcomes. Methods: Within the Healthy Start prospective cohort, concentrations of 11 PFAS, fasting glucose, and lipids were measured in maternal mid-pregnancy serum (n=628). Infant body composition was measured using air displacement plethysmography. Associations between PFAS and birth weight and adiposity, and between PFAS and maternal glucose and lipids, were estimated via linear regression. Associations were decomposed into direct and indirect effects. Results: Five PFAS were detectable in >50% of participants. Maternal perfluorooctanoate (PFOA) and perfluorononanoate (PFNA) concentrations were inversely associated with birth weight. Adiposity at birth was approximately 10% lower in the highest categories of PFOA, PFNA, and perfluorohexane sulfonate (PFHxS) compared to the lowest categories. PFOA, PFNA, perfluorodecanoate (PFDeA), and PFHxS were inversely associated with maternal glucose. Up to 11.6% of the effect of PFAS on neonatal adiposity was mediated by maternal glucose concentrations. Perfluorooctane sulfonate (PFOS) was not significantly associated with any outcomes studied. Conclusions: Follow-up of offspring will determine the potential long-term consequences of lower weight and adiposity at birth associated with prenatal PFAS exposure.			1											1			1		B	A	USA, Healthy Start birth cohort study, 628 (BW)/604 (glucose), 出生時 2009-2014年にリクルート Outcome: BW, %fat mass（子）, glucose, TC, HDL, non-HDL, TG（母） LODの算出方法は不明、LOD未満はinstrument-reported valueで置換し、ゼロの場合は最小濃度/2で置換 PFNA濃度は連続変数はln変換、カテゴリーは中央値以上か未満かの二値 共変量の選択は既報を参照 母親血中PFNA濃度とBW（連続, カテゴリー）、fat mass（カテゴリー）、母親のグルコース濃度（連続, カテゴリー）と負の関連	
733	ヒト（脂質代謝）	Starling, Anne P; Engel, Stephanie M; Whitworth, Kristina W; Richardson, David B; Stuebe, Alison M; Daniels, Julie L; Haug, Line Småstuen; Eggesbø, Merete; Becher, Georg; Sabaredzovic, Azemira; Thomsen, Cathrine; Wilson, Ralph E; Travlos, Gregory S; Hoppin, Jane A; Baird, Donna D; Longnecker, Matthew P	Perfluoroalkyl substances and lipid concentrat	2014	Environ Int. 2014 Jan;62:104-12. doi: 10.1016/j.envint.2013.10.004. Epub 2013 Nov 2.	BACKGROUND: Perfluoroalkyl substances (PFASs) are widespread and persistent environmental pollutants. Previous studies, primarily among non-pregnant individuals, suggest positive associations between PFAS levels and certain blood lipids. If there is a causal link between PFAS concentrations and elevated lipids during pregnancy, this may suggest a mechanism by which PFAS exposure leads to certain adverse pregnancy outcomes, including preeclampsia. METHODS: This cross-sectional analysis included 891 pregnant women enrolled in the Norwegian Mother and Child (MoBa) Cohort Study in 2003-2004. Non-fasting plasma samples were obtained at mid-pregnancy and analyzed for nineteen PFASs. Total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein cholesterol, and triglycerides were measured in plasma. Linear regression was used to quantify associations between each PFAS exposure and each lipid outcome. A multiple PFAS model was also fitted. RESULTS: Seven PFASs were quantifiable in >50% of samples. Perfluorooctane sulfonate (PFOS) concentration was associated with total cholesterol, which increased 4.2mg/dL per inter-quartile shift (95% CI=0.8, 7.7) in adjusted models. Five of the seven PFASs studied were positively associated with HDL cholesterol, and all seven had elevated HDL associated with the highest quartile of exposure. Perfluoroundecanoic acid showed the strongest association with HDL: HDL increased 3.7 mg/dL per inter-quartile shift (95% CI=2.5, 4.9). CONCLUSION: Plasma concentrations of PFASs were positively associated with HDL cholesterol, and PFOS was positively associated with totalcholesterol in this sample of pregnant Norwegian women. While elevated HDL is not an adverse outcome per se, elevated total cholesterol associated with PFASs during pregnancy could be of concern if causal.			1											1		1			B	B	（Aに近い）Norwey, MoBa study, 891人, 19-44歳 1999-2008年にリクルート Outcome: TC, HDL, LDL, TG LOQの算出方法は不明（既報にあり）、LOQ未満の値の対応は不明 PFAS濃度は、連続変数としてはln変換およびIQR単位の増加、カテゴリーとしては四分位 共変量の選択にはDAGを使用 血中PFNA濃度とHDLとの間に正の関連	
734	ヒト（代謝）	Su, T. C.; Kuo, C. C.; Hwang, J. J.; Lien, G. W.; Chen, M. F.; Chen, P. C.	Serum perfluorinated chemicals, glucose home	2016	Environ Int. 2016 Mar;88:15-22. doi: 10.1016/j.envint.2015.11.016. Epub 2015 Dec 14.	Background: The link among perfluoroalkyl and polyfluoroalkyl substances (PFASs), abnormal glucose homeostasis and the risk of diabetes has been intensively debated with conflicting evidence. Objectives: We evaluated the associations among PFASs, oral glucose tolerance testing (OGTT) curves and diabetes prevalence in 571 working-aged Taiwanese participants. Methods: Exposure measures included serum perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA), and perfluoroundecanoic acid (PFUA). Outcomes were OGTT curves and prevalent diabetes defined by fasting blood glucose (FBG) ≥126mg/dL, 2-h glucose ≥200mg/dL, or glycated hemoglobin ≥6.5%. Analyses were performed with multiple logistic regression and functional data analysis. Results: A total of 39 participants (6.8%) had diabetes in this study. After full adjustment, the increase in the geometric means of FBG, 2-h glucose concentrations, and area under the OGTT curve (AUC120) with a doubling increase in PFOS was 3% (95% CI 1-4), 8% (5-12), and 6% (4-9), respectively. Compared to the lowest-quartile of PFOS concentrations (<2.4ng/ml), the OGTT trajectories were significantly steeper in participants of the highest-quartile PFOS exposure (>4.8ng/ml) and the vertical shifting of the mean curve for each PFOS quartile showed a dose-response pattern. The adjusted odds ratio for diabetes comparing the highest to lowest quartile was 3.37 (95% CI 1.18-9.65). For PFOA, PFNA, and PFUA, the opposite pattern of OGTT trajectory and the opposite risk profile for diabetes were observed. Conclusions: Chronic PFOS exposure was associated with impaired glucose homeostasis and the increased prevalence of diabetes. However, PFOA, PFNA, and PFUA showed a potential protective effect against glucose intolerance and the risk of diabetes. Future research focusing on clarifying possible differential effects of different species of PFASs on glucose homeostasis and establishing the prospective associations between PFASs and diabetes is needed.			1											1		1			B	B	Taiwan, 571人（ボランティア）, 20-60歳 2009-2011年にリクルート Outcome: oral glucose tolerance/DM LODの計算方法は不明、LOD未満の値はLOD/2で置換 PFAS濃度は四分位群を使用 共変量の選択方法は不明 血中PFNA濃度とグルコース濃度（時系列で見ても）、糖尿病リスクとの間に負の関連	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用														備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
735	ヒト（代謝）	Sun, Q.; Zong, G.; Valvi, D.; Nielsen, F.; Coull, B.; Grandjean, P.	Plasma concentrations of perfluoroalkyl substa	2018	Environ Health Perspect. 2018 Mar 1;126(3):037001. doi: 10.1289/EHP2619.	Background: Emerging evidence suggests that perfluoroalkyl substances (PFASs) are endocrine disruptors and may contribute to the etiology of type 2 diabetes (T2D), but this hypothesis needs to be clarified in prospective human studies. Objectives: Our objective was to examine the associations between PFAS exposures and subsequent incidence of T2D in the Nurses' Health Study II (NHSII). In addition, we aimed to evaluate potential demographic and lifestyle determinants of plasma PFAS concentrations. Methods: A prospective nested case-control study of T2D was conducted among participants who were free of diabetes, cardiovascular disease, and cancer in 1995-2000 [(mean ± SD): 45.3 ± 4.4 y) of age]. We identified and ascertained 793 incident T2D cases through 2011 (mean ± SD) years of follow-up: 6.7 ± 3.7 y). Each case was individually matched to a control (on age, month and fasting status at sample collection, and menopausal status and hormone replacement therapy). Plasma concentrations of five major PFASs, including perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonate, perfluorononanoic acid, and perfluorodecanoic acid were measured. Odds ratios (ORs) of T2D by PFAS tertiles were estimated by conditional logistic regression. Results: Shorter breastfeeding duration and higher intake of certain foods, such as seafood and popcorn, were significantly associated with higher plasma concentrations of PFASs among controls. After multivariate adjustment for T2D risk factors, including body mass index, family history, physical activity, and other covariates, higher plasma concentrations of PFOS and PFOA were associated with an elevated risk of T2D. Comparing extreme tertiles of PFOS or PFOA, ORs were 1.62 (95% CI: 1.09, 2.41; ptrend=0.02) and 1.54 (95% CI: 1.04, 2.28; ptrend=0.03), respectively. Other PFASs were not clearly associated with T2D risk. Conclusions: Background exposures to PFASs in the late 1990s were associated with higher T2D risk during the following years in a prospective case-control study of women from the NHSII. These findings support a potential diabetogenic effect of PFAS exposures.			1											1						B	B	USA, NHS2, 女性1586人（case793）, 平均45.3歳 1995-2000年にサンプリング⇒2011年まで2年ごとにフォローアップ Outcome: 2型糖尿病 LODの計算方法は不明、LOD未満の値はLOD/√2で置換 PFAS濃度はlog10か三分位群を使用 共変量の選択方法は不明 血中PFNA濃度と2型糖尿病との間に関連なし	
736	ヒト（代謝）	Zhang, C.; Sundaram, R.; Maisog, J.; Calafat, A. M.; Barr, D. B.; Buck Louis, G. M.	A prospective study of prepregnancy serum co	2015	Fertil Steril. 2015 Jan;103(1):184-9. doi: 10.1016/j.fertnstert.2014.10.001. Epub 2014 Oct 22.	Objective: To examine preconception serum concentrations of perfluorooctanoic acid (PFOA) and six other PFCs in relation to gestational diabetes (GDM) risk. Design: Prospective cohort with longitudinal follow-up. Setting: Not applicable. Patient(s): Among 501 women recruited upon discontinuing contraception for the purpose of becoming pregnant, 258 (51%) became pregnant and were eligible for the study, of which 28 (11%) reported having physician-diagnosed GDM during follow-up. Intervention(s): None. Main outcome measure(s): The odds ratios (ORs) and 95% confidence intervals (CIs) of GDM associated with each standard deviation (SD) increment of preconception serum PFOA concentration (ng/mL, log-transformed) and six other PFCs were estimated with the use of logistic regression after adjusting for age, prepregnancy body mass index, smoking, and parity conditional on gravidity. Result(s): Preconception geometric mean (95% CI) PFOA concentrations (in ng/mL) were higher for women with than without GDM (3.94 [3.15-4.93] vs. 3.07 [2.83-3.12], respectively). Each SD increment in PFOA was associated with a 1.87-fold increased GDM risk (adjusted OR 1.86 [95% CI 1.14-3.02]). A slightly increased risk associated with each SD increment for the six other PFCs was observed as well (all ORs >1.0, range 1.06-1.27), although the associations were not statistically significant. Conclusion(s): Our findings suggested that higher environmentally relevant concentrations of PFOA were significantly associated with an increased risk of GDM. If corroborated, these findings may be suggestive of a possible environmental etiology for GDM.			1											1						B	B	USA, LIFE study, 258人の妊婦, 平均30歳 2005-2009年にリクルート Outcome: 妊娠糖尿病（約10%） LODの計算方法およびLOD未満の値への対応は不明（CDCで測定） PFAS濃度はlog(SD) 共変量の選択方法は不明 血中PFNA濃度と妊娠糖尿病との関連なし	
737	ヒト（代謝）	Donat-Vargas, C.; Bergdahl, I. A.; Tornevi, A.; Wennberg, M.; Sommar, J.; Koponen, J.; Kiviranta, H.; Åkesson, A.	Associations between repeated measure of pla	2019	Environ Int. 2019 Mar;124:58-65. doi: 10.1016/j.envint.2019.01.007. Epub 2019 Jan 10.	Background: Perfluoroalkyl substances (PFAS) are persistent synthetic chemicals that may affect components of metabolic risk through the peroxisome proliferator-activated receptor but epidemiological data remain scarce and inconsistent. Objective: To estimate associations between repeated measurements of the main PFAS in plasma and total cholesterol, triglycerides and hypertension among the control subjects from a population-based nested case-control study on diabetes type 2 in middle-aged women and men. Methods: Participants (n = 187) were free of diabetes at both baseline and follow-up visits to the Västerbotten Intervention Programme, 10 years apart: during 1990 to 2003 (baseline) and 2001 to 2013 (follow-up). Participants left blood samples, completed questionnaires on diet and lifestyle factors, and underwent medical examinations, including measurement of blood pressure. PFAS and lipids were later determined in stored plasma samples. Associations for the repeated measurements were assessed using generalized estimating equations. Results: Six PFAS exceeded the limit of quantitation. Repeated measures of PFAS in plasma, cardiometabolic risk factors and confounders, showed an average decrease of triglycerides from -0.16 mmol/l (95% confidence interval [CI]: -0.33, 0.02 for PFOA) to -0.26 mmol/l (95% CI: -0.50, -0.08 for PFOS), when comparing the highest tertile of PFAS plasma levels with the lowest. Associations based on average PFAS measurements and follow-up triglycerides revealed similar inverse associations, although attenuated. The estimates for cholesterol and hypertension were inconsistent and with few exception non-significant. Conclusions: This study found inverse associations between PFAS and triglycerides, but did not support any clear link with either cholesterol or hypertension.			1											1						B	C	Sweden, VIP study, 187人, 平均46/56歳 1990-2003年リクルート、2001-2013年フォローアップ Outcome: TC, TG, 高血圧 LOQの計算方法は不明、PFNAは全てLOQ以上 PFAS濃度はSDに変換と三分位群を使用 共変量の選択は既報を参照 繰り返しサンプリングを考慮した血中PFNA濃度とTGとの間に負の関連（カテゴリーは最高三分位群のみ関連あり）	
738	ヒト（脂質代謝）	Dong, Z.; Wang, H.; Yu, Y. Y.; Li, Y. B.; Naidu, R.; Liu, Y.	Using 2003-2014 U.S. NHANES data to determ	2019	Ecotoxicol Environ Saf. 2019 May 30;173:461-468. doi: 10.1016/j.ecoenv.2019.02.061. Epub 2019 Feb 21.	Exposure to per- and polyfluoroalkyl substances (PFASs) is a major concern due to their widespread occurrence and adverse health outcomes. The possible binding of PFASs to peroxisome proliferator-activated receptors (PPARs) and nuclear receptors raises concerns that PFASs may impact cholesterol levels in human. In this study, the U.S. National Health and Nutrition Examination Survey (NHANES) data were employed to address the temporal trend for PFAS concentrations in biomonitoring and associations between cholesterol levels and PFAS exposure. Compared to the PFAS levels in 2003-2004, the median perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) levels in human serum in 2013-2014 decreased from 3.7 to 1.8 ng/mL, 19.2-4.7 ng/mL, 1.7 ng/mL to 1.3 ng/mL and 0.8 ng/mL to 0.6 ng/mL, respectively. Also, an estimate of 1.5 ± 0.7 mg/dL (95% confidence interval: 0.2 - 2.8) and 0.4 ± 0.2 mg/dL (95% confidence interval: 0.1 - 0.6) total cholesterol increases for unit PFOA and PFOS increase (ng/mL), respectively. By using hybrid approach, RfDs were estimated to be 2.0 ng PFOS/kg per day and 0.8 ng PFOA/kg per day. However, it should be cautious when using proposed RfDs based on data obtained from cross-sectional datasets, especially evidence based on data originating from experimental or animal studies is still controversial.			1											1						A	C	USA, NHANESデータの解析, 11895人(青年2987）, 12-19歳/20-80歳の群で解析 2003-2014年にサンプリング Outcome: TC, HDL, LDL LODの計算方法は不明（NHANESのHP？）、LOD未満の値はLOD/2で置換 PFAS濃度は変換せず解析（1ng/mlあたり） 共変量の選択は既報を参照 血中PFNA濃度とTCおよびLDLとの間に正の関連（毎年見られたわけではない） BMDも算出（RfDはパラメータが足りず算出できず）	
739	ヒト（代謝）	Jain, Ram B	Contribution of diet and other factors to the lev	2014	Int J Hyg Environ Health. 2014 Jan;217(1):52-61. doi: 10.1016/j.ijheh.2013.03.008. Epub 2013 Mar 27.	Contribution of diet and selected risk factors to the levels of four polyfluorinated compounds was evaluated. Data from National Health and Nutrition Examination Survey for the years 2003-2008 were used. Dietary factors accounted for 10.4% to 21.2% of the explained variation. Amount of milk consumed was found to be positively associated ($p<0.01$) with perfluorononanoic acid (PFNA) but negatively associated with perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) ($p<0.01$). Amount of meat and fish consumed was positively associated ($p<0.01$) with PFNA and PFOS. Amount of non-alcoholic beverages consumed was positively associated ($p<0.01$) with PFNA and PFOA. Levels of PFOS increased ($p<0.01$) with increase in the amount of alcoholic beverages consumed. Total amount of alcohol consumed was positively associated ($p<0.01$) with PFNA. Levels of both PFOA and PFOS decreased with increase in total amount of caffeine consumed. Total amount of fat consumed was negatively associated with PFNA and positively associated with PFOS. Total calories consumed were negatively associated with perfluorohexane sulfonate (PFHxS) and PFOS but positively associated with PFNA. New to this study, positive correlations ($p<0.01$) between serum cholesterol and PFNA, PFOA, and PFOS were found. Serum albumin levels were negatively correlated with PFHxS but positively correlated with PFOA and PFOS. Males had statistically significantly higher levels of all four PFCs as compared to females and Mexican Americans had the lowest levels of all four PFCs than other race/ethnic groups. Levels of all four PFCs increased with increase infamily income. Body mass index was negatively correlated with PFNA but positively associated with PFOA. There was a statistically significant decrease in the levels of PFOS over survey years 2003-2008.			1											1						C	C	PFAS濃度を従属変数とした解析であり、非該当と判断	
740	ヒト（代謝）	Jain, R. B.; Ducatman, A.	Roles of gender and obesity in defining correla	2019	Sci Total Environ. 2019 Feb 25;653:74-81. doi: 10.1016/j.scitotenv.2018.10.362. Epub 2018 Oct 29.	Data from National Health and Nutrition Examination Survey (NHANES) for 2005-2014 for those aged ≥20 years fasting for ≥8 h (N = 3629) were analyzed to evaluate the role that gender and obesity play in defining correlations between selected perfluoroalkyl substances (PFAS) and total cholesterol (TC), low density lipoprotein cholesterol (LDL), high density lipoprotein cholesterol (HDL), and triglycerides. PFAS considered for analyses were: perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorodecanoic acid (PFDA), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), perfluoroundecanoic acid (PFUnDA), and 2-(N-methyl-perfluorooctane sulfonamido) acetic acid (Me-FOSAA). Gender and obesity stratified regression models were fitted to estimate associations between PFAS and lipid/lipoproteins with adjustments made for confounders. For obese males, but not for nonobese males, positive associations were found between TC and LDL with PFOA ($\beta = 0.0519$, $p = 0.01$ for TC and $\beta = 0.0822$, $p = 0.03$ for LDL), and PFNA ($\beta = 0.0328$, $p = 0.03$ for TC and $\beta = 0.0679$, $p = 0.04$ for LDL). For obese females, adjusted concentrations of TC increased with increase in the concentrations of PFDA ($\beta = 0.0247$, $p = 0.048$), PFNA ($\beta = 0.0286$, $p = 0.04$), and Me-PFOSAA ($\beta = 0.0274$, $p = 0.02$), and there was a positive association of LDL with PFOS ($\beta = 0.0375$, $p = 0.04$), PFDA ($\beta = 0.0397$, $p = 0.047$), and PFNA ($\beta = 0.0593$, $p = 0.02$). The findings, concerning the relationship of longer chain PFAS to serum lipids, suggest greater susceptibility toelevated TC and LDL cholesterol in the obese participants, with some differences between men and women. The key contributing modifiable risk for nonalcoholic steatosis is obesity, and, the development of nonalcoholic steatosis is recognized to be sexually dimorphic. The epidemiologic observation of a susceptible obese subgroup in our data is consistent with toxicology literature findings of disrupted cholesterol metabolism via induced steatosis following PFAS exposure. Gender differences affect serum concentration of PFAS during the reproductive years, and our data add a secondary question concerning whether they also affect the interaction between PFAS exposure and lipid handling in males and females.			1											1						B	B	（Aに近い）USA, NHANES, 3629人, BMI18.5以上 2005-2014年にサンプリング Outcome: TC, HDL, LDL, TG LODの算出方法は不明（NHANES方式？）、LOD未満の値はMIで補完 PFAS濃度は、log10および10%増加 共変量の選択方法は不明 血中PFNA濃度とTC（肥満男性・女性）、LDL（肥満男性・女性）との間に正の関連、TGと負の関連（非肥満女性）	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
741	ヒト（代謝）	Lin, Chien-Yu; Wen, Li Li; Lin, Lian-Yu; Wen, Ting-Wen; Lien, Guang-Wen; Chen, Chia-Yang; Hsu, Sandy H J; Chien, Kuo-Liong; Sung, Fung-Chang; Chen, Pau-Chung; Su, Ta-Chen	Associations between levels of serum perfluori	2011	Environ Sci Technol. 2011 Dec 15;45(24):10691-8. doi: 10.1021/es201964x. Epub 2011 Nov 17.	In animals, perfluorinated chemicals (PFCs), specifically perfluorooctanoic acid (PFOA) and perfluorooctane sulfate (PFOS), function as peroxisome proliferator-activated receptor (PPAR) alpha agonists. However, the relevance of animal (primarily rodent) data to humans is unresolved. While plasma adiponectin level is very responsive to PPAR gamma agonist drugs, it has not been determined whether adiponectin level is related to serum PFCs concentrations. In the present study, 287 subjects (12-30 years of age) were recruited to determine the relationship between serum level of PFCs and serum level of adiponectin. The results showed males had higher serum PFOS concentrations than females and that those with metabolic syndrome had lower serum PFOA than controls. Besides, it showed regional elevations of the perfluoroundecanoic acid (PFUA) (median concentration: 7.11 ng/mL) in the study subjects. No relationship of PFOA, PFOS, PFUA, and the sum of all four PFCs was found to glucose homeostasis, adiponectin level, lipid profile, and inflammatory markers. The median and the range of perfluorononanoic acid (PFNA) concentration (in ng/mL; for four categories corresponding to the <50, 50-74, 75-89, and ≥90th percentiles) were 0.38 (0.38-1.68), 3.22 (1.73-4.65), 5.85 (4.75-8.29), 10.56 (8.40-25.40), respectively. After controlling for confounding factors, multiple linear regression analysis revealed that the mean natural log-transformed level of adiponectin increased significantly across categories of PFNA (in ng/mL; 8.78, 8.73, 9.06, 9.36; P for trend = 0.010 in the full model). In conclusion, higherserum PFNA concentration is associated with elevated serum adiponectin concentration.			1											1			B	B	Taiwan, 287人 1992-2000年にリクルート、2006-2008年にサンプリング Outcome: TG, HDL, insulin, adiponectin, CRP, HOMA, HOMA-IR LOQの算出方法は不明、LOQ未満の値はLOQ/2で置換 PFAS濃度は、50th未満、50-74th、75-89th、90th以上の四群 共変量の選択方法は不明 血中PFNA濃度とadiponectinとの間に正の関連（特に男児、あるいは、HOMA-IR>0.57）	
742	ヒト（代謝）	Lin, P.; Cardenas, A.; Hauser, R.; Gold, D. R.; Kleinman, K.; Hivert, M. F.; Fleisch, A. F.; Calafat, A. M.; Webster, T. F.; Horton, E. S.; Oken, E.	Per- and polyfluoroalkyl substances and blood	2019	Environ Int. 2019 Aug;129:343-353. doi: 10.1016/j.envint.2019.05.027. Epub 2019 May 28.	Exposure to per- and polyfluoroalkyl substances (PFASs) may interfere with lipid regulation. However, most previous studies were cross-sectional with the risk of reverse causation, suggesting a need for long-term prospective studies. We examined the relationship of baseline plasma PFAS concentrations with repeated measures of blood lipids. We included 888 prediabetic adults from the Diabetes Prevention Program (DPP) and DPP Outcomes Study, who had measurements of 6 plasma PFAS concentrations at baseline (1996-1999) and repeated measures of blood lipids over 15 years of follow-up, and were initially randomized to placebo or a lifestyle intervention. We used linear regression to examine cross-sectional associations of PFAS concentrations and lipid levels at baseline, and evaluated prospective risks of hypercholesterolemia and hypertriglyceridemia using Cox proportional hazard models, and tested for effect modification by study arm. Participants (65.9% female, 0.57 White, 0.659 aged 40-59 years) had comparable PFAS concentrations [e.g., median (IQR) perfluorooctanoic acid (PFOA) 4.9 ng/mL (3.2)] with the general U.S. population in 1999-2000. We observed higher total cholesterol at baseline per doubling of PFOA (β: 6.1 mg/dL, 0.95 CI: 3.1, 9.04), perfluorohexane sulfonic acid (PFHxS, β: 2.2 mg/dL, 0.95 CI: 0.2, 4.3), and perfluorononanoic acid (PFNA, β: 2.9 mg/dL, 0.95 CI: 0.7, 5.0). Prospectively, baseline concentrations of several PFASs, includingPFOA, PFOS, PFHxS and PFNA, predicted higher risks of incident hypercholesterolemia and hypertriglyceridemia, but only in the placebo group and not the lifestyle intervention group. For example, participants in the placebo group with PFOA concentration > median (4.9 ng/mL) were almost twice as likely (HR: 1.90, 0.95 CI: 1.25, 2.88) to develop hypertriglyceridemia compared to those ≤median. Findings suggest adverse effects of some PFASs on lipid profiles in prediabetic adults. However, the detrimental effect was attenuated with a lifestyle intervention.			1											1			B	B	USA, Diabetes Prevention Program (DPP)/DPPO, 888人, 25歳以上 ベースライン1996-1999年（PFAS測定）、フォローアップ2002-2014年 Outcome: TC, TG, LDL, HDL, very low-density lipoprotein, non-HDLC LODの算出方法は不明（CDC？）、LOD未満の値はLOD/√2で置換 PFAS濃度はlog2か4分位群を使用 共変量の選択方法は不明 血中PFNA濃度とTCおよびLDLと正の関連、プラセボ群で高コレステロール血症のリスク上昇、トータル群およびプラセボ群で高トリグリセリド血症のリスク上昇	
743	ヒト（内分泌）	Kim, D. H.; Kim, U. J.; Kim, H. Y.; Choi, S. D.; Oh, J. E.	Perfluoroalkyl substances in serum from South	2016	Environ Res 147: 399-404. doi: 10.1016/j.envres.2016.02.037.	Exposure to perfluoroalkyl substances (PFASs) may disrupt thyroid systems, though the specific effects of PFASs are still being elucidated. Since research regarding exposure in infants is highly limited, our goal was to investigate exposure levels of PFASs in infant serum and correlate these levels with thyroid hormones (THs). This was accomplished by analyzing 16 PFASs in sera from a case group of infants with congenital hypothyroidism and a control group. Total PFAS exposure level was 2.63-44.7ng/mL in the case group and 2.44-22.4ng/mL in the control group. Concentrations of serum perfluorooctanoic acid (PFOA, p<0.01), perfluorononanoic acid (PFNA, p<0.001), perfluorooctanoic acid (PFDA, p<0.005), and perfluoroundecanoic acid (PFUnDA, p<0.005) were significantly higher in the case group than the control group. Levels of certain PFASs (PFOA, perfluorotridecanoic acid [PFTrDA], and perfluorohexane sulfonate [PFHxS]) showed a moderate to weak correlation with relevant antibodies.	1		1			1	1	1							1		1			C	C	ケースコントロール研究であるが、集団情報が乏しく、単相間のみ 濃度情報は使えるか	
744	ヒト（内分泌）	Li, Y.; Cheng, Y.; Xie, Z.; Zeng, F.	Perfluorinated alkyl substances in serum of the	2017	Sci Rep 7: 43380. doi: 10.1038/srep43380.	In this study, eight perfluorinated alkyl substances (PFASs) and five thyroid hormones (TSH, FT4, FT3, TGAb, and TMAb) were determined in 202 human serum samples of the general population of Guangdong, Guangxi and Hainan provinces in southern China. Σ8PFASs concentrations ranged from 0.85 to 24.3 ng/mL with a mean value of 4.66 ng/mL. The PFASs composition profiles of human serum samples nearly make no difference at different locations. A significant increase was observed for Σ8PFASs, PFOS, and PFHxS concentrations with age (p < 0.01). Gender-related differences were found; PFOS, PFHxS, PFBS, and PFOA levels were higher in males (p < 0.05), and the mean concentration of Σ8PFASs was 1.5 times greater in males (6.02 ng/mL) than in females (4.15 ng/mL). PFOS and Σ8PFASs were significantly negatively correlated with FT3 and FT4 and positively correlated with TSH while PFPeA and PFHxA were significantly positively correlated with TGAb and TMAb in all the samples. The opposite associations between FT3, TSH and PFOS, PFOA and PFHxS levels in hypothyroidism and hyperthyroidism group indicate that the PFOS, PFOA and PFHxS enhance the negative feedback mechanisms of the thyroid gland.	1			1		1	1			1							1			C	C	China, manufacturing industry area, 202人, 症状無し・甲状腺機能亢進症・甲状腺機能低下症・橋本病、7割以上が女性 2013-2014年にサンプリング Outcome: 甲状腺ホルモン（TSH, FT4, FT3, TGAb, TMAb） LOD, LOQの算出方法は不明、LOD未満はLOD/√2、LOD以上LOQ未満はLOQ/2 PFAS濃度はlog変換値を使用 共変量の選択方法は不明 重回帰分析はステップワイズ法を採用 （健常者）PFBAとTSHとの間に負の関連、PFHxAとTGAbとの間に正の関連	
745	ヒト（内分泌）	Zoeller, R Thomas; Tan, Shirlee W; Tyl, Rochelle W	General background on the hypothalamic-pituit	2007	Crit Rev Toxicol. 2007 Jan-Feb;37(1-2):11-53. doi: 10.1080/10408440601123446.	This article reviews the thyroid system, mainly from a mammalian standpoint. However, the thyroid system is highly conserved among vertebrate species, so the general information on thyroid hormone production and feedback through the hypothalamic-pituitary-thyroid (HPT) axis should be considered for all vertebrates, while species-specific differences are highlighted in the individual articles. This background article begins by outlining the HPT axis with its components and functions. For example, it describes the thyroid gland, its structure and development, how thyroid hormones are synthesized and regulated, the role of iodine in thyroid hormone synthesis, and finally how the thyroid hormones are released from the thyroid gland. It then progresses to detail areas within the thyroid system where disruption could occur or is already known to occur. It describes how thyroid hormone is transported in the serum and into the tissues on a cellular level, and how thyroid hormone is metabolized. There is an in-depth description of the alpha and beta thyroid hormone receptors and their functions, including how they are regulated, and what has been learned from the receptor knockout mouse models. The nongenomic actions of thyroid hormone are also described, such as in glucose uptake, mitochondrial effects, and its role in actin polymerization and vesicular recycling. The article discusses the concept of compensation within the HPT axis and how this fits into the paradigms that exist in thyroid toxicology/endocrinology. There is a section on thyroid hormone and its role in mammalian development: specifically, how it affects braindevelopment when there is disruption to the maternal, the fetal, the newborn (congenital), or the infant thyroid system. Thyroid function during pregnancy is critical to normal development of the fetus, and several spontaneous mutant mouse lines are described that provide research tools to understand the mechanisms of thyroid hormone during mammalian brain development. Overall this article provides a basic understanding of the thyroid system and its components. The complexity of the thyroid system is clearly demonstrated, as are new areas of research on thyroid hormone physiology and thyroid hormone action developing within the field of thyroid endocrinology. This review provides the background necessary to review the current assays and endpoints described in the following articles for rodents, fishes, amphibians, and birds.	1					1	1	1									C	C	甲状腺機能に関するレビューであり、PFASとの関連は考えられていない	
746	システマティックレビュー（内分泌）	Borghoff, S J; Fitch, S; Rager, J E; Huggett, D	A hypothesis-driven weight-of-evidence analys	2018	Regul Toxicol Pharmacol. 2018 Nov;99:168-181. doi: 10.1016/j.yrtph.2018.09.001. Epub 2018 Sep 18.	Perfluorohexanoic acid (PFHxA) is a potential impurity and environmental degradation product of C6-based fluorotelomer products. Considering the potential endocrine activity of perfluoroalkyl acids, a hypothesis-driven weight-of-evidence (WoE) analysis was conducted to evaluate the potential endocrine disruptor activity of PFHxA, as defined by World Health Organization (WHO), across estrogen (E), androgen (A), thyroid (T), and steroidogenesis (S) pathways. A comprehensive literature search identified primary and secondary studies across species for review. The ToxCast/Tox21 database provided in vitro data. Studies identified were reviewed for reliability, and relevance, with endocrine endpoints ranked, and lines of evidence evaluated across pathways. Overall, PFHxA showed no endocrine effects in Japanese medaka, juvenile rainbow trout, chickens or reproductive parameters in northern bobwhite with no significant activity in rodent repeated-dose toxicity, lifetime cancer, or reproductive and developmental studies. In vitro, there was weak or negative activity for T transport protein or activation of E, A or T receptors. PFHxA was also negative in vitro and in vivo for disrupting steroidogenesis. Based on this WoE endocrine analysis, PFHxA exposure did not cause adverse effects associated with alterations in endocrine activity in these models, as such would not be characterized as an endocrine disruptor according to the WHO definition.			1				1										B	C	PFHxAのシステマティックレビューであり、甲状腺機能については動物実験の結果がまとめられている、参考資料として使用可	
747	ヒト（内分泌）	Zhou, Y.; Hu, L. W.; Qian, Z. M.; Chang, J. J.; King, C.; Paul, G.; Lin, S.; Chen, P. C.; Lee, Y. L.; Dong, G. H.	Association of perfluoroalkyl substances expos	2016	Environ Int 94: 189-195. doi: 10.1016/j.envint.2016.05.018	Polyfluoroalkyl substances (PFASs) are a group of common chemicals that ubiquitously exist in wildlife and humans. However, few studies have researched the effect of PFASs on reproductive hormones in adolescents. To provide information in this regard, we recruited 225 Taiwanese adolescents aged 13-15years from 2009 to 2010 to investigate the relationship between serum PFASs (PFOS, PFOA, PFBS, PFDA, PFDoA, PFHxA, PFHxS, PFNA and PFTA) and reproductive hormone concentrations using a cross-sectional study design. Results showed PFOS and PFTA levels were highest among the PFASs, with a median concentrations of 29.9 (interquartile range: 13.0-43.8) ng/mL and 6 (0.6-25.9) ng/mL in males, and a median concentrations of 28.8 (14.8-42.6) ng/mL and 4.5 (0.3-18.4) ng/mL in females. After adjustment for confounding factors, nonsignificant associations between PFASs and reproductive hormone were found except for PFNA with ln(estradiol) (β=0.2060, 95%CI: 0.0016, 0.4105). When stratified by sex, more significant associations were found in males than in females. Among males, PFASs were negatively associated with ln(testosterone) level for PFOS (β=-0.0029, 95%CI: -0.0055, -0.0003), PFDA (β=-0.2565, 95%CI: -0.4135, -0.0994), PFHxA (β=-0.3095, 95%CI: -0.5942, -0.0248), and PFNA (β=-0.4233, 95%CI: -0.6998, -0.1467). Furthermore, male participant ln(estradiol) levels were positively associated with PFOA (β=0.0921, 95%CI: 0.0186, 0.1656), and PFHxS (β=0.0462, 95%CI:0.0020, 0.0905). Among females, a significant relationship was found only for PFDoA with ln(testosterone) (β=-0.0119, 95%CI: -0.0227, -0.0010). In conclusion, this study showed higher levels of PFASs coincide with lower testosterone and higher estradiol levels, and more significant associations of PFASs with reproductive hormone were found in males than in females.			1	1	1		1	1		1					1		D	C	エストロゲン、テストステロンとの関連についての研究であり、生殖の分類か？	
748	ヒト（内分泌）	Zhou, Y.; Hu, L. W.; Qian, Z. M.; Geiger, S. D.; Parrish, K. L.; Dharmage, S. C.; Campbell, B.; Roponen, M.; Jalava, P.; Hirvonen, M. R.; Heinrich, J.; Zeng, X. W.; Yang, B. Y.; Qin, X. D.; Lee, Y. L.; Dong, G. H.	Interaction effects of polyfluoroalkyl substance	2017	Sci Rep 7: 899. doi: 10.1038/s41598-017-01140-5	To evaluate the interactions between polyfluoroalkyl substances (PFASs) and reproductive hormones and associated asthma, a total of 231 asthmatic and 225 non-asthmatic adolescents were selected from northern Taiwan in the Genetic and Biomarkers study for Childhood Asthma from 2009-2010. The interaction between PFASs and reproductive hormones on asthma was analyzed with a two-level binary logistic regression model. The results showed that, among asthmatics, PFASs were positively associated with estradiol levels and negatively associated with testosterone levels. However, only significant association was identified for PFNA and estradiol in control group. After controlling for hormone levels, associations between PFAS exposure and asthma were consistently stronger among children with higher than lower estradiol, with odds ratios (OR) for asthma ranging from 1.25 for PFOS (95% Confidence Interval [CI]: 0.90, 1.72) to 4.01 for PFDA (95% CI: 1.46, 11.06) among boys and 1.25 for PFOS (95% CI: 0.84, 1.86) to 4.16 for PFNA (95% CI: 1.36, 12.73) among girls. Notably, the interactions between estradiol and PFASs were significant for PFOS (p = 0.026) and PFNA (p = 0.043) among girls. However, testosterone significantly attenuated the association between PFOS and asthma across sex. In conclusions, our findings suggested that reproductive hormones amplify the association between PFASs and asthma among adolescents.			1	1			1								1		D	C	エストロゲン、テストステロンを考慮した喘息との関連についての研究であり、分野違いか？	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
749	ヒト（内分泌）	Andersen, Stine Linding; Andersen, Stig; Liew, Zeyan; Vestergaard, Peter; Olsen, Jørn	Maternal Thyroid Function in Early Pregnancy	2018	J Clin Endocrinol Metab. 2018 Feb 1;103(2):660-670. doi: 10.1210/jc.2017-02171.	CONTEXT: Abnormal maternal thyroid function in pregnancy may impair fetal brain development, but more evidence is needed to refine and corroborate the hypothesis. OBJECTIVE: To estimate the association between maternal thyroid function in early pregnancy and neuropsychological performance of the child at 5 years of age. DESIGN: Follow-up study. PARTICIPANTS: A cohort of 1153 women and their children sampled from the Danish National Birth Cohort. Maternal thyroid-stimulating hormone (TSH) and free thyroxine (fT4) were measured in stored biobank sera from early pregnancy. MAIN OUTCOMES MEASURES: Child neuropsychological test results (Wechsler Intelligence Scale/Test of Everyday Attention), test of motor function (Movement Assessment Battery), and results of parent and teacher reports (Behavior Rating Inventory of Executive Function/Strengths and Difficulties Questionnaire). RESULTS: Altogether 145 children (12.6%) were born to mothers with abnormal thyroid function in the early pregnancy. High maternal TSH and low fT4 were associated with lower child verbal intelligence quotient (adjusted mean difference TSH ≥ 10 mIU/L vs 0.1 to 2.49 mIU/L, -8.9 [95% confidence interval (CI), -15 to -2.4]; fT4 < 10 pmol/l vs 12.0 to 18.99 pmol/l, -13 [95% CI, -19 to -7.3]). Abnormal maternal thyroid function was also associated with adverse motor function and teacher-reported problems of executive function and behavior, and these associations were dominated by exposure to maternal hypothyroxinemia. CONCLUSIONS: Maternal thyroid hormone abnormalities were associated with adverse neuropsychological function of thechild at 5 years of age. For intelligence, marked hypothyroidism was important, whereas for motor function and executive and behavior problems, maternal hypothyroxinemia was predominant.				1					1														C	C	甲状腺機能と神経発達との関連についての論文であり、PFASとの関連は検討されていない	
750	ヒト（内分泌）	Casey, Brian M; Thom, Elizabeth A; Peaceman, Alan M; Varner, Michael W; Sorokin, Yoram; Hirtz, Deborah G; Reddy, Uma M; Wapner, Ronald J; Thorp, John M Jr; Saade, George; Tita, Alan T N; Rouse, Dwight J; Sibai, Baha; Iams, Jay D; Mercer, Brian M; Tolosa, Jorge; Caritis, Steve N; VanDorsten, J Peter	Treatment of Subclinical Hypothyroidism or Hy	2017	N Engl J Med. 2017 Mar 2;376(9):815-825. doi: 10.1056/NEJMoa1606205.	BACKGROUND: Subclinical thyroid disease during pregnancy may be associated with adverse outcomes, including a lower-than-normal IQ in offspring. It is unknown whether levothyroxine treatment of women who are identified as having subclinical hypothyroidism or hypothyroxinemia during pregnancy improves cognitive function in their children. METHODS: We screened women with a singleton pregnancy before 20 weeks of gestation for subclinical hypothyroidism, defined as a thyrotropin level of 4.00 mU or more per liter and a normal free thyroxine (T(4)) level (0.86 to 1.90 ng per deciliter [11 to 24 pmol per liter]), and for hypothyroxinemia, defined as a normal tyrotropin level (0.08 to 3.99 mU per liter) and a low free T(4) level (<0.86 ng per deciliter). In separate trials for the two conditions, women were randomly assigned to receive levothyroxine or placebo. Thyroid function was assessed monthly, and the levothyroxine dose was adjusted to attain a normal thyrotropin or free T(4) level (depending on the trial), with sham adjustments for placebo. Children underwent annual developmental and behavioral testing for 5 years. The primary outcome was the IQ score at 5 years of age (or at 3 years of age if the 5-year examination was missing) or death at an age of less than 3 years. RESULTS: A total of 677 women with subclinical hypothyroidism underwent randomization at a mean of 16.7 weeks of gestation, and 526 with hypothyroxinemia at a mean of 17.8 weeks of gestation. In the subclinical hypothyroidism trial, the median IQ score of the children was 97 (95% confidence interval [CI], 94 to 99) in the levothyroxine group and 94 (95% CI, 92 to 96) inthe placebo group (P=0.71). In the hypothyroxinemia trial, the median IQ score was 94 (95% CI, 91 to 95) in the levothyroxine group and 91 (95% CI, 89 to 93) in the placebo group (P=0.30). In each trial, IQ scores were missing for 4% of the children. There were no significant between-group differences in either trial in any other neurocognitive or pregnancy outcomes or in the incidence of adverse events, which was low in both groups. CONCLUSIONS: Treatment for subclinical hypothyroidism or hypothyroxinemia beginning between 8 and 20 weeks of gestation did not result in significantly better cognitive outcomes in children through 5 years of age than no treatment for those conditions. (Funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development and the National Institute of Neurological Disorders and Stroke; ClinicalTrials.gov number, NCT00388297 .).				1					1														C	C	甲状腺機能低下と神経発達との関連についての論文であり、PFASとの関連は検討されていない	
751	ヒト（内分泌）	Yao, Q.; Shi, R.; Wang, C.; Han, W.; Gao, Y.; Zhang, Y.; Zhou, Y.; Ding, G.; Tian, Y.	Cord blood per- and polyfluoroalkyl substances	2019	Environ Int 129: 573-582. doi: 10.1016/j.envint.2019.03.047	Background: Per- and polyfluoroalkyl substances (PFASs) are widely used in China, but little is known about the association between prenatal PFASs exposure and fetal reproductive development as well as its potential mechanism. Objective: We investigated the effects of cord blood PFASs on fetal reproductive hormones and its potential mechanism in relation to steroidogenic enzymes. Methods: Ten selected PFASs (n = 351) including PFOS, PFOA, PFBS, PFDA, PFDoA, PFHpA, PFHxS, PFNA, PFOSA, and PFUA, and two reproductive hormones estradiol (E2) (n = 351) and testosterone (T) (n = 349) were measured in 351 cord blood serum samples from a Chinese birth cohort between 2010 and 2013. Three steroidogenic enzymes including P450arom (n = 125), 3β-HSD1 (n = 123), and 17β-HSD1 (n = 116) were measured in 125 placental tissue samples. Linear regression tested the associations between cord blood PFASs and reproductive hormones in cord blood. Mediation analysis assessed the role of placental steroidogenic enzymes between cord blood PFASs and reproductive hormones. Results: The positive associations between PFOA, PFHxS and E2 levels, PFOS, PFUA, PFNA and T levels, and PFOS, PFUA and T/E2 ratio were significant. PFUA, PFNA, PFDA, PFHxS, and ΣPFASs were associated with higher P450arom levels. PFHxS was also associated with increased 3β-HSD1 and 17β-HSD1 levels. These associations were more pronounced in females than males when stratified by gender. Furthermore, 17β-HSD1 demonstrated mediating effects in the positive association between cord blood PFHxS and E2 levels in females. Conclusion: Our findings suggested the potential impacts of cord blood PFASs on fetal reproductive hormones, in which steroidogenic enzymes may play important roles. These associations were more pronounced in females than males.				1					1													1	D	C	エストロゲン、テストステロン等との関連を検討した研究であり、分野違いか？	
752	ヒト（内分泌）	Zhang, S.; Tan, R.; Pan, R.; Xiong, J.; Tian, Y.; Wu, J.; Chen, L.	Association of perfluoroalkyl and polyfluoroalky	2018	J Clin Endocrinol Metab 103: 2543-2551. doi: 10.1210/jc.2017-02783	Context: Perfluoroalkyl and polyfluoroalkyl substances (PFASs), a group of ubiquitous environmental chemicals with properties of endocrine disruption, are often detectable in humans. Objective: The current study investigated the association between exposure to PFAS and primary ovarian insufficiency (POI). Design, patients, interventions, and main outcome measures: Levels of plasma PFAS were measured in 120 Chinese women with overt POI and 120 healthy control subjects from 2013 to 2016. Associations between PFAS levels and odds of POI, as well as hormonal profiles, were evaluated using multiple logistic regression and multiple linear regression models. Results: Levels of perfluorooctanate (PFOA), perfluorooctane sulfonate (PFOS), and perfluorohexanesulfonate (PFHxS) were positively associated with the risks of POI (highest vs. lowest tertile, PFOA: OR, 3.80; 95% CI, 1.92-7.49; PFOS: OR, 2.81; 95% CI, 1.46-5.41; PFHxS: OR, 6.63; 95% CI, 3.22-13.65). In patients with POI, levels of PFOS and PFHxS exposure were positively associated with FSH (PFOS: adjusted β, 0.26; 95% CI, 0.15 to 0.38; PFHxS: adjusted β, 0.16; 95% CI, 0.04 to 0.28) and negatively associated with estradiol (PFOS: adjusted β, -0.30; 95% CI, -0.47 to -0.12; PFHxS: adjusted β, -0.19; 95% CI, -0.37 to -0.02). Exposure to PFOS and PFOA was associated with elevation of prolactin (PFOS: adjusted β, 0.17; 95% CI, 0.06 to 0.29; PFOA: adjusted β, 0.16; 95% CI, 0.01 to 0.30) or with a decrease of free triiodothyronine (PFOS: adjusted β, -0.88; 95% CI, -1.64 to -0.09; PFOA: adjusted β, -0.90; 95% CI, -1.88 to 0.09) and thyroxine (PFOS: adjusted β, -2.99; 95% CI, -4.52 to -1.46; PFOA: adjusted β, -3.42; 95% CI, -5.39 to -1.46). Conclusion: High exposure to PFOA, PFOS, and PFHxS is associated with increased risk of POI in humans.				1					1													1	D	C	早発卵巣不全との関連を検討した研究であり、分野違いか？	
753	ヒト（内分泌）	Calvo, Rosa M; Jauniaux, Eric; Gulbis, Beatrice; Asunción, Myriam; Gervy, Christine; Contempré, Bernard; Morreale de Escobar, Gabriella	Fetal tissues are exposed to biologically releva	2002	J Clin Endocrinol Metab. 2002 Apr;87(4):1768-77. doi: 10.1210/jcem.87.4.8434.	Maternal hypothyroxinemia in early pregnancy is often associated with irreversible effects on neuropsychomotor development. To evaluate fetal tissue exposure to maternal thyroid hormones up to midgestation, we measured total T(4) and free T(4) (FT(4)), T(3), rT(3), TSH, and possible binding proteins in first trimester coelomic and amniotic fluids and in amniotic fluid and fetal serum up to 17 wk. Samples were obtained before interruption of maternal-fetal connections. The concentrations in fetal compartments of T(4) and T(3) are more than 100-fold lower than those in maternal serum, and their biological relevance for fetal development might be questioned. We found, however, that in all fetal fluids the concentrations of T(4) available to developing tissues, namely FT(4), reach values that are at least one third of those biologically active in their euthyroid mothers. FT(4) levels in fetal fluids are determined by both their T(4)-binding protein composition and the T(4) or FT(4) in maternal serum. The binding capacity is determined ontogenically, is independent of maternal thyroid status, and is far in excess of the T(4) in fetal fluids. Thus, the availability of FT(4) for embryonic and fetal tissues would decrease in hypothyroxinemic women, even if they were euthyroid. A decrease in the availability of FT(4), a major precursor of intracellular nuclear receptor-bound T(3), may result in adverse effects on the timely sequence of developmental events in the human fetus. These findings ought to influence our present approach to maternal hypothyroxinemia in early pregnancy regardless of whether TSH is increased orwhether overt or subclinical hypothyroidism is detected.				1					1														C	C	PFASとの関連は検討されていない	
754	ヒト（内分泌）	Weiss, Jana M; Andersson, Patrik L; Lamoree, Marja H; Leonards, Pim E G; van Leeuwen, Stefan P J; Hamers, Timo	Competitive binding of poly- and perfluorinate	2009	Toxicol Sci. 2009 Jun;109(2):206-16. doi: 10.1093/toxsci/kfp055. Epub 2009 Mar 17.	Due to their unique surfactant properties, poly- and perfluorinated compounds (PFCs) have been extensively used and can be found all over the environment. Concern about their environmental fate and toxicological properties has initiated several research projects. In the present study, we investigated if PFCs can compete with thyroxine (T(4), i.e., the transport form of thyroid hormone) for binding to the human thyroid hormone transport protein transthyretin (TTR). Such competitive capacity may lead to decreased thyroid hormone levels as previously reported for animals exposed to PFCs. Twenty-four PFCs, together with 6 structurally similar natural fatty acids, were tested for binding capacity in a radioligand-binding assay. The binding potency decreased in the order: perfluorohexane sulfonate > perfluorooctane sulfonate/perfluorooctanoic acid > perfluoroheptanoic acid > sodium perfluoro-1-octanesulfinate > perfluorononanoic acid, with TTR binding potencies 12.5-50 times lower than the natural ligand T(4). Some lower molecular weight compounds with structural similarity to these PFCs were > 100 times less potent than T(4). Simple descriptors based on the two-dimensional molecular structures of the compounds were used to visualize the chemical variation and to model the structure-activity relationship for the competitive potencies of the TTR-binding compounds. The models indicated the dependence on molecular size and functional groups but demanded a more detailed description of the chemical properties and data for validation and further quantitative structure-activity relationship (QSAR) development. Competitivebinding of PFCs to TTR, as observed for human TTR in the present study, may explain altered thyroid hormone levels described for PFC-exposed rats and monkeys. Median human blood levels of the most potent TTR-binding PFCs are one to two orders of magnitude lower than concentration at 50% inhibition (IC(50)) values determined in the present study. In addition, this study contributes to the understanding of the bioaccumulation of PFCs in man and possibly in other wildlife species.				1						1	1							1			C	B	疫学調査の結果ではない	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用														備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
755	ヒト（内分泌）	Berg, V.; Nøst, T. H.; Pettersen, R. D.; Hansen, S.; Veyhe, A. S.; Jorde, R.; Odland, J. Ø.; Sandanger, T. M.	Persistent organic pollutants and the associati	2017	Environ Health Perspect. 2017 Jan;125(1):127-133. doi: 10.1289/EHP152. Epub 2016 May 24.	Background: Disruption of thyroid homeostasis has been indicated in human studies targeting effects of persistent organic pollutants (POPs). Influence on the maternal thyroid system by POPs is of special interest during pregnancy because such effects could impair infant thyroid homeostasis. Objectives: We investigated the association between POPs and thyroid-stimulating hormone (TSH) and thyroid hormones (THs) in mother and child pairs from the Northern Norway Mother-and-Child Contaminant Cohort Study (MISA). Methods: Nineteen POPs and 10 thyroid parameters were analyzed in serum from 391 pregnant women in their second trimester. In addition, TSH concentrations in heel-prick samples from the infants were analyzed by the Norwegian Newborn Screening program. Association studies with a multipollutant approach were performed using multivariate analyses; partial least squares (PLS) regression, hierarchical clustering, and principal component analysis (PCA). Results: Several POPs were significantly associated with TSH and THs: a) PFOS was positively associated with TSH; b) PCBs, HCB, and nonachlors were inversely associated with T3, T4, and FT4; and, c) PFDA and PFUnDA were inversely associated with T3 and FT3. After mutual adjustments for the other contaminants, only PFDA and PFUnDA remained significantly associated with T3 and FT3, respectively. Infants born to mothers within the highest TSH quartile had 10% higher mean concentrations of TSH compared with children born to mothers in the lowest TSH quartile. Conclusion: The present results suggest that background exposures to POPs can alter maternal thyroid homeostasis. This research contributes to the understanding of multipollutant exposures using multivariate statistical approaches and highlights the complexity of investigating environmental concentrations and mixtures in regard to maternal and infant thyroid function. Citation: Berg V, Nøst TH, Pettersen RD, Hansen S, Veyhe AS, Jorde R, Odland JØ, Sandanger TM. 2017. Persistent organic pollutants and the association with maternal and infant thyroid homeostasis: a multipollutant assessment.			1													1		1			B	C	（優先度低い）PFNAとの関連は無し？	
756	ヒト（内分泌）	Bloom, M. S.; Kannan, K.; Spliethoff, H. M.; Tao, L.; Aldous, K. M.; Vena, J. E.	Exploratory assessment of perfluorinated comp	2010	Physiol Behav. 2010 Feb 9;99(2):240-5. doi: 10.1016/j.physbeh.2009.02.005. Epub 2009 Feb 10.	Thyroid hormones play critical roles in human neurodevelopment and adult neurocognitive function. Persistent organohalogen pollutants, such as perfluorinated compounds (PFCs), may interfere with thyroid homeostasis and thus exposures to these compounds might represent risk factors for neurologic and cognitive abnormalities. In this study, serum specimens collected from thirty-one licensed anglers in New York State were analyzed for levels of thyroid stimulating hormone (TSH), free thyroxine (FT(4)), perfluorodecanoic acid (PFDA), perfluorononanoic acid (PFNA), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonate (PFHxS), perfluorooctanoic acid (PFOA), perfluorooctanesulfonate (PFOS), perfluorooctanesulfonamide (PFOSA), and perfluoroundecanoic acid (PFUnDA). PFOS and PFOA occurred in the highest concentrations with geometric means of 19.6 ng/mL (95% CI 16.3-23.5) and 1.3 ng/mL (95% CI 1.2-1.5), respectively. In a cross-sectional analysis, no statistically significant associations were detected for PFCs, or their sum, with TSH or FT(4) at alpha=0.05. However, post hoc power analyses, though limited, suggested that moderate increases in sample size, to 86 and 129 subjects, might facilitate 0.8 power to detect statistically significant associations for FT(4) and PFDA (beta=0.09) and PFUnDA (beta=0.08), respectively. The consumption of sportfish may have contributed to PFDA (r=0.52, P=0.003) and PFUnDA (r=0.40, P=0.025) levels. This preliminary study does not indicate associations between non-occupational PFCs exposures and thyroid function.However, the possibility for weak associations for FT(4) with PFDA and PFUnDA, PFCs measured in low concentrations, is raised. Given the ubiquity of PFCs in the environment and the importance of thyroid function to neurodevelopmental and neurocognitive endpoints, a confirmatory study is warranted.			1													1		1			B	C	（優先度低い）対象者31人、濃度情報あり、関連なし	
757	ヒト（内分泌）	Bonefeld-Jorgensen, E. C.; Long, M.; Bossi, R.; Ayotte, P.; Asmund, G.; Krüger, T.; Ghisari, M.; Mulvad, G.; Kern, P.; Nzulumiki, P.; Dewailly, E.	Perfluorinated compounds are related to breas	2011	Environ Health. 2011 Oct 6;10:88. doi: 10.1186/1476-069X-10-88.	Background: Breast cancer (BC) is the most common cancer for women in the western world. From very few cases an extraordinary increase in BC was observed in the Inuit population of Greenland and Canada although still lower than in western populations. Previous data suggest that exposure to persistent organic pollutants (POPs) might contribute to the risk of BC. Rat studies showed that perfluorinated compounds (PFCs) cause significantly increase in mammary fibroadenomas. This study aimed at evaluating the association between serum levels of POPs/PFCs in Greenlandic Inuit BC cases and their controls, and whether the combined POP related effect on nuclear hormone receptors affect BC risk. Methods: Thirty-one BC cases and 115 controls were sampled during 2000-2003 from various Greenlandic districts. The serum levels of POPs, PFCs, some metals and the combined serum POP related effect on estrogen- (ER), androgen- (AR) and Ah-receptor (AhR) transactivity were determined. Independent student t-test was used to compare the differences and the odds ratios were estimated by unconditional logistic regression models. Results: We observed for the very first time a significant association between serum PFC levels and the risk of BC. The BC cases also showed a significantly higher concentration of polychlorinated biphenyls at the highest quartile. Also for the combined serum POP induced agonistic AR transactivity significant association to BC risk was found, and cases elicited a higher frequency of samples with significant POP related hormone-like agonistic ER transactivity. The AhR toxic equivalent was lowest in cases. Conclusions: The level of serum POPs, particularly PFCs, might be risk factors in the development of BC in Inuit. Hormone disruption by the combined serum POP related xenoestrogenic and xenoandrogenic activities may contribute to the risk of developing breast cancer in Inuit. Further investigations are needed to document these study conclusions.			1													1					D	C	乳がんとの関連を検討した論文であり、分野違いか？	
758	ヒト（内分泌）	Dufour, P.; Pirard, C.; Seghaye, M. C.; Charlier, C.	Association between organohalogenated pollut	2018	Environ Pollut. 2018 Jul;238:389-396. doi: 10.1016/j.envpol.2018.03.058. Epub 2018 Mar 26.	The last decades have seen the increasing prevalence of thyroid disorders. These augmentations could be the consequence of the increasing contamination of the environment by chemicals that may disrupt the thyroid function. Indeed, in vitro studies have shown that many chemicals contaminating our environment and highlighted in human serum, are able to interfere with the thyroid function. Given the crucial importance of thyroid hormones on neurodevelopment in fetus and newborns, the influence of these pollutants on newborn thyroid homeostasis is a major health concern. Unfortunately, the overall evidence for a deleterious influence of environmental pollutants on thyroid remains poorly studied. Therefore, we assessed the contamination by polychlorinated biphenyls (PCBs), organochlorine pesticides and perfluorinated compounds (PFC) in 221 cord blood samples collected in Belgium between 2013 and 2016 Our results showed that compared to previous studies performed on newborns recruited in Belgium during the two last decades, the present pollutant contamination is declining. Multivariate statistical analyses pointed out a decrease of thyroid stimulating hormone (TSH) level in male newborns with detectable level of 4,4'- dichlorodiphenyldichloroethylene (4,4'-DDE) in comparison with those with no detectable level (p = 0.025). We also highlighted a negative association between perfluorononanoic acid (PFNA) concentration and TSH in male newborns (p = 0.018).Logistic regression showed increased odds ratio for presentation of hypothyroid in mother for each one unit augmentation of log natural concentration of PFOA (OR = 2.30, [1.18-4.5]) and PFOS (OR = 2.03 [1.08-3.83]). Our findings showed that the residual contamination by PFCs and organochlorine pollutants in cord blood are correlated with thyroid hormone in the newborns and the risk of hypothyroid in mothers.			1													1					B	B	Belgium, 214人の母子 2013-2016年にリクルート Outcome: 新生児の甲状腺ホルモンTSH、母の甲状腺機能低下症 臍帯血中PFAS：LOQは40%を超えない最大不確実性で測定された最小濃度として定義（？）、LOQ未満はLOQ*DFで置換 PFAS濃度は、母は四分位群、児はln変換値を使用 共変量の選択方法は不明、モデルには単変量解析でp-value<0.20のものを投入 PFNAと母は関連なし、児は男児のみTSH低下	
759	ヒト（内分泌）	Jain, R.	Association between thyroid profile and perfluo	2013	Environ Res. 2013 Oct;126:51-9. doi: 10.1016/j.envres.2013.08.006. Epub 2013 Sep 18.	The effect of six perfluoroalkyl acids (PFAAs), namely, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorodecanoic acid (PFDE), perfluorohexane sulfonic acid (PFHxS), 2-(N-methylperfluorooctane sulfonamide) acetic acid (MPAH), and perfluorononanoic acid (PFNA) on the levels of six thyroid function variables, namely, thyroid stimulating hormone (TSH), free and total thyroxine (FT4, TT4), free and total triiodothyronine (FT3, TT3), and thyroglobulin (TGN) was evaluated. Data from National Health and Nutrition Examination Survey for the years 2007-2008 were used for this evaluation. TSH levels increased with increase in levels of PFOA ($p < 0.01$). There were no statistically significant associations between the levels of FT3, and FT4 with the levels of any of the six PFAAs. Levels of TT3 were found to increase with the levels of PFOA ($p = 0.01$) and TT4 levels were found to increase with increase in PFHxS levels ($p < 0.01$). Males had statistically significantly higher levels of FT3 than females and females had statistically significantly higher levels of TT4 than males. As compared to non-Hispanics whites and Hispanics, non-Hispanic blacks had lower levels of TSH, FT3, TT3, and TT4 but Hispanics had the lowest levels of TGN. Age was negatively associated with FT3 and TT3 but positively associated withFT4 and TT4. Non-smokers had higher levels of TSH and TT4 than smokers and smokers had higher levels of FT3 and TGN than non-smokers. Iodine deficiency was associated with increased levels of TSH, TT3, TT4, and TGN.			1													1		1			B	C	（優先度低い）NHANESデータ、濃度情報なし、関連なし	
760	ヒト（内分泌）	Ji, Kyunghee; Kim, Sunmi; Kho, Younglim; Paek, Domyung; Sakong, Joon; Ha, Jongsik; Kim, Sungkyoon; Choi, Kyungho	Serum concentrations of major perfluorinated c	2012	Environ Int. 2012 Sep 15;45:78-85. doi: 10.1016/j.envint.2012.03.007. Epub 2012 May 9.	Perfluorinated compounds (PFCs) have been frequently detected in both the environment and biota, and have become a growing concern. However, information is limited on the potential sources and human health implications of such exposure. We evaluated the exposure levels of 13 major PFCs among a population (n=633, >12 years of age) in a mid-sized city of Korea, and investigated for their potential dietary sources and the impact on thyroid hormone concentrations. For this purpose, we collected blood samples from a general population in Siheung, Korea and measured for 13 PFCs, total thyroxine (T4), and thyroid stimulating hormone (TSH). In addition, a questionnaire survey on diet was conducted. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) were detected in relatively greater concentrations than the other 9 PFCs in the blood serum. Males tend to have greater concentrations than females for most PFCs, and the concentrations were elevated as age increased up to 50s. Body mass index (BMI) was also shown to influence the serum concentrations of several PFCs. After adjustment for age, sex, and BMI, the consumption of vegetable, potato, fish/shellfish, and popcorn was identified to be significantly related with concentrations of major PFCs in blood. Among the studied PFCs, the concentrations of perfluorotridecanoic acid (PFTrDA) were negatively correlated with total T4, and positively with TSH levels, especially among females. The result of this study will provide information useful for developing public health and safety management measuresfor PFCs.			1													1		1			B	B	韓国、633人、濃度情報あり、TSHおよびT4と関連なし 芋の摂取と血中PFNAとの間に関連あり	
761	ヒト（内分泌）	Lewis, R. C.; Johns, L. E.; Meeker, J. D.	Serum Biomarkers of Exposure to Perfluoroalky	2015	Int J Environ Res Public Health. 2015 May 29;12(6):6098-114. doi: 10.3390/ijerph120606098.	Perfluoroalkyl substances (PFASs) are a group of environmentally-persistent chemicals that have been widely used in many industrial applications. There is human and animal evidence that PFASs may alter levels of reproductive and thyroid-related hormones. However, human studies on the potential age-related effects of PFASs on these outcomes among males and females are limited. We explored the relationship between serum PFASs and serum total testosterone (T), thyroid stimulating hormone (TSH), and free and total triiodothyronine (FT3, TT3) and thyroxine (FT4, TT4) among males and females 12 to 80 years of age from the 2011-2012 cycle of the National Health and Nutrition Examination Survey. Associations were assessed using multiple linear regression models that were stratified on sex and age categories. Effect estimates from the majority of the adjusted models were not statistically significant. However, exposure to PFASs may be associated with increases in FT3, TT3, and FT4 among adult females, but during adolescence, PFASs may be related to increases in TSH among males and decreases in TSH among females. No significant relationships were observed between PFASs and T in any of the models. These findings suggest that exposure to PFASs may disrupt thyroid hormone homeostasis.			1													1		1			B	C	（生殖分野？）NHANESデータ、1682人 2011-2012年データ Outcome: テストステロン、FT3/TT3、FT4/TT4、TSH LOD算出方法は不明（NHANES）、LOD未満はLOD/√2で置換 PFAS濃度はlog2変換値を使用 共変量の選択方法は不明、モデルには単変量解析でPFAS濃度の10%変動が見られた変数を投入 男性では、12-19歳で、血中PFNAとTSHとの間に正の関連（16.3%増加） 女性では、20-39歳で、血中PFNAとFT4戸の間に正の関連（2.4%増加）	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用														備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
762	ヒト（内分泌）	Lopez-Espinosa, M. J.; Mondal, D.; Armstrong, B.; Bloom, M. S.; Fletcher, T.	Thyroid function and perfluoroalkyl acids in chi	2012	Environ Health Perspect. 2012 Jul;120(7):1036-41. doi: 10.1289/ehp.1104370. Epub 2012 Mar 27.	Background: Animal studies suggest that some perfluoroalkyl acids (PFAAs), including perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), and perfluorononanoic acid (PFNA) may impair thyroid function. Epidemiological findings, mostly related to adults, are inconsistent. Objectives: We investigated whether concentrations of PFAAs were associated with thyroid function among 10,725 children (1-17 years of age) living near a Teflon manufacturing facility in the Mid-Ohio Valley (USA). Methods: Serum levels of thyroid-stimulating hormone (TSH), total thyroxine (TT4), and PFAAs were measured during 2005-2006, and information on diagnosed thyroid disease was collected by questionnaire. Modeled in utero PFOA concentrations were based on historical information on PFOA releases, environmental distribution, pharmacokinetic modeling, and residential histories. We performed multivariate regression analyses. Results: Median concentrations of modeled in utero PFOA and measured serum PFOA, PFOS, and PFNA were 12, 29, 20, and 1.5 ng/mL, respectively. The odds ratio for hypothyroidism (n = 39) was 1.54 [95% confidence interval (CI): 1.00, 2.37] for an interquartile range (IQR) contrast of 13 to 68 ng/mL in serum PFOA measured in 2005-2006. However, an IQR shift in serum PFOA was not associated with TSH or TT4 levels in all children combined. IQR shifts in serum PFOS (15 to 28 ng/mL) and serum PFNA (1.2 to 2.0 ng/mL) were both associated with a 1.1% increase in TT4 in children 1-17 years old (95% CIs: 0.6, 1.5 and 0.7, 1.5 respectively). Conclusions: This is the first large-scale report in children suggesting associations of serum PFOS and PFNA with thyroid hormone levels and of serum PFOA and hypothyroidism.			1													1		1			B	B	USA, C8 project, 10725人, 1-17歳 2005-2006年にサンプリング LODは検量線の一番下の濃度？、LOD未満はLOD/2で置換 Outcome: TT4, TSH PFAS濃度は、ln変換値および四分位群で解析 血中PFNAとTT4との間に正の関連（年齢4群別（+性別）に見ても関連が見られるが、リニアではない 疾患の有無とは関連なし	
763	ヒト（内分泌）	Lopez-Espinosa, M. J.; Mondal, D.; Armstrong, B. G.; Eskenazi, B.; Fletcher, T.	Perfluoroalkyl Substances, Sex Hormones, and	2016	Environ Health Perspect. 2016 Aug;124(8):1269-75. doi: 10.1289/ehp.1509869. Epub 2016 Jan 22.	Background: Exposure to some perfluoroalkyl substances (PFAS), such as perfluorohexane sulfonate (PFHxS), perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), and perfluorononanoic acid (PFNA), may alter levels of sex hormones and insulin-like growth factor-1 (IGF-1) in animals. Human studies on this topic are scarce, and none have been conducted in young children. Objectives: We investigated the relationship between levels of PFAS and estradiol, total testosterone, and IGF-1 in 2,292 children (6-9 years of age) from the C8 Health Project who lived near a chemical plant in the Mid-Ohio Valley (USA) with local contamination from PFOA. Methods: Serum samples were collected in 2005-2006 and analyzed for PFAS, sex hormones, and IGF-1. Results from regression models were expressed as the adjusted percentage difference (95% CI) per sex-specific interquartile range (IQR) increment of each PFAS serum concentration. Analyses by PFAS quartiles were also conducted. Results: Median concentrations of PFHxS, PFOA, PFOS, and PFNA were 8, 35, 22, and 1.7 ng/mL in boys and 7, 30, 21, and 1.7 ng/mL in girls. In boys, PFOA concentrations were significantly associated with testosterone levels (-4.9%; 95% CI: -8.7, -0.8%); PFOS with estradiol (-4.0%; 95% CI: -7.7, -0.1%), testosterone (-5.8%; 95% CI: -9.4, -2.0%), and IGF-1 (-5.9%; 95% CI: -8.3, -3.3%); and PFNA with IGF-1 (-3.5%; 95% CI: -6.0, -1.0%). In girls, significant associations were found between PFOS and testosterone (-6.6%; 95% CI: -10.1, -2.8%) and IGF-1 (-5.6%; -8.2, -2.9%); and PFNA and IGF-1 (-3.8%; 95% CI: -6.4, -1.2%). In both sexes, the magnitudes of the associations decreased monotonically across quartiles for both testosterone and IGF-1 in relation to PFOS, and for IGF-1 and PFNA in girls. Conclusions: To our knowledge, this is the first study suggesting that PFAS are associated with lower levels of IGF-1 and sex hormones in young children.			1													1					D	B	エストロゲン、テストステロン、IGF-1との関連を検討した研究であり、生殖分野か？	
764	ヒト（内分泌）	Maisonet, M.; Calafat, A. M.; Marcus, M.; Jaakkola, J. J.; Lashen, H.	Prenatal exposure to perfluoroalkyl acids and s	2015	Environ Health Perspect. 2015 Dec;123(12):1325-30. doi: 10.1289/ehp.1408847. Epub 2015 Jun 2.	Background: Exposure to perfluorooctane sulfonic acid (PFOS) or to perfluorooctanoic acid (PFOA) increases mouse and human peroxisome proliferator-activated receptor alpha (PPARα) subtype activity, which influences lipid metabolism. Because cholesterol is the substrate from which testosterone is synthesized, exposure to these substances has the potential to alter testosterone concentrations. Objectives: We explored associations of total testosterone and sex hormone-binding globulin (SHBG) concentrations at age 15 years with prenatal exposures to PFOS, PFOA, perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) in females. Methods: Prenatal concentrations of the perfluoroalkyl acids (PFAAs) were measured in serum collected from pregnant mothers at enrollment (1991-1992) in the Avon Longitudinal Study of Parents and Children (ALSPAC). The median gestational age when the maternal blood sample was obtained was 16 weeks (interquartile range, 11-28 weeks). Total testosterone and SHBG concentrations were measured in serum obtained from their daughters at 15 years of age. Associations between prenatal PFAAs concentrations and reproductive outcomes were estimated using linear regression models (n = 72). Results: Adjusted total testosterone concentrations were on average 0.18-nmol/L (95% CI: 0.01, 0.35) higher in daughters with prenatal PFOS in the upper concentration tertile compared with daughters with prenatal PFOS in the lower tertile. Adjusted total testosterone concentrations were also higher in daughters with prenatal concentrations of PFOA (β = 0.24; 95% CI: 0.05, 0.43) and PFHxS (β = 0.18; 95% CI: 0.00, 0.35) in the upper tertile compared with daughters with concentrations in the lower tertile. We did not find evidence of associations between PFNA and total testosterone or between any of the PFAAs and SHBG. Conclusions: Our findings were based on a small study sample and should be interpreted with caution. However, they suggest that prenatal exposure to some PFAAs may alter testosterone concentrations in females.			1													1					D	C	女子のテストステロンとの関連を検討した研究であり、生殖分野か？	
765	ヒト（内分泌）	Preston, E. V.; Webster, T. F.; Oken, E.; Claus Henn, B.; Mcclean, M. D.; Rifas-Shiman, S. L.; Pearce, E. N.; Braverman, L. E.; Calafat, A. M.; Ye, X.; Sagiv, S. K.	Maternal plasma per- and polyfluoroalkyl subs	2018	Environ Health Perspect. 2018 Feb 27;126(2):027013. doi: 10.1289/EHP2534.	Background: Prenatal exposure to some per- and polyfluoroalkyl substances (PFASs) may disrupt maternal and neonatal thyroid function, which is critical for normal growth and neurodevelopment. Objectives: We examined associations of PFAS exposure during early pregnancy with maternal and neonatal thyroid hormone levels. Methods: We studied 732 mothers and 480 neonates in Project Viva, a longitudinal prebirth cohort in Boston, Massachusetts. We quantified six PFASs, including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), and maternal thyroid hormones [thyroxine (T4), Free T4 Index (FT4I), thyroid stimulating hormone (TSH)] in plasma samples collected at a median 9.6 wk gestation and neonatal T4 levels from postpartum heel sticks. We estimated associations of PFAS concentrations with thyroid hormone levels using covariate-adjusted linear regression models and explored effect measure modification by maternal thyroid peroxidase antibody (TPOAb) status and infant sex. Results: PFAS concentrations were not associated with maternal T4, but PFOA, perfluorohexane sulfonate (PFHxS), and 2-(N-methyl-perfluorooctane sulfonamido) acetate (MeFOSAA) were inversely associated with maternal FT4I [e.g., -1.87% (95% confidence interval (CI): -3.40, -0.31) per interquartile (IQR) increase in PFOA]. PFAS concentrations [PFOA, PFOS, and perfluorononanoate (PFNA)] were inversely associated with TSH levels in TPOAb-positive women only. Prenatal PFOS, PFOA, and PFHxS concentrations were inversely associated with T4 levels in male [e.g., PFHxS, quartile 4 vs.1: -2.51 μg/dL (95% CI: -3.99, -1.04)], but not female neonates [0.40 μg/dL (95% CI: -0.98, 1.79)]. Conclusions: In this study, prenatal exposure to some PFASs during early pregnancy was inversely associated with maternal FT4I and neonatal T4 in male infants. These results support the hypothesis that prenatal exposure to PFASs influences thyroid function in both mothers and infants.			1													1					B	B	USA, Viva project, 母732, 児480 1999－2002年にサンプリング Outcome: 母FT4、TT4、TSH、児TT4 母甲状腺ペルオキシターゼ抗体も測定 LODの算出方法は不明（CDCで測定）、LOD未満はLOD/√2 eGFRを測定しているが、共変量として用いられていない？ 共変量の選択方法は不明（一部文献を参照） 母甲状腺ペルオキシターゼ抗体有群において、母TSHと負の関連	
766	ヒト（内分泌）	Shah-Kulkarni, S.; Kim, B. M.; Hong, Y. C.; Kim, H. S.; Kwon, E. J.; Park, H.; Kim, Y. J.; Ha, E. H.	Prenatal exposure to perfluorinated compound	2016	Environ Int. 2016 Sep;94:607-613. doi: 10.1016/j.envint.2016.06.024. Epub 2016 Jul 7.	Perfluorinated compounds (PFCs) are ubiquitous in the environment and have been detected in humans and wildlife. Exposure to PFCs has decreased in the United States recently, while exposure to PFCs continues in Asian countries, which represents a public health concern. Various mechanisms by which PFCs affect fetal growth have been proposed, such as activation of peroxisome proliferators, disruption of thyroid hormones and changes in lipid metabolism. However, the overall evidence for an association with thyroid hormones is not strong. Therefore, we examined the effect of various prenatal PFCs on cord blood thyroid hormones: triiodothyronine (T3), thyroxine (T4), thyroid stimulating hormone (TSH) levels, and explored the endocrine disrupting effect of these PFCs on thyroid hormone levels in children according to gender. Two hundred and seventy-nine study participants were selected from among the enrolled participants in the Ewha Birth & Growth Retrospective Cohort, a retrospective birth cohort study conducted at Ewha Womans University Hospital, Seoul, Korea between 2006 and 2010 A generalized linear model was constructed to explore the association of PFCs and thyroid hormones. Further, an analysis stratified by gender was conducted. Our study shows that cord blood perfluoro n-pentanoic acid (PFPeA) was positively associated with cord blood T4 (p=0.01) level.Gender-specific analysis showed that prenatal PFCs: PFPeA and Perfluorohexane sulfonic acid (PFHxS) exposure significantly increased T4 (p<0.01) and T3 (p=0.03), respectively, while perfluorononanoic acid (PFNA) decreased TSH (p=0.04) concentration in newborn girls. Thus, prenatal PFC exposure may disrupt thyroid hormone homeostasis. Thyroid hormones play a crucial role in fetal development and may have gender specific action. Hence, these results are of utmost importance in high-risk groups, such as pregnant women and children.			1													1		1			B	B	韓国, EBGRCコホート, 279名の母子 2006－2010年にサンプリング Outcome: 臍帯血中のT3,T4,TSH 臍帯血中PFAS濃度のLOD, LOQの算出方法は不明、LOD未満はLOD/√2 PFAS濃度はln変換値を使用 共変量の選択方法は不明 女児のみPFNA濃度とTSHとの間に負の関連	
767	ヒト（内分泌）	Tsai, M. S.; Lin, C. C.; Chen, M. H.; Hsieh, W. S.; Chen, P. C.	Perfluoroalkyl substances and thyroid hormone	2017	Environ Pollut. 2017 Mar;222:543-548. doi: 10.1016/j.envpol.2016.11.027. Epub 2016 Dec 23.	Background: Perfluoroalkyl substances (PFASs) are pollutants that tend to accumulate in the environment and organisms. The animal and human studies to date have focused on thyroid function, but the results are inconsistent. Methods: A sample of 118 mother-infant pairs was obtained from the Taiwan Birth Panel Study (TBPS). Cord blood PFASs levels were evaluated using the Waters ACQUITY UPLC system coupled with a Waters Quattro Premier XE triple quadrupole mass spectrometer, and cord blood thyroid hormones were assessed using a Roche Analytics E170 modular analyser (Roche Diagnostics, Mannheim, Germany). PFASs concentrations were analysed in the final models to examine the associations between cord blood PFASs levels and thyroid hormone concentrations. Results: The cord blood perfluorooctane sulfonate (PFOS) concentration was negatively associated with the cord blood thyroxine (T4) concentration [per ln unit: adjusted β (95% confidence interval, CI) = -0.458(-0.916, -0.001)]. Moreover, the level of cord blood thyroid stimulating hormone (TSH) was positively associated with the cord blood PFOS concentration [per ln unit: adjusted β (95% confidence interval, CI) = 0.346(0.101, 0.592)]. The sex stratified effects of PFOS on T4 were suggestive of differential effects in high-exposure groups compared with low-exposure group in boys. Conclusions: We found that cord blood thyroid hormone levels are affected by PFASs, with a negative association between T4 and PFOS and a positive association between TSH and PFOS. The causal associations of thyroid hormones and PFASs require further exploration.			1													1					B	B	台湾, TBPSコホート, 118組の母子 2004－2005年にサンプリング Outcome: 臍帯血中T3, T4, TSH, FT3, FT4 臍帯血中PFAS濃度のLOD, LOQ算出方法は不明、LOQ未満はLOQ/2 PFAS濃度は、ln変換値および4群（<40, 40以上59未満, 60以上89未満, 90th以上）に分類⇒検出率は68.5% 共変量の選択方法は不明 男児のみ、T4最高3分位群でPFNAと負の関連	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
768	ヒト（内分泌）	Tsai, M. S.; Lin, C. Y.; Lin, C. C.; Chen, M. H.; Hsu, S. H.; Chien, K. L.; Sung, F. C.; Chen, P. C.; Su, T. C.	Association between perfluoroalkyl substances	2015	Int J Hyg Environ Health. 2015 Jul;218(5):437-43. doi: 10.1016/j.ijheh.2015.03.008. Epub 2015 Mar 26.	Background: Few studies have explored the association between perfluoroalkyl substances (PFAS) and reproductive hormones in adolescents and young adults. Objectives: This study aimed to investigate the association of PFAS with reproductive hormones in adolescents and young adults. Methods: We recruited 540 subjects aged 12-30 years from a 1992 to 2000 mass urine screening population and established a cohort from 2006 to 2008 via invitations by mail or/and telephone. Serum PFAS levels were analyzed with a Waters ACQUITY UPLC system coupled with a Waters Quattro Premier XE triple quadrupole mass spectrometer. Serum reproductive hormone levels were measured by immunoluminometric assay with an Architect random access assay system. PFAS levels were divided into different percentiles according to their detection limits in the multiple regression models to analyze associations between reproductive hormone levels and exposure with PFAS. Results: The adjusted mean serum level of sex hormone-binding globulin (SHBG) decreased significantly in association with the <50th, 50-75, 75-90 and >90th percentile categories of perfluorooctanoic acid (PFOA) compared with a reference category for the females in the 12-17-year-old group. The follicle-stimulating hormone (FSH) levels were significantly decreased in association with the different percentile categories of perfluorooctane sulfonate (PFOS) in the male 12-17-year-old group and the different percentile categories of perfluoroundecanoic acid (PFUA) in the female 12-17-year-old group. The serum FSH levels in the females aged 12-17 were also decreased in association with the different percentile categories of PFUA. On the other hand, there was a significantly negative association between the different percentile categories of PFOS and the serum testosterone level among the female 12-17-year-old group. Conclusions: We found that the serum concentrations of PFOA, PFOS, and PFUA were negatively associated with the serum levels of SHBG, FSH, and testosterone in the young Taiwanese population and that these effects were the strongest in the females aged 12-17. Further studies are needed to determine whether these associations are causal.			1												1					D	C	エストロゲン、テストステロン等との関連を検討した研究であり、分野違いか？	
769	ヒト（内分泌）	Wang Y, Starling AP, Haug LS, et al.	Association between perfluoroalkyl substances	2013	Environ Health 12(1):76. doi: 10.1186/1476-069x-12-76.	Background: Perfluoroalkyl substances (PFASs) are a group of highly persistent chemicals that are widespread contaminants in wildlife and humans. Exposure to PFAS affects thyroid homeostasis in experimental animals and possibly in humans. The objective of this study was to examine the association between plasma concentrations of PFASs and thyroid stimulating hormone (TSH) among pregnant women. Methods: A total of 903 pregnant women who enrolled in the Norwegian Mother and Child Cohort Study from 2003 to 2004 were studied. Concentrations of thirteen PFASs and TSH were measured in plasma samples collected around the 18th week of gestation. Linear regression models were used to evaluate associations between PFASs and TSH. Results: Among the thirteen PFASs, seven were detected in more than 60% of samples and perfluorooctane sulfonate (PFOS) had the highest concentrations (median, 12.8 ng/mL; inter-quartile range [IQR], 10.1 -16.5 ng/mL). The median TSH concentration was 3.5 (IQR, 2.4 - 4.8) μIU/mL. Pregnant women with higher PFOS had higher TSH levels. After adjustment, with each 1 ng/mL increase in PFOS concentration, there was a 0.8% (95% confidence interval: 0.1%, 1.6%) rise in TSH. The odds ratio of having an abnormally high TSH, however, was not increased, and other PFASs were unrelated to TSH. Conclusions: Our results suggest an association between PFOS and TSH in pregnant women that is small and may be of no clinical significance.			1												1					B	D	Norway, MoBa study, 903人の妊娠女性 2003-2004年にサンプリング Outcome: TSH PFAS濃度のLOQ算出方法は不明（既報にあり？）、LOQ未満はLOQ/√2で置換（PFNAは99%検出） PFASはlog変換せず解析 共変量は既報を参照→PFASおよびTSHと関連が見られた（p<0.1）変数を最終モデルに投入 血中PFNA濃度とTSHとの間に関連なし	
770	ヒト（内分泌）	Webster, Glenys M; Rauch, Stephen A; Marie, Nathalie Ste; Mattman, Andre; Lanphear, Bruce P; Venners, Scott A	Cross-Sectional Associations of Serum Perfluo	2016	Environ Health Perspect. 2016 Jul;124(7):935-42. doi: 10.1289/ehp.1409589. Epub 2015 Oct 30.	BACKGROUND: Perfluoroalkyl acids (PFASs) are suspected thyroid toxicants, but results from epidemiological studies are inconsistent. OBJECTIVES: We examined associations between serum PFASs and thyroid hormones (THs) in a representative, cross-sectional sample of U.S. adults. We hypothesized that people with high thyroid peroxidase antibodies and low iodine would be more susceptible to PFAS-induced thyroid disruption. METHODS: Our sample included 1,525 adults (≥ 18 years) from the 2007-2008 NHANES study with available serum PFASs and THs. We examined associations between four serum PFASs [perfluorohexane sulfonate (PFHxS), perfluorononanoate (PFNA), perfluorooctanoate (PFOA), and perfluorooctane sulfonate (PFOS)], and serum THs [free triiodothyronine (fT3), free thyroxine (fT4), fT3/fT4, thyroid-stimulating hormone (TSH), total T3 (TT3), and total T4 (TT4)] using multivariable linear regression. We stratified subjects into four groups by two indicators of thyroid "stress": thyroid peroxidase antibody (TPOAb ≥ 9 IU/mL) and iodine status (< 100 μg/L urine). RESULTS: Of 1,525 participants, 400 (26%) had low iodine only (T0I1), 87 (6%) had high TPOAb only (T1I0), and 26 (2%) had both high TPOAb and low iodine (T1I1). In general, associations were similar among participants in the groups with neither (T0I0) or only one thyroid stressor (T0I1 or T1I0), suggesting that PFAS-TH associations were not modified by high TPOAb or low iodine alone. However, PFHxS and PFOS were negatively associated ($p < 0.05$) with fT4, and all four PFASs were positively associated ($p < 0.05$) with fT3, fT3/fT4, TSH, and TT3 in the group with jointexposure to high TPOAb and low iodine (T1I1). CONCLUSIONS: We found evidence of PFAS-associated thyroid disruption in a subset of U.S. adults with high TPOAb (a marker of autoimmune hypothyroidism) and low iodine status, who may represent a vulnerable subgroup. However, the small sample size, cross-sectional design, and possibility of reverse causation are limitations of this work. CITATION: Webster GM, Rauch SA, Ste Marie N, Mattman A, Lanphear BP, Venners SA. 2016. Cross-sectional associations of serum perfluoroalkyl acids and thyroid hormones in U.S. adults: variation according to TPOAb and iodine status (NHANES 2007-2008).			1												1		1			B	B	（解釈難しい）NHANES, 1525人, 18歳以上 PFNA濃度データあり Outcome: FT4, TT4, FT3, TT3, TSH, FT3/FT4 高TPO抗体かつ低ヨウ素群において、PFNAとfT4との間に負の関連、その他との間に正の関連（TT4は関連無し）、但し、該当群の人数は26名と少ない	
771	ヒト（内分泌）	Wen, L. L.; Lin, L. Y.; Su, T. C.; Chen, P. C.; Lin, C. Y.	Association between serum perfluorinated che	2013	J Clin Endocrinol Metab. 2013 Sep;98(9):E1456-64. doi: 10.1210/jc.2013-1282. Epub 2013 Jul 17.	Context: Perfluorinated chemicals (PFCs) have been widely used in a variety of products worldwide for years. The relationship between serum PFCs and thyroid function has never been addressed in a nationally representative survey. Objectives: The study examined the association between serum PFCs and thyroid function in the general U.S. population. Design and participants: We selected 1181 subjects (aged >20 years) from a National Health and Nutrition Examination Survey (NHANES) in 2007 through 2008 and 2009 through 2010 to determine the relationship between serum PFCs and thyroid function. Data were adjusted for confounding variables. Results: The geometric means and 95% confidence interval (CI) concentrations of perfluorooctanoate (PFOA), perfluorooctane sulfonate, perfluorononanoic acid, and perfluorohexane sulfonate (PFHxS) were 4.15 (4.02-4.29), 14.2 (13.59-14.86), 1.54 (1.48-1.59), and 2.00 (1.89-2.11) ng/mL, respectively. After weighting for sampling strategy, we determined a 1-U increase in natural log-serum PFOA increased serum total T3 concentration by 6.628 ng/dL (95% CI = 0.545-12.712, P = .035) in women. A 1-U increase in natural log-PFHxS was associated with an increase of total T4 by 0.26 μg/mL (95% CI = 0.108-0.413, P = .002) and total T3 by 4.074 ng/dL (95% CI = 2.232-5.916, P < .001) in women and a decrease of natural log-free T4 by 0.016 (ng/dL) (95% CI = -0.029 to 0.003, P = .019) in men. Conclusion: Higher serum concentrations of PFOA and PFHxS are associated with total T3, total T4, and free T4 in the U.S. general population. More studies are warranted to clarify the causal relationship between PFCs and thyroid function.			1												1		1			B	B	USA, NHANES, 1181人, 20歳以上 2007－2008年, 2009-2010年データ Outcome: TT4, FT4, TT3, FT3, TSH, thyroglobin PFNA濃度はln変換値を使用、LOD未満（0.4%）はLOD/√2で置換 共変量の選択方法は不明（既報も参照）、尿中ヨウ素濃度あり 血中PFNAとの関連は無し	
772	ヒト（内分泌）	Heffernan, A. L.; Cunningham, T. K.; Drage, D. S.; Aylward, L. L.; Thompson, K.; Vijayasarathy, S.; Mueller, J. F.; Atkin, S. L.; Sathyapalan, T.	Perfluorinated alkyl acids in the serum and foll	2018	Int J Hyg Environ Health. 2018 Aug;221(7):1068-1075. doi: 10.1016/j.ijheh.2018.07.009. Epub 2018 Jul 20.	Women with polycystic ovarian syndrome (PCOS) undergoing treatment for infertility could be a sensitive subpopulation for endocrine effects of exposure to perfluorinated alkyl acids (PFAAs), persistent organic pollutants with potential endocrine activity. Women with, PCOS (n = 30) and age- and BMI-matched controls (n = 29) were recruited from a UK fertility clinic in 2015 Paired serum and follicular fluid samples were collected and analysed for 13 PFAAs. Sex steroid and thyroid hormones, and metabolic markers were measured and assessed for associations with serum PFAAs. Four PFAAs were detected in all serum and follicular fluid samples and concentrations in the two matrices were highly correlated ($R2 > 0.95$): perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonate (PFHxS), and perfluorononanoic acid (PFNA). Serum PFOS was positively associated with age (1 ng/mL per yr, $p < 0.05$) and was higher in PCOS cases than controls (geometric mean [GM] 3.9 vs. 3.1 ng/mL, $p < 0.05$) and in women with irregular vs. regular menstrual cycles (GM 3.9 vs. 3.0 ng/mL, $p = 0.01$). After adjustment for confounders, serum testosterone was significantly associated with PFOA, PFHxS, PFNA, and the molar sum of the four frequently detected serum PFAAs (approximately 50 percent increase per ln-unit) among controls but not PCOS cases. HbA1c in PCOS cases was inversely associated with serumPFOA, PFHxs, and sum of PFAAs (2-3 mmol/mol per ln-unit). In controls, fasting glucose was positively associated with serum PFOA and sum of PFAAs (0.25 nmol/L per ln-unit increase in PFAAs). Few other associations were observed. The analyses and findings here should be considered exploratory in light of the relatively small sample sizes and large number of statistical comparisons conducted. However, the data do not suggest increased sensitivity to potential endocrine effects of PFAAs in PCOS patients.	1	1	1	1										1					D	C	対象者が不妊治療を受けている者であり、分野違いか？	
773	ヒト（内分泌）	Kim, S.; Choi, K.; Ji, K.; Seo, J.; Kho, Y.; Park, J.; Kim, S.; Park, S.; Hwang, I.; Jeon, J.; Yang, H.; Giesy, J. P.	Trans-placental transfer of thirteen perfluorina	2011	Environ Sci Technol. 2011 Sep 1;45(17):7465-72. doi: 10.1021/es202408a. Epub 2011 Aug 12.	While the results of animal studies have shown that perfluorinated compounds (PFCs) can modulate concentrations of thyroid hormones in blood, limited information is available on relationships between concentrations of PFCs in human blood serum and fetal thyroid hormones. The relationship between concentrations of PFCs in blood and fetal thyroid hormone concentrations or birth weight, and ratios of major PFCs between maternal and fetal serum were determined. Concentrations of PFCs were measured in blood serum of pregnant women (n = 44), fetal cord blood serum (n = 43) and breast milk (n = 35). Total concentrations of thyroxin (T4), triiodothyronin (T3) and thyroid stimulating hormone (TSH) in blood serum were also quantified. The ratios of major PFCs in maternal versus fetal serum were 1:1.93, 1.02, 0.72, and 0.48 for perfluorotridecanoic acid (PFTrDA), perfluorooctanoic acid (PFOA), perfluorohexane sulfonate (PFHxS), and perfluorooctane sulfonate (PFOS), respectively. Fetal PFOS, PFOA, PFTrDA and maternal PFTrDA were correlated with fetal total T4 concentrations, but after adjusting for major covariates, most of the relationships were no longer statistically significant. However, the significant negative correlations between maternal PFOS and fetal T3, and maternal PFTrDA and fetal T4 and T3 remained. Since thyroid hormones are crucial in the early developmentof the fetus, its clinical implication should be evaluated. Given the observed trans-placental transfer of PFCs, efforts should be also made to elucidate the exposure sources among pregnant women.			1												1					B	C	（優先度低い）母親血中、臍帯血中、母乳中 PFASの測定、31－34人 PFNA濃度のデータはあるが、直接の関連を検討していない	
774	ヒト（内分泌）	Lin, Chien-Yu; Wen, Li-Li; Lin, Lian-Yu; Wen, Ting-Wen; Lien, Guang-Wen; Hsu, Sandy H J; Chien, Kuo-Liong; Liao, Chien-Chang; Sung, Fung-Chang; Chen, Pau-Chung; Su, Ta-Chen	The associations between serum perfluorinate	2013	J Hazard Mater. 2013 Jan 15;244-245:637-44. doi: 10.1016/j.jhazmat.2012.10.049. Epub 2012 Nov 2.	Perfluorinated chemicals (PFCs) have been widely used in a variety of products worldwide for years. However, the effect of PFCs on thyroid function has not yet been clearly defined. We recruited 567 subjects (aged 12-30 years) in a population-based cohort of adolescents and young adults with abnormal urinalysis in the childhood to determine the relationship between serum level of PFCs and the levels of serum free thyroxine (T4) and thyroid stimulating hormone (TSH). The geometric means and geometric standard deviation concentrations of perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA) and perfluoroundecanoic acid (PFUA) were 2.67 (2.96) ng/ml, 7.78 (2.42) ng/ml, 1.01 (3.48) ng/ml and 5.81 (2.92) ng/ml, respectively. Differences in the levels of free T4 and TSH across different categories of PFOA, PFOS and PFUA were insignificant. After controlling for confounding factors, multiple linear regression analyses revealed mean serum level of free T4 increased significantly across categories (<60th, 60-89 and >90th percentiles) of PFNA (P for trend =0.012 in the full model). The association between PFNA and free T4 was more significant in male subjects in age group 20-30, active smokers and in those with higher body mass index in stratified analysis. Serum concentrations of PFNA were associated with serum free T4 levels in adolescents and young adults.			1												1					B	B	台湾, 551人, 12-30歳 1992－2000年にリクルート、2006－2008年にサンプリング Outcome: 血中FT4、TSH PFNA濃度は3分位群（<60th, 60-90th, >90th）、LODの算出方法は不明（既報？） 共変量の選択方法は不明 血中PFNAとFT4との間に正の関連（全体、男性20-30歳群）、特に喫煙者とBMI≥24以上で関係あり	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用														備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
775	ヒト（内分泌）	Long, M.; Ghisari, M.; Kjeldsen, L.; Wielsøe, M.; Nørgaard-Pedersen, B.; Mortensen, E. L.; Abdallah, M. W.; Bonefeld-Jørgensen, E. C.	Autism spectrum disorders, endocrine disruptio	2019	Molecular autism. 2019 Jan 9;10:1. doi: 10.1186/s13229-018-0253-1. eCollection 2019.	Background: Evidence has indicated that some non-inherited factors such as exposure to environmental pollutants are associated with neurodevelopment disorders like autism spectrum disorder (ASD). Studies report that endocrine disrupting compounds (EDCs), including polychlorinated biphenyls, organochlorine pesticides, perfluoroalkyl substances (PFAS), and some metals, have adverse effects on the fetal neurodevelopment. The aim of this study was to measure the amniotic fluid (AF) levels of EDCs and metals as well as the receptor transactivities induced by AF and investigate the possible link between prenatal exposure to EDCs and heavy metals and ASD risk. Methods: In this case-control study, we included AF samples of 75 ASD cases and 135 frequency-matched controls and measured the levels of the endogenous sex hormones, PFAS, and elements including heavy metals. The combined effect of endogenous hormones and EDCs on the receptor of estrogen (ER), androgen (AR), aryl hydrocarbon (AhR), and thyroid hormone-like activity were also determined and expressed as receptor ligand equivalents. We assessed the associations of AF levels of chemicals, sex hormones, and receptor activities with ASD risk using unconditional logistical regression analyses. To control for multiple comparisons, the false discovery rate (FDR) was used and q values less than 0.25 were designated as statistical significance. Results: PFAS and metals were detectable in AF samples. The ASD cases had significantly lower AF levels of PFAS than controls, and the adjusted odds ratio (OR) was 0.410 (95% CI 0.174, 0.967; p = 0.042; FDR qvalue = 0.437) for perfluorooctane sulfonate (PFOS). The principal component, including PFAS congeners, copper, iron, and estrogenic activity, was significantly inversely associated with ASD risk (adjusted OR = 0.100; 95% CI 0.016, 0.630; p = 0.014; FDR qvalue = 0.098).Testosterone level in AF weakly associated with ASD risk (adjusted OR = 1.002; 95% CI 1.000, 1.004; p = 0.05). However, after multiple comparison correction, the association was not significant (FDR qvalue = 0.437). No significant associations between AF-induced receptor transactivities and ASD risk were observed. The adjusted OR was 2.176 (95%CI 0.115, 41.153) for the ratio of the combined androgenic activity to combined estrogenic activity. Conclusions: The presence of PFAS and heavy metals in AF indicates that they can cross the placenta. The inverse association between levels of PFAS congeners in AF and ASD risk might relate to the weak estrogenic activities and anti-androgenic activities of PFAS.The observed tendency of positive association between the ratio of combined androgenic effect to the combined estrogenic effect and ASD risk needs further studies to explore whether EDCs together with endogenous hormones play a role in the development of ASD.			1	1	1														1			D	C	自閉症との関連を検討した研究であり、分野違いか？	
776	ヒト（内分泌）	Shelly, Colleen; Grandjean, Philippe; Oulhote, Youssef; Plomgaard, Peter; Frikke-Schmidt, Ruth; Nielsen, Flemming; Zmirou-Navier, Denis; Weihe, Pal; Valvi, Damaskini	Early Life Exposures to Perfluoroalkyl Substanc	2019	J Clin Endocrinol Metab. 2019 Nov 1;104(11):5338-5348. doi: 10.1210/jc.2019-00385.	BACKGROUND: Birth cohort studies have linked exposure to perfluoroalkyl substances (PFASs) with child anthropometry. Metabolic hormone dysregulation needs to be considered as a potential adverse outcome pathway. We examined the associations between PFAS exposures and concentrations of adipokine hormones from birth to adolescence. METHODS: We studied 80 mother-child pairs from a Faroese cohort born in 1997 to 2000. Five PFASs were measured in maternal pregnancy serum and in child serum at ages 5, 7, and 13 years. Leptin, adiponectin, and resistin were analyzed in cord serum and child serum at the same ages. We fitted multivariable-adjusted generalized estimating equations to assess the associations of PFASs at each age with repeated adipokine concentrations at concurrent and subsequent ages. RESULTS: We observed tendencies of inverse associations between PFASs and adipokine hormones specific to particular ages and sex. Significant associations with all adipokines were observed for maternal and child 5-year serum PFAS concentrations, whereas associations for PFASs measured at ages 7 to 13 years were mostly null. The inverse associations with leptin and adiponectin were seen mainly in females, whereas the inverse PFAS associations with resistin levels were seen mainly in males. Estimates for significant associations (P value <0.05) suggested mean decreases in hormone levels (range) by 38% to 89% for leptin, 16% to 70% for adiponectin, and 33% to 62% for resistin for each twofold increase in serum PFAS concentration. CONCLUSIONS: These findings suggest adipokine hormone dysregulation in early life as a potentialpathway underlying PFAS-related health outcomes and underscore the need to further account for susceptibility windows and sex-dimorphic effects in future investigations.				1														1			B	C	（優先度低い）フェロー研究, 80人の母子, 5/7/13歳まで追跡 1997－2000年に参加 Outcome: 臍帯血中および児の血中レプチン、アディポネクチン、レジスチン PFAS濃度のLOD算出方法は不明（既報にあり？）、全てLOD以上 PFAS濃度情報なし PFAS濃度はlog2変換値を使用 共変量の選択方法は既報を参照 母体血中PFNAと臍帯血中アディポネクチン（全体？、女児）および臍帯血中レジスチン（男児）との間に負の関連	
777	ヒト（内分泌）	Wang, Y.; Starling, A. P.; Haug, L. S.; Eggesbo, M.; Becher, G.; Thomsen, C.; Travlos, G.; King, D.; Hoppin, J. A.; Rogan, W. J.; Longnecker, M. P.	Association between perfluoroalkyl substances	2013	Environ Health. 2013 Sep 8;12(1):76. doi: 10.1186/1476-069X-12-76.	Background: Perfluoroalkyl substances (PFASs) are a group of highly persistent chemicals that are widespread contaminants in wildlife and humans. Exposure to PFAS affects thyroid homeostasis in experimental animals and possibly in humans. The objective of this study was to examine the association between plasma concentrations of PFASs and thyroid stimulating hormone (TSH) among pregnant women. Methods: A total of 903 pregnant women who enrolled in the Norwegian Mother and Child Cohort Study from 2003 to 2004 were studied. Concentrations of thirteen PFASs and TSH were measured in plasma samples collected around the 18th week of gestation. Linear regression models were used to evaluate associations between PFASs and TSH. Results: Among the thirteen PFASs, seven were detected in more than 60% of samples and perfluorooctane sulfonate (PFOS) had the highest concentrations (median, 12.8 ng/mL; inter-quartile range [IQR], 10.1 -16.5 ng/mL). The median TSH concentration was 3.5 (IQR, 2.4 - 4.8) μIU/mL. Pregnant women with higher PFOS had higher TSH levels. After adjustment, with each 1 ng/mL increase in PFOS concentration, there was a 0.8% (95% confidence interval: 0.1%, 1.6%) rise in TSH. The odds ratio of having an abnormally high TSH, however, was not increased, and other PFASs were unrelated to TSH. Conclusions: Our results suggest an association between PFOS and TSH in pregnant women that is small and may be of no clinical significance.				1														1			C	C	769と被り	
778	ヒト（内分泌）	Webster, G. M.; Venners, S. A.; Mattman, A.; Martin, J. W.	Associations between perfluoroalkyl acids (PF/	2014	Environ Res. 2014 Aug;133:338-47. doi: 10.1016/j.envres.2014.06.012. Epub 2014 Jul 12.	Background: Associations between perfluoroalkyl acids (PFASs) and human thyroid hormone levels remain unclear, especially during early pregnancy when small changes in maternal thyroid hormones can affect fetal brain development. Objectives: To examine associations between maternal serum PFAS levels and maternal thyroid hormone levels in the early 2nd trimester of pregnancy. Methods: Participants were euthyroid pregnant women (n=152) enrolled in the Chemicals, Health and Pregnancy (CHirP) study based in Vancouver, Canada. Associations between maternal serum PFASs, including perfluorohexanesulfonate (PFHxS), perfluorononanoate (PFNA), perfluorooctanoate (PFOA) and perfluorooctanesulfonate (PFOS) and repeated measures of maternal thyroid hormones, including free thyroxine (fT4), total thyroxine (TT4) and thyroid stimulating home (TSH) were examined using mixed effects linear models. Associations were considered in all women, then separately in women with high (≥ 9 IU/mL) vs normal (<9 IU/mL) levels of thyroid peroxidase antibody (TPOAb), a marker of autoimmune hypothyroidism (Hashimoto's disease). Results: Median PFAS concentrations (ng/mL) in maternal sera were 1.0 (PFHxS), 0.6 (PFNA), 1.7 (PFOA) and 4.8 (PFOS). PFASs were not associated with fT4, TT4 or TSH among women with normal TPOAb. However, among the 9% of women with high TPOAb (n=14), interquartile range (IQR) increases of PFASs were associated with a 46-69% increase in maternal TSH (95% CIs ranging from 8% to 123%) (PFNA, PFOA and PFOS only), and with a 3% to 7% decrease in maternal fT4 (95% CIs ranging from -18% to 5%) (all 4 PFASs). PFNA was also associated with higher maternal TSH in the whole sample. Conclusions: PFASs were positively associated with TSH, and weakly negatively associated with fT4 in the subset of pregnant women with high TPOAb, which occurs in 6-10% of pregnancies. PFASs may exacerbate the already high TSH and low fT4 levels in these women during early pregnancy, which is a critical time of thyroid hormone-mediated fetal brain development. The clinical significance of these findings is not clear. We propose a "multiple hit hypothesis" to explain these findings; this hypothesis deserves evaluation in larger, more representative study samples.				1														1			B	B	カナダ, 152人の妊婦女性 2006－2008年にサンプリング Outcome: 血中FT4, T4, TSH 血中PFASのLODの算出方法は不明、LOD未満はLOD/√2で置換 PFAS濃度は四分位群で解析 共変量の選択方法は不明 特に高甲状腺ペルオキシターゼ抗体群で、PFNA濃度とTSHとの間に正の関連	
779	ヒト（生殖発生毒性）	Li, M.; Zeng, X. W.; Qian, Z. M.; Vaughn, M. G.; Sauvé, S.; Paul, G.; Lin, S.; Lu, L.; Hu, L. W.; Yang, B. Y.; Zhou, Y.; Qin, X. D.; Xu, S. L.; Bao, W. W.; Zhang, Y. Z.; Yuan, P.; Wang, J.; Zhang, C.; Tian, Y. P.; Nian, M.; Xiao, X.; Fu, C.; Dong, G. H.	Isomers of perfluorooctanesulfonate (PFOS) in	2017	Environ Int 102: 1-8. doi: 10.1016/j.envint.2017.03.006.	Prior investigations on the associations of polyfluoroalkyl substances (PFASs) with fetal growth are mixed. Moreover, little research has accrued pertaining to the association between isomers of PFASs with gestational age and birth weight. To address this gap and present novel information, we conducted a study including 321 pairs of mothers and their infants recruited from Guangzhou, China. High performance liquid chromatography-mass spectrometry was utilized to analyze isomers of perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA) along with other PFAS levels in cord serum samples. Mothers' and infants' characteristics were gathered from medical records. The resulting data revealed that higher PFOS, PFOA and isomers of PFOS were associated with lower birth weight. Per ln-unit (ng/mL) increase in cord serum total branched PFOS isomers was associated with a 126.3g (95% CI: -195.9, -56.8) reduction in the weight of infants at birth, while an ln-unit (ng/mL) increase of serum linear PFOS isomers (n-PFOS) was associated with a 57.2g (95% CI: -103.1, -11.3) reduction in the weight of infants at birth upon the subsequent adjustment for potential confounding variables. Notably, the association between cord PFAS level and birth weight was more pronounced in male infants. Furthermore, a positive association among branched PFOS isomers (1m-PFOS and 3+4+5m-PFOS) andgestational age was found. No associations could be found among other PFASs in conjunction with gestational age or birth weight. In conclusion, this investigation suggests that higher PFAS concentrations are associated with lower birth weight, and branched PFOS isomers show greater impact on infant birth weight than linear PFOS.		1			1										1						B	B	PFBAはネガティブデータ	
780	ヒト（生殖発生毒性）	Gyllenhammar, I.; Diderholm, B.; Gustafsson, J.; Berger, U.; Ridefelt, P.; Benskin, J. P.; Lignell, S.; Lampa, E.; Glynn, A.	Perfluoroalkyl acid levels in first-time mothers	2018	Environ Int 111: 191-199. doi: 10.1016/j.envint.2017.12.002	We investigated if maternal body burdens of perfluoroalkyl acids (PFAAs) at the time of delivery are associated with birth outcome and if early life exposure (in utero/nursing) is associated with early childhood growth and weight gain. Maternal PFAA body burdens were estimated by analysis of serum samples from mothers living in Uppsala County, Sweden (POPUP), sampled three weeks after delivery between 1996 and 2011 Data on child length and weight were collected from medical records and converted into standard deviation scores (SDS). Multiple linear regression models with appropriate covariates were used to analyze associations between maternal PFAA levels and birth outcomes (n=381). After birth Generalized Least Squares models were used to analyze associations between maternal PFAA and child growth (n=200). Inverse associations were found between maternal levels of perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA), and birth weight SDS with a change of -0.1 to -0.18 weight SDS for an inter-quartile range (IQR) increase in ng/g PFAA. After birth, weight and length SDS were not significantly associated with maternal PFAA. However, BMI SDS was significantly associated with PFOA, PFNA, and PFHxS at 3 and 4years of age, and with PFOS at 4 and 5years of age. Ifcausal, these associations suggest that PFAA affects fetal and childhood body development in different directions.				1				1												1	A	B	母体血清のPFNAと出生時および3歳、4歳時点のBMI SDSと関連。PFNAは最小値、25%tile, 50%tile, 75%tile, 最大値それぞれ0.20, 1.6, 2.3, 3.0, 13 ng/g、PFBSはそれぞれ< MDL, < MDL, 0.012, 0.037, 0.80	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用														備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
781	ヒト（生殖発生毒性）	Zhou, W.; Zhang, L.; Tong, C.; Fang, F.; Zhao, S.; Tian, Y.; Tao, Y.; Zhang, J.	Plasma perfluoroalkyl and polyfluoroalkyl subst	2017	Environ Health Perspect 125: 067012. doi: 10.1289/EHP1203	Background: Perfluoroalkyl and polyfluoroalkyl substances (PFASs) are persistent synthetic chemicals that are widely used in industrial applications and often detectable in humans. In rats, PFASs can interfere with the estrous cycle. In humans, menstruation has been viewed as a proxy of female fecundity, and periodic menstruation plays a critical role in endometrial sloughing in the absence of pregnancy and in preparing for embryo implantation. Objectives: We investigated the association between PFAS exposure and menstrual cycle characteristics in women who plan to become pregnant. Methods: Plasma level of 10 PFASs was measured in 950 women who were attempting to become pregnant and recruited in two preconception care clinics in Shanghai, China, from August 2013 to April 2015. Information on menstrual cycle characteristics was collected by questionnaires. Associations between PFAS levels and menstrual cycle regularity, length, and bleeding volume were examined using multiple logistic regression models. Results: Pre-pregnant women with higher levels of log-transformed perfluorooctanate (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexanesulfonate (PFHxS) had increased odds of self-reported history of irregular menstrual cycle [PFOA-adjusted odds ratio (OR)=1.52 (95% CI: 1.08, 2.15); PFOS OR=1.29 (95% CI: 0.98, 1.70); PFNA OR=1.50 (95% CI: 1.03, 2.07); PFHxS OR=1.80 (95% CI: 1.17, 2.77)] and long menstrual cycle [PFOA OR=1.50 (95% CI: 1.06, 2.10); PFOS OR=1.34 (95% CI: 1.02, 1.75); PFNA OR=1.49 (95% CI: 1.05, 2.11); PFHxS OR=1.73 (95% CI: 1.13, 2.65)]. Log-transformed PFOA, PFOS, PFNA. and PFHxS levels were negatively associated with self-reported history of menorrhagia [PFOA OR=0.37 (95% CI: 0.21, 0.65); PFOS OR=0.57 (95% CI: 0.37, 0.90); PFNA OR=0.47 (95% CI: 0.26, 0.86); PFHxS OR=0.14 (95% CI: 0.06, 0.36)]. Conclusions: Certain PFASs are associated with abnormal menstruation in humans.			1	1					1													1	A	B	PFNA>1.85の第４四分位群で月経Long cycleの調整OR上昇1.67(95%CI 1.03-2.70)。連続量でも有意な上昇。連続量に関してはIrregular cycleについても有意な上昇。PFBSはネガティブデータ。PFNAの5%tile, 25%tile, 50%tile, 75%tile, 95%tile値はそれぞれ0.72, 1.04, 1.36, 1.85, 3.17。PFBSはそれぞれ 0.21, 0.23, 0.24, 0.27, 0.32	
782	ヒト（生殖発生毒性）	Bach CC, Liew Z, Bech BH, et al.	Perfluoroalkyl acids and time to pregnancy rev	2015	Environ Health. 2015 Jul 7:14:59. doi: 10.1186/s12940-015-0040-9.	Background: We previously demonstrated an association between plasma perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) and longer time to pregnancy (TTP) in a sample from the Danish National Birth Cohort (DNBC, 1996-2002). In this study we investigated this association in a new sample from the same cohort. Methods: Sample 1 consisted of 440 women, and Sample 2 consisted of 1161 women from whom we previously published the associations between PFOS or PFOA and TTP. We performed sample-specific and pooled analyses using discrete-time survival analyses to estimate fecundability ratios according to PFOS and PFOA quartiles, adjusted for potential confounders chosen guided by a directed acyclic graph. We also estimated odds ratios for infertility (TTP > 12 months or infertility treatment) according to PFOS and PFOA by multivariable logistic regression. Results: In Sample 1 PFOS was not associated with lower fecundability ratios or infertility, and there was a tendency towards longer TTP with increasing PFOA only in parous women. In Sample 2 previously reported associations were again seen. In the pooled analyses including both parous and nulliparous women fecundability ratios were 13-22 % lower for the three higher quartiles of PFOS or PFOA compared to the reference quartile. Conclusions: The pooled analyses were driven by the larger old sample, but we did not corroborate our previous finding of an association between high PFOS and longer TTP in the new sample. The tendency towards an association for PFOA and TTP in parous women may be due to reverse causation. Results from the new sample are more in line with the recent literature.			1											1								A	C	要約中にPFNAの記載は見つけられなかった。PFOSとPFOAのみを対象にしているように読めるので、Cだと思われる。	
783	ヒト（生殖発生毒性）	Bach, C. C.; Bech, B. H.; Nohr, E. A.; Olsen, J.; Matthiesen, N. B.; Bossi, R.; Uldbjerg, N.; Bonefeld-Jørgensen, E. C.; Henriksen, T. B.	Serum perfluoroalkyl acids and time to pregnar	2015	Environ Res. 2015 Oct;142:535-41. doi: 10.1016/j.envres.2015.08.007.	Background: Previous studies on the exposure to perfluoroalkyl acids (PFAAs) and female fertility have provided conflicting results. We aimed to investigate the association between several PFAAs and time to pregnancy among nulliparous women. Methods: From 2008 to 2013, we included 1372 women from the Aarhus Birth Cohort, Aarhus University Hospital, Denmark, who provided data on time to pregnancy and a blood sample before 20 gestational weeks. We measured the levels of 16 PFAAs in maternal serum and report data for seven compounds with quantifiable values in at least 50% of samples. Fecundability ratios according to PFAA levels (quartiles or continuous levels) were estimated by discrete-time survival analyses, adjusted for potential confounders. We further investigated the association between PFAAs and infertility (time to pregnancy>12 months or infertility treatment prior to the studied pregnancy) by multivariable logistic regression. Results: Median levels of perfluorooctane sulfonate and perfluorooctanoate were 8.3 and 2.0 ng/mL. Overall, no obvious associations were found between any PFAAs and fecundability or infertility. Adjusted fecundability ratios (95% confidence intervals) were 1.09 (0.92-1.29) for perfluorooctane sulfonate and 1.10 (0.93-1.30) for perfluorooctanoate (highest versus lowest quartile). Conclusions: We found no evidence of an association between present serum levels of PFAAs and longer time to pregnancy or infertility in nulliparous women. This study further adds to the sparse knowledge on PFAAs besides perfluorooctane sulfonate and perfluorooctanoate.			1											1		1						B	B	PFNAはネガティブデータ。中央値と四分位範囲 0.8 (0.6–1.0)	
784	ヒト（生殖発生毒性）	Bach, C. C.; Bech, B. H.; Nohr, E. A.; Olsen, J.; Matthiesen, N. B.; Bonefeld-Jørgensen, E. C.; Bossi, R.; Henriksen, T. B.	Perfluoroalkyl acids in maternal serum and ind	2016	Environ Health Perspect. 2016 Jun;124(6):848-54. doi: 10.1289/ehp.1510046. Epub 2015 Oct 23.	Background: Previous studies indicated an association between intrauterine exposure to perfluorooctane sulfonate (PFOS) or perfluorooctanoate (PFOA) and lower birth weight. However, these perfluoroalkyl acids (PFAAs) have to some extent been substituted by other compounds on which little is known. Objectives: We investigated the association between specific PFAAs and birth weight, birth length, and head circumference at birth. Methods: We studied 1,507 mothers and their children from the Aarhus Birth Cohort (2008-2013). Nulliparous women were included during pregnancy, and serum levels of 16 PFAAs were measured between 9 and 20 completed gestational weeks (96% within 13 weeks). For compounds with quantifiable values in > 50% of samples (7 compounds), we report the associations with birth weight, birth length, and head circumference at birth determined by multivariable linear regression. Results: Estimated mean birth weights were lower among women with serum perfluorohexane sulfonate, perfluoroheptane sulfonate, and PFOS concentrations above the lowest exposure quartile, but we found no consistent monotonic dose-response patterns. These associations were stronger when the population was restricted to term births (n = 1,426). For PFOS, the birth weight estimates for the highest versus lowest quartile were -50 g (95% CI: -123, 23 g) in all births and -62 g (95% CI: -126, 3 g) in term births. For the other PFAAs, the direction of the associations was inconsistent, and no overall association with birth weight was apparent. No PFAAs were associated with birth length or head circumference at birth. Conclusions: Overall, we did not find strong or consistent associations between PFAAs and birth weight or other indices of fetal growth, though estimated mean birth weights were lower among those with exposures above the lowest quartile for some compounds.				1										1		1						B	B	通常の量反応関係ではないとのことなので、リスク評価に用いるのは難しい。	
785	ヒト（生殖発生毒性）	Bae, Jisuk; Kim, Sungduk; Schisterman, Enrique F; Boyd Barr, Dana; Buck Louis, Germaine M	Maternal and paternal serum concentrations o	2015	Chemosphere. 2015 Aug;133:31-40. doi: 10.1016/j.chemosphere.2015.03.015. Epub 2015 Apr 2.	Select persistent environmental chemicals have been associated with a reduction in the secondary sex ratio (SSR), or the ratio of male to female live births. We evaluated preconception maternal, paternal, and couple serum concentrations of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in relation to the SSR, given the absence of previous investigation. Two hundred thirty-three couples from Michigan and Texas were enrolled prior to conception and prospectively followed through delivery of a singleton birth, 2005-2009. Maternal and paternal serum concentrations (ng mL(-1)) were measured at baseline for seven PFASs. Logistic regression models were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for a male birth, after adjusting for potential confounders. When maternal and paternal PFAS concentrations were modeled jointly, five of the seven PFASs, including the two most prominent PFASs, perfluorooctane sulfonic acid and perfluorooctanoic acid, were not significantly associated with the SSR. However, paternal N-methyl-perfluorooctane sulfonamidoacetic acid (MeFOSAA) and perfluorononanoic acid (2nd versus 1st tertile, OR, 0.43, 95% CI, 0.21-0.88) were significantly associated with an excess of female births. Meanwhile, a dose-response relation was observed only for paternal MeFOSAA (2nd versus 1st tertile, OR, 0.53, 95% CI, 0.26-1.10; 3rd versus 1st tertile, OR, 0.34, 95% CI, 0.13-0.89). This study suggests a possible dose-response relation between a less prevalent PFAS and a reversal in the SSR, though the underlying mechanisms remain unknown and the findings await corroboration to eliminate otherexplanations including chance.				1										1								C	B	通常の量反応関係ではないとのことなので、リスク評価に用いるのは難しい上、性比をあつかっているもののサンプリングに偏りがないとは言えないデザイン。	
786	ヒト（生殖発生毒性）	Barrett, Emily S; Chen, Chongshu; Thurston, Sally W; Haug, Line Småstuen; Sabaredzovic, Azemira; Fjeldheim, Freydis Nyborg; Frydenberg, Hanne; Lipson, Susan F; Ellison, Peter T; Thune, Inger	Perfluoroalkyl substances and ovarian hormon	2015	Fertil Steril. 2015 May;103(5):1261-70.e3. doi: 10.1016/j.fertnstert.2015.02.001. Epub 2015 Mar 4.	OBJECTIVE: To examine associations between environmental exposure to perfluoroalkyl substances (PFASs) and ovarian hormone concentrations in naturally cycling women. DESIGN: E2 and P were measured in saliva samples collected daily for a single menstrual cycle and concentrations of PFASs (including perfluorooctane sulfonate [PFOS] and perfluorooctanoic acid) were measured in serum samples collected during the same cycle. SETTING: Not applicable. PATIENT(S): A total of 178 healthy, naturally cycling women, aged 25-35 years. INTERVENTION(S): None. MAIN OUTCOME MEASURE(S): Mean follicular E2 (cycle days -7 to -1, where 0 is the day of ovulation); mean luteal P (cycle days +2 to 10). RESULT(S): Among nulliparous, but not parous women, PFOS concentrations were inversely associated with E2 (β = -0.025, 95% CI -0.043, -0.007) and P (β = -0.027, 95% CI -0.048, -0.007). Similar, but weaker results were observed for perfluorooctanesulfonic acid. No associations were observed between other PFASs (including perfluorooctanoic acid) and ovarian steroid concentrations, nor were any associations noted in parous women. CONCLUSION(S): Our results demonstrate that PFOS and perfluorooctanesulfonic acid may be associated with decreased production of E2 and P in reproductive age women. These results suggest a possible mechanism by which PFASs affect women's health, and underscore the importance of parity in research on PFASs and women's reproductive health.				1										1								B	D	ネガティブデータかつ閾値無モデル	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
787	ヒト（生殖発生毒性）	Buck Louis, G. M.; Chen, Z.; Schisterman, E. F.; Kim, S.; Sweeney, A. M.; Sundaram, R.; Lynch, C. D.; Gore-Langton, R. E.; Barr, D. B.	Perfluorochemicals and human semen quality:	2015	Environ Health Perspect. 2015 Jan;123(1):57-63. doi: 10.1289/ehp.1307621. Epub 2014 Aug 15.	Background: The relation between persistent environmental chemicals and semen quality is evolving, although limited data exist for men recruited from general populations. Objectives: We examined the relation between perfluorinated chemicals (PFCs) and semen quality among 501 male partners of couples planning pregnancy. Methods: Using population-based sampling strategies, we recruited 501 couples discontinuing contraception from two U.S. geographic regions from 2005 through 2009. Baseline interviews and anthropometric assessments were conducted, followed by blood collection for the quantification of seven serum PFCs (perfluorosulfonates, perfluorocarboxylates, and perfluorosulfonamides) using tandem mass spectrometry. Men collected a baseline semen sample and another approximately 1 month later. Semen samples were shipped with freezer packs, and analyses were performed on the day after collection. We used linear regression to estimate the difference in each semen parameter associated with a one unit increase in the natural log-transformed PFC concentration after adjusting for confounders and modeling repeated semen samples. Sensitivity analyses included optimal Box-Cox transformation of semen quality end points. Results: Six PFCs [2-(N-methyl-perfluorooctane sulfonamido) acetate (Me-PFOSA-AcOH), perfluorodecanoate (PFDeA), perfluorononanoate (PFNA), perfluorooctane sulfonamide (PFOSA), perfluorooctane sulfonate (PFOS), and perfluorooctanoic acid (PFOA)] were associated with 17 semen quality end points before Box-Cox transformation. PFOSA was associated with smaller sperm head area and perimeter, a lower percentage of DNA stainability, and a higher percentage of bicephalic and immature sperm. PFDeA, PFNA, PFOA, and PFOS were associated with a lower percentage of sperm with coiled tails. Conclusions: Select PFCs were associated with certain semen end points, with the most significant associations observed for PFOSA but with results in varying directions.			1										1						B	B	PFNAと正常精子形態と正の関連。Coiled tailと負の関連。いずれも有害影響とは言えない。	
788	ヒト（生殖発生毒性）	Louis, G. M. B.; Peterson, C. M.; Chen, Z.; Hediger, M. L.; Croughan, M. S.; Sundaram, R.; Stanford, J. B.; Fujimoto, V. Y.; Varner, M. W.; Giudice, L. C.; Kennedy, A.; Sun, L.; Wu, Q.; Kannan, K.	Perfluorochemicals and endometriosis: The EN	2012	Epidemiology. 2012 Nov;23(6):799-805. doi: 10.1097/EDE.0b013e31826cc0cf.	Background: Environmental chemicals may be associated with endometriosis. No published research has focused on the possible role of perfluorochemicals (PFCs) despite their widespread presence in human tissues. Methods: We formulated two samples. The first was an operative sample comprising 495 women aged 18-44 years scheduled for laparoscopy/laparotomy at one of 14 participating clinical sites in the Salt Lake City or San Francisco area, 2007-2009. The second was a population-based sample comprising 131 women matched to the operative sample on age and residence within a 50-mile radius of participating clinics. Interviews and anthropometric assessments were conducted at enrollment, along with blood collection for the analysis of nine PFCs, which were quantified using liquid chromatography-tandem mass spectrometry. Endometriosis was defined based on surgical visualization (in the operative sample) or magnetic resonance imaging (in the population sample). Using logistic regression, we estimated odds ratios (ORs) and 95% confidence intervals (CIs) for each PFC (log-transformed), adjusting for age and body mass index, and then parity. Results: Serum perfluorooctanoic acid (PFOA; OR = 1.89 [95% CI = 1.17-3.06]) and perfluorononanoic acid (2.20 [1.02-4.75]) were associated with endometriosis in the operative sample; findings were moderately attenuated with parity adjustment (1.62 [0.99-2.66] and 1.99 [0.91-4.33], respectively). Perfluorooctane sulfonic acid (1.86 [1.05-3.30]) and PFOA (2.58 [1.18-5.64]) increased the odds for moderate/severe endometriosis, although the odds were similarly attenuated with parity adjustment (OR = 1.50 and 1.86, respectively). Conclusions: Select PFCs were associated with an endometriosis diagnosis. These associations await corroboration.			1										1		1				B	B	手術検体においては子宮内膜症との関連が見られているが、出産回数での調整で弱まる。ポピュレーションベースの方では関連が見られていない。	
789	ヒト（生殖発生毒性）	Louis, G. M.; Sapra, K. J.; Barr, D. B.; Lu, Z.; Sundaram, R.	Preconception perfluoroalkyl and polyfluoroalk	2016	Reprod Toxicol. 2016 Oct;65:11-17. doi: 10.1016/j.reprotox.2016.06.011. Epub 2016 Jun 16.	Equivocal findings are reported for perfluoroalkyl and polyfluoroalkyl substances (PFASs) and self-reported pregnancy loss. We prospectively assessed PFASs and pregnancy loss in a cohort comprising 501 couples recruited preconception and followed daily through 7 post-conception weeks. Seven PFASs were quantified: 2-N-ethyl-perfluorooctane sulfonamide acetate (Et-PFOSA-AcOH); 2-N-methyl-perfluorooctane sulfonamido acetate (Me-PFOSA-AcOH); perfluorodecanoate (PFDeA); perfluorononanoate (PFNA); perfluorooctane sulfonamide (PFOSA); perfluorooctane sulfonate (PFOS); and perfluorooctanoate (PFOA). Women used home pregnancy test kits. Loss denoted conversion from a positive to a negative pregnancy test, onset of menses or clinical confirmation (n=98; 28%). Chemicals were log transformed and rescaled by their standard deviations to estimate adjusted hazard ratios (HRs) and 0.95 confidence intervals. No significantly elevated HRs were observed for any PFASs suggesting no association with loss: Et-PFOSA-AcOH (1.04; 0.87, 1.23), Me-PFOSA-AcOH (0.79; 0.61, 1.00; p<;0.05), PFDeA (0.83; 0.66, 1.04), PFNA (0.86; 0.70, 1.06), PFOSA (0.74; 0.50, 1.09), PFOS (0.81; 0.65, 1.00), and PFOA (0.93; 0.75, 1.16).			1										1		1				B	B	流産死産のハザード比	
790	ヒト（生殖発生毒性）	Buck Louis, Germaine M; Sundaram, Rajeshwari; Schisterman, Enrique F; Sweeney, Anne M; Lynch, Courtney D; Gore-Langton, Robert E; Maisog, José; Kim, Sungduk; Chen, Zhen; Barr, Dana B	Persistent environmental pollutants and couple	2013	Environ Health Perspect. 2013 Feb;121(2):231-6. doi: 10.1289/ehp.1205301. Epub 2012 Nov 14.	BACKGROUND: Evidence suggesting that persistent environmental pollutants may be reproductive toxicants underscores the need for prospective studies of couples for whom exposures are measured. OBJECTIVES: We examined the relationship between selected persistent pollutants and couple fecundity as measured by time to pregnancy. METHODS: A cohort of 501 couples who discontinued contraception to become pregnant was prospectively followed for 12 months of trying to conceive or until a human chorionic gonadotrophin (hCG) test confirmed pregnancy. Couples completed daily journals on lifestyle and provided biospecimens for the quantification of 9 organochlorine pesticides, 1 polybrominated biphenyl, 10 polybrominated diphenyl ethers, 36 polychlorinated biphenyls (PCBs), and 7 perfluorochemicals (PFCs) in serum. Using Cox models for discrete time, we estimated fecundability odds ratios (FORs) and 95% CIs separately for each partner's concentrations adjusting for age, body mass index, serum cotinine, serum lipids (except for PFCs), and study site (Michigan or Texas); sensitivity models were further adjusted for left truncation or time off of contraception (≤ 2 months) before enrollment. RESULTS: The adjusted reduction in fecundability associated with standard deviation increases in log-transformed serum concentrations ranged between 18% and 21% for PCB congeners 118, 167, 209, and perfluorooctane sulfonamide in females; and between 17% and 29% for p,p′-DDE and PCB congeners 138, 156, 157, 167, 170, 172, and 209 in males. The strongest associations were observed for PCB 167 (FOR 0.79; 95% CI: 0.64, 0.97) in femalesand PCB 138 (FOR = 0.71; 95% CI: 0.52, 0.98) in males. CONCLUSIONS: In this couple-based prospective cohort study with preconception enrollment and quantification of exposures in both female and male partners, we observed that a subset of persistent environmental chemicals were associated with reduced fecundity.			1										1		1				B	D	ネガティブデータ	
791	ヒト（生殖発生毒性）	Callan, A. C.; Rotander, A.; Thompson, K.; Heyworth, J.; Mueller, J. F.; Odland, J. Ø.; Hinwood, A. L.	Maternal exposure to perfluoroalkyl acids mea	2016	Sci Total Environ. 2016 Nov 1;569-570:1107-1113. doi: 10.1016/j.scitotenv.2016.06.177. Epub 2016 Jul 4.	Perfluoralkyl and polyfluoralkyl substances have been measured in plasma and serum of pregnant women as a measure of prenatal exposure. Increased concentrations of individual perfluoroalkyl acids (PFAAs), (typically perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been reported to be associated with reductions in birth weight and other birth outcomes. We undertook a study of 14 PFAAs in whole blood (including PFOS, PFHxS, PFHpA, PFOA, PFNA, PFDA and PFUnDA) from 98 pregnant women in Western Australia from 2008 to 2011 Median concentrations (in μg/L) were: PFOS 1.99; PFHxS 0.33; PFOA 0.86; PFNA 0.30; PFDA 0.12 and PFUnDA 0.08. Infants born to women with the highest tertile of PFHxS exposure had an increased odds of being <95% of their optimal birth weight (OR 3.5, 0.95 CI 1.1-11.5). Conversely, maternal blood concentrations of PFUnDA were associated with non-significant increases in average birth weight (+102g, 0.95 CI -41, 245) and significant increases in proportion of optimal birth weight (+4.7%, 0.95 CI 0.7, 8.8) per ln-unit change. This study has reported a range of PFAAs in the whole blood of pregnant women and suggests that PFHxS and PFUnDA may influence foetal growth and warrant further attention. Additional studies are required to identify the sourcesof PFAA exposure with a view to prevention, in addition to further studies investigating the long term health effects of these ubiquitous chemicals.			1										1						B	B	ネガティブデータ	
792	ヒト（生殖発生毒性）	Campbell, S.; Raza, M.; Pollack, A. Z.	Perfluoroalkyl substances and endometriosis in	2016	Reprod Toxicol. 2016 Oct;65:230-235. doi: 10.1016/j.reprotox.2016.08.009. Epub 2016 Aug 17.	Exposure to endocrine-active perfluoroalkyl substances (PFASs), is nearly ubiquitous, but data on the association between PFASs and endometriosis diagnosis are limited. We aimed to examine the relationship between PFASs and endometriosis. Women aged 20-50 years from the National Health and Nutrition Examination Survey (2003-2006) were selected (n=753). Serum PFAS levels were measured and endometriosis status was determined by self-report of doctor diagnosis. Weighted survey sampling logistic regression was used. Women reporting endometriosis were older (39.4 vs. 33.7 years), and more likely to be non-Hispanic white. Geometric mean levels of perfluorononanoic acid (PFNA), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS) were significantly higher among women reporting endometriosis. Endometriosis was associated with select quartiles of PFOA, PFNA, and PFOS. Sensitivity analyses had similar results but wider confidence intervals. These findings suggest that PFOA, PFNA, and PFOS may be of interest in future studies with improved endometriosis diagnostic criteria and prospectively measured exposure.			1										1					1	A	B	PFNA第3四分位のみで子宮内膜症の調整OR5.27 (1.20, 23.06)。第４四分位は3.24 (0.81, 12.91)。で濃度依存的ではないが、子宮内膜症の割合が第3で22/175、第4で18/199とサンプル数が少ないことに因る可能性もあり。	
793	ヒト（生殖発生毒性）	Cao, W.; Liu, X.; Liu, X.; Zhou, Y.; Zhang, X.; Tian, H.; Wang, J.; Feng, S.; Wu, Y.; Bhatti, P.; Wen, S.; Sun, X.	Perfluoroalkyl substances in umbilical cord ser	2018	Environ Int. 2018 Jul;116:197-205. doi: 10.1016/j.envint.2018.04.015. Epub 2018 Apr 23.	Although animal studies have found that perfluoroalkyl substances (PFASs) affect gestational and postnatal growth, the epidemiological findings are limited and not in agreement. We explored the associations of PFAS concentrations in umbilical cord blood with gestational and postnatal growth in China. Three hundred thirty-seven singleton newborns and their mothers were recruited from November 2013 to December 2015 in Zhoukou City, China. Umbilical cord blood was collected to measure eleven PFASs by liquid chromatography-mass spectrometry. The index of gestational and postnatal growth contained fetal weight, length, and head circumference. These were obtained at birth and at the follow-up investigation (mean 19 months). Exposed to higher perfluorooctanoic acid (PFOA) were connected with reduced length at birth (p for trend = 0.01) and decreased postnatal weight (β = -429.2 g; 0.95 CI: -858.4, -0.121 for 2nd VS. 1st). Exposed to perfluoroundecanoic acid (PFUdA) were positively associated with indications of gestational growth and postnatal growth (p for trend = 0.02 for birth length; p for trend = 0.04 for postnatal length). Exposed to higher perfluorododecanoic acid (PFDoA) were associated with lower birth weight (β = -122.9 g, 0.95 CI: -244.7 to -1.2 for 2nd VS. 1st), but higher postnatal length (p for trend = 0.03). Neonates in the highest exposure group of per-fluorohexanesulfonate (PFHxS) showed decreased birth length (β = -0.33 cm,0.95 CI: -0.68 to -0.01, for 2nd VS. 1st), but increased postnatal head circumference (p for trend = 0.04). Increased PFOA concentrations was associated with shorter birth length only in girls (p for trend = 0.04), suggesting that the effect of PFASs on gestational growth were different between boys and girls. In utero exposure to PFASs may affect gestational and postnatal growth.			1										1						B	B	ネガティブデータ	
794	ヒト（生殖発生毒性）	Chen, Mei-Huei; Ha, Eun-Hee; Wen, Ting-Wen; Su, Yi-Ning; Lien, Guang-Wen; Chen, Chia-Yang; Chen, Pau-Chung; Hsieh, Wu-Shiun	Perfluorinated compounds in umbilical cord blo	2012	PLoS One. 2012;7(8):e42474. doi: 10.1371/journal.pone.0042474. Epub 2012 Aug 3.	BACKGROUND: Previous animal studies have shown that perfluorinated compounds (PFCs) have adverse impacts on birth outcomes, but the results have been inconclusive in humans. We investigated associations between prenatal exposure to perfluorooctanoic acid (PFOA), perfluorooctyl sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluoroundecanoic acid (PFUA) and birth outcomes. METHODS: In total, 429 mother-infant pairs were recruited from the Taiwan Birth Panel Study (TBPS). Demographic data were obtained by interviewing mothers using a structured questionnaire and birth outcomes were extracted from medical records. Cord blood was collected for PFOA, PFOS, PFNA, and PFUA analysis by ultra-high-performance liquid chromatography/tandem mass spectrometry. RESULTS: The geometric mean (standard deviation) levels of PFOA, PFOS, PFNA, and PFUA in cord blood plasma were 1.84 (2.23), 5.94 (1.95), 2.36(4.74), and 10.26 (3.07) ng/mL, respectively. Only PFOS levels were found to be inversely associated with gestational age, birth weight, and head circumference [per ln unit: adjusted β (95% confidence interval, CI) = -0.37 (-0.60, -0.13) wks, -110.2 (-176.0, -44.5) gm and -0.25 (-0.46, -0.05) cm]. Additionally, the odds ratio of preterm birth, low birth weight, and small for gestational age increased with PFOS exposure [per ln unit: adjusted odds ratio (OR) (95%CI) = 2.45 (1.47, 4.08), 2.61(0.85, 8.03) and 2.27 (1.25, 4.15)]. When PFOS levels were divided into quartiles, a dose-response relation was observed. However, PFOA, PFNA, and PFUA were not observed to have any convincing impact on birth outcomes. CONCLUSIONS: An adverse dose-dependentassociation was observed between prenatal PFOS exposure and birth outcomes. However, no associations were found for the other examined PFCs.			1										1		1			1	B	A	ネガティブデータ	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
795	ヒト（生殖発生毒性）	Christensen, K. Y.; Maisonet, M.; Rubin, C.; Holmes, A.; Calafat, A. M.; Kato, K.; Flanders, W. D.; Heron, J.; Mcgeehin, M. A.; Marcus, M.	Exposure to polyfluoroalkyl chemicals during p	2011	Environ Int. 2011 Jan;37(1):129-35. doi: 10.1016/j.envint.2010.08.007. Epub 2010 Sep 16.	Introduction: Polyfluoroalkyl chemicals (PFCs) are commercially synthesized chemicals used in consumer products. Exposure to certain PFCs is widespread, and some PFCs may act as endocrine disruptors. We used data from the Avon Longitudinal Study of Parents and Children (ALSPAC) in the United Kingdom to conduct a nested case-control study examining the association between age at menarche, and exposure to PFCs during pregnancy. Methods: Cases were selected from female offspring in the ALSPAC who reported menarche before the age of 11.5 years (n = 218), and controls were a random sample of remaining girls (n = 230). Serum samples taken from the girls' mothers during pregnancy (1991-1992) were analyzed using on-line solid-phase extraction coupled to isotope dilution high-performance liquid chromatography-tandem mass spectrometry for 8 PFCs. Logistic regression was used to determine association between maternal serum PFC concentrations, and odds of earlier age at menarche. Results: PFOS and PFOA were the predominant PFCs (median serum concentrations of 19.8 ng/mL and 3.7 ng/mL). All but one PFC were detectable in most samples. Total PFC concentration varied by number of births (inverse association with birth order; p-value < 0.0001) and race of the child (higher among whites; p-value = 0.03). The serum concentrations of carboxylates were associated with increased odds of earlier age at menarche; concentrations of perfluorooctane sulfonamide, the sulfonamide esters and sulfonates were all associated with decreased odds of earlier age at menarche. However, all confidence intervals included the null value of 1.0. Conclusions: ALSPAC study participants had nearly ubiquitous exposure to most PFCs examined, but PFC exposure did not appear to be associated with altered age at menarche of their offspring.			1													1		1			B	B	ネガティブデータだが濃度分布情報あり Total Median (quartiles)0.6 (0.5–0.8) Early menarche 0.7 (0.5–0.8) Not early menarche 0.6 (0.5–0.8)	
796	ヒト（生殖発生毒性）	Crawford, N. M.; Fenton, S. E.; Strynar, M.; Hines, E. P.; Pritchard, D. A.; Steiner, A. Z.	Effects of perfluorinated chemicals on thyroid f	2017	Reprod Toxicol. 2017 Apr;69:53-59. doi: 10.1016/j.reprotox.2017.01.006. Epub 2017 Jan 19.	Perfluorinated chemicals (PFCs) can act as endocrine-disrupting chemicals, but there has been limited study of their effects on ovarian reserve or fecundability. 99 women, 30-44 years old, without infertility were followed until pregnancy. Initially, serum was evaluated for Antimullerian hormone (AMH), thyroid hormones: thyroid stimulating hormone (TSH), thyroxine (T4), free thyroxine (fT4), and triiodothyronine (T3), and PFCs: perfluorooctanoate (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexanesulfonic acid (PFHxS). Bivariate analyses assessed the relationship between thyroid hormones, AMH, and PFCs. Fecundability ratios (FR) were determined for each PFC using a discrete time-varying Cox model and a day-specific probability model. PFC levels were positively correlated with each other (r 0.24-0.90), but there was no correlation with TSH (r 0.02-0.15) or AMH (r -0.01 to -0.15). FR point estimates for each PFC were neither strong nor statistically significant. Although increased exposure to PFCs correlates with thyroid hormone levels, there is no significant association with fecundability or ovarian reserve.			1													1		1			B	B	ネガティブデータ	
797	ヒト（生殖発生毒性）	Jensen, T. K.; Andersen, L. B.; Kyhl, H. B.; Nielsen, F.; Christesen, H. T.; Grandjean, P.	Association between perfluorinated compound	2015	PLoS ONE. 2015 Apr 7;10(4):e0123496. doi: 10.1371/journal.pone.0123496. eCollection 2015.	Perfluorinated alkylated substances (PFAS) have been extensively used in consumer products and humans are widely exposed to these persistent compounds. A recent study found no association between exposure to perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) and miscarriage, but no studies have examined adverse effect of the more recently introduced PFASs. We therefore conducted a case-control study within a population-based, prospective cohort during 2010-2012. Newly pregnant women residing in the Municipality of Odense, Denmark were invited to enroll in the Odense Child Cohort at their first antenatal visit before pregnancy week 12 Among a total of 2874 participating women, 88 suffered a miscarriage and 59 had stored serum samples, of which 56 occurred before gestational week 12 They were compared to a random sample (N=336) of delivering women, who had also donated serum samples before week 12 Using a case-control design, 51 of the women suffering a miscarriage were matched on parity and gestational day of serum sampling with 204 delivering women. In a multiple logistic regression with adjustment for age, BMI, parity and gestational age at serum sampling, women with the highest tertile of exposure to perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) in pregnancy had odds ratios formiscarriage of 16.5 (95% CI 7.4-36.6-36.5) and 2.67 (1.31-5.44), respectively, as compared to the lowest tertile. In the matched data set, the OR were 37.9 (9.9-145.2) and 3.71 (1.60-8.60), respectively. The association with perfluorohexane sulfonic acid (PFHxS) was in the same direction, but not statistically significant, while no association was found with PFOA and PFOS. Our findings require confirmation due to the possible public health importance, given that all pregnant women are exposed to these widely used compounds.			1													1		1		1	A	A	matched case-control designの場合PFNA第2三分位、第3三分位で流産の調整ORは18.97(5.49-65.58), 37.93(9.90-145.2)。ケースが各群で18-19しかいない。三分位点の濃度がざっと見た感じ見当たらない。	
798	ヒト（生殖発生毒性）	Joensen, Ulla Nordström; Veyrand, Bruno; Antignac, Jean-Philippe; Blomberg Jensen, Martin; Petersen, Jørgen Holm; Marchand, Philippe; Skakkebæk, Niels Erik; Andersson, Anna-Maria; Le Bizec, Bruno; Jørgensen, Niels	PFOS (perfluorooctanesulfonate) in serum is n	2013	Hum Reprod. 2013 Mar;28(3):599-608. doi: 10.1093/humrep/des425. Epub 2012 Dec 18.	STUDY QUESTION: Is exposure to perfluorinated compounds (PFCs) associated with testicular function (reproductive hormone levels and semen quality) in healthy men? SUMMARY ANSWER: PFOS levels were significantly negatively associated with serum testosterone (total and calculated free), but not with any other reproductive hormones or semen quality. WHAT IS KNOWN ALREADY: In animals, some PFCs have endocrine disrupting potential, but few studies have investigated PFCs in relation to human testicular function. Previously, we and others have observed a negative association between serum PFC levels and sperm morphology. The potential associations with reproductive hormones remain largely unresolved. STUDY DESIGN, SIZE, DURATION: A cross-sectional study of 247 men was conducted during 2008-2009. PARTICIPANTS/MATERIALS, SETTING, METHODS: Healthy men from the general population, median age of 19 years, gave serum and semen samples. Serum samples were analysed for total testosterone (T), estradiol (E), sex hormone-binding globulin (SHBG), luteinizing hormone (LH), follicle-stimulating hormone (FSH) and inhibin-B and 14 PFCs, including perfluorooctanesulfonate (PFOS). Semen samples were analysed according to the WHO criteria. MAIN RESULTS AND THE ROLE OF CHANCE: PFOS levels were negatively associated with testosterone (T), calculated free testosterone (FT), free androgen index (FAI) and ratios of T/LH, FAI/LH and FT/LH. Other PFCs were found at lower levels than PFOS and did not exhibit the same associations. PFC levels were not significantly associated with semen quality. PFOS levels in these samples collected in 2008-2009 werelower than in our previous study of men participating in 2003. LIMITATIONS, REASONS FOR CAUTION: Results were robust to adjustment for relevant confounders; however, the possibility of chance associations due to multiple testing or effects of uncontrolled confounding cannot be ruled out. WIDER IMPLICATIONS OF THE FINDINGS: Our previous findings of decreased sperm morphology in the most highly PFC exposed men were not replicated, possibly due to a lack of highly exposed individuals; however, a recent independent study also did corroborate such an inverse association. The negative association between serum PFOS and testosterone indicates that testosterone production may be compromised in individuals with high PFOS exposure. STUDY FUNDING/COMPETING INTEREST(S): The authors received financial support from the European Commission (DEER, FP7-2007-212844), the Danish Agency for Science, Technology and Innovation (grant nos. 27107068 and 09-067180), Rigshospitalet (grant no. 961506336), the University of Copenhagen, the Danish Ministry of Health and the Danish Environmental Protection Agency (MST-621-00013), and Kirsten and Freddy Johansen Foundation (grant no. 95-103-72087). The funding organizations played no role in the design and conduct of the study, in collection, management, analysis and interpretation of the data; or in the presentation, review or approval of the manuscript. The authors declare that they have no competing financial interests.			1													1		1			A	D	PFNAが抄録中に出てこない。取り寄せないと全文が見れない。	
799	ヒト（生殖発生毒性）	Jørgensen, K. T.; Specht, I. O.; Lenters, V.; Bach, C. C.; Rylander, L.; Jönsson, B. A.; Lindh, C. H.; Giwercman, A.; Heederik, D.; Toft, G.; Bonde, J. P.	Perfluoroalkyl substances and time to pregnan	2014	Environ Health. 2014 Dec 22;13:116. doi: 10.1186/1476-069X-13-116.	Background: Perfluoroalkyl substances (PFAS) are suggested to affect human fecundity through longer time to pregnancy (TTP). We studied the relationship between four abundant PFAS and TTP in pregnant women from Greenland, Poland and Ukraine representing varying PFAS exposures and pregnancy planning behaviors. Methods: We measured serum levels of perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorohexane sulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) in 938 women from Greenland (448 women), Poland (203 women) and Ukraine (287 women). PFAS exposure was assessed on a continuous logarithm transformed scale and in country-specific tertiles. We used Cox discrete-time models and logistic regression to estimate fecundability ratios (FRs) and infertility (TTP >13 months) odds ratios (ORs), respectively, and 95% confidence intervals (CI) according to PFAS levels. Adjusted analyses of the association between PFAS and TTP were done for each study population and in a pooled sample. Results: Higher PFNA levels were associated with longer TTP in the pooled sample (log-scale FR = 0.80; 95% CI 0.69-0.94) and specifically in women from Greenland (log-scale FR = 0.72; 95% CI 0.58-0.89). ORs for infertility were also increased in the pooled sample (log-scale OR = 1.53; 95% CI 1.08-2.15) and in women from Greenland (log-scale OR = 1.97; 95% CI 1.22-3.19). However, in a sensitivity analysis of primiparous women these associations could not be replicated. Associations with PFNA were weaker for women from Poland and Ukraine. PFOS, PFOA and PFHxS were not consistently associated with TTP.			1													1		1		1	A	B	PFNA高値とtime to pregnantの延長との関係を示唆する論文。Greenlandの High群のみで不妊の調整OR上昇 2.15 (1.05, 4.42), 受胎確率比低下 0.71 (0.54, 0.94)。Greenlandの High群の血清PFNA濃度は0.90-5.71ng/mL(Poland 0.74-2.76, Ukraine 0.73-3.72)	
800	ヒト（生殖発生毒性）	Lee, E. S.; Han, S.; Oh, J. E.	Association between perfluorinated compound	2016	Reprod Toxicol. 2016 Jan;59:53-9. doi: 10.1016/j.reprotox.2015.10.020. Epub 2015 Nov 10.	The effects of exposure to the perfluoroalkyl and polyfluoroalkyl substances (PFASs) perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) on birth weight have been examined in several studies, but other PFASs have not been considered. We conducted a cross-sectional survey of newborns in Seoul, South Korea, collecting 118 serum samples, for 85 of which we had a full range of information. We conducted multiple regression analyses to examine the association between nine PFAS concentrations in cord serum and birth weight. Seven PFASs were found in cord serum, PFOA and PFOS being dominant, with mean concentrations of 1.11 and 0.87ng/mL, respectively. The adjusted birth weight changes (natural log) were -0.14 (95% confidence interval -0.33-0.03) for PFOS and -0.03 (95% confidence interval -0.25-0.18) for PFOA. None of the PFASs were statistically associated with birth weight in this population.			1													1					B	B	ネガティブデータだが濃度分布情報あり PFNA最小-最大ND-1.33 Mean0.36 SD(0.15) 25%tile0.29 50%tile0.35 75%tile 0.43	
801	ヒト（生殖発生毒性）	Lenters, V.; Portengen, L.; Rignell-Hydbom, A.; Jönsson, B. A.; Lindh, C. H.; Piersma, A. H.; Toft, G.; Bonde, J. P.; Heederik, D.; Rylander, L.; Vermeulen, R.	Prenatal phthalate, perfluoroalkyl acid, and org	2016	Environ Health Perspect. 2016 Mar;124(3):365-72. doi: 10.1289/ehp.1408933. Epub 2015 Jun 26.	Background: Some legacy and emerging environmental contaminants are suspected risk factors for intrauterine growth restriction. However, the evidence is equivocal, in part due to difficulties in disentangling the effects of mixtures. Objectives: We assessed associations between multiple correlated biomarkers of environmental exposure and birth weight. Methods: We evaluated a cohort of 1,250 term (≥ 37 weeks gestation) singleton infants, born to 513 mothers from Greenland, 180 from Poland, and 557 from Ukraine, who were recruited during antenatal care visits in 2002-2004. Secondary metabolites of diethylhexyl and diisononyl phthalates (DEHP, DiNP), eight perfluoroalkyl acids, and organochlorines (PCB-153 and p,p´-DDE) were quantifiable in 72-100% of maternal serum samples. We assessed associations between exposures and term birth weight, adjusting for co-exposures and covariates, including prepregnancy body mass index. To identify independent associations, we applied the elastic net penalty to linear regression models. Results: Two phthalate metabolites (MEHHP, MOiNP), perfluorooctanoic acid (PFOA), and p,p´-DDE were most consistently predictive of term birth weight based on elastic net penalty regression. In an adjusted, unpenalized regression model of the four exposures, 2-SD increases in natural log-transformed MEHHP, PFOA, and p,p´-DDE were associated with lower birth weight: -87 g (95% CI: -137, -340 per 1.70 ng/mL), -43 g (95% CI: -108, 23 per 1.18 ng/mL), and -135 g (95% CI: -192, -78 per 1.82 ng/g lipid), respectively; and MOiNP was associated with higher birth weight (46 g; 95% CI: -5, 97 per 2.22 ng/mL). Conclusions: This study suggests that several of the environmental contaminants, belonging to three chemical classes, may be independently associated with impaired fetal growth. These results warrant follow-up in other cohorts.			1													1		1			B	B	ネガティブデータだが曝露の分布情報あり 各5%tile, 50%tile, 95%tile グリーンランド0.33 0.69 1.99 ポーランド0.30 0.56 1.34 ウクライナ0.30 0.61 1.37	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用												備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
802	ヒト（生殖発生毒性）	Liew, Z.; Ritz, B.; Bonefeld-Jørgensen, E. C.; Henriksen, T. B.; Nohr, E. A.; Bech, B. H.; Fei, C.; Bossi, R.; von Ehrenstein, O. S.; Streja, E.; Uldall, P.; Olsen, J.	Prenatal exposure to perfluoroalkyl substances	2014	Am J Epidemiol. 2014 Sep 15;180(6):574-81. doi: 10.1093/aje/kwu179. Epub 2014 Aug 19.	Perfluoroalkyl substances (PFASs) are persistent pollutants and endocrine disruptors that may affect fetal brain development. We investigated whether prenatal exposure to PFASs increases the risk of congenital cerebral palsy (CP). The source population for this study includes 83389 liveborn singletons and mothers enrolled in the Danish National Birth Cohort during 1996-2002. We identified 156 CP cases by linking the cohort to the Danish National Cerebral Palsy Register, and we randomly selected 550 controls using a case-cohort design. We measured 16 PFASs in maternal plasma collected in early or midpregnancy, and 6 PFASs were quantifiable in more than 0.9 of the samples. We found a higher risk of CP in boys with higher maternal PFAS levels; per 1-unit (natural-log ng/mL) increase, the risk ratios were 1.7 (95% confidence interval: 1.0, 2.8) for perfluorooctane sulfonate and 2.1 (95% confidence interval: 1.2, 3.6) for perfluorooctanoic acid. We also observed a dose-response pattern of CP risk in boys per quartile of maternal level of perfluorooctane sulfonate and perfluorooctanoic acid (P for trend < 0.01). PFASs were associated with both unilateral and bilateral spastic CP subphenotypes. No association between PFASs and CP was found in girls. Prenatal exposures to PFASs may increase the risk ofCP in boys, but the finding is novel and replication is needed.			1												1		1			B	C	ネガティブデータ。 各群の中央値と四分位範囲ng/mL 0.46 (0.38–0.58) 0.44 (0.35–0.55) 0.39 (0.33–0.53) 0.41 (0.31–0.59)	
803	ヒト（生殖発生毒性）	Lind, D. V.; Priskorn, L.; Lassen, T. H.; Nielsen, F.; Kyhl, H. B.; Kristensen, D. M.; Christesen, H. T.; Jørgensen, J. S.; Grandjean, P.; Jensen, T. K.	Prenatal exposure to perfluoroalkyl substances	2017	Reprod Toxicol. 2017 Mar;68:200-206. doi: 10.1016/j.reprotox.2016.08.019. Epub 2016 Aug 31.	In the Odense child cohort, serum concentrations of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) were measured in 638 pregnant women. Birth weight, head and abdominal circumferences and gestational age were determined. Anogenital distance (AGD), the distance from the anus to the genital organs, and penile width were measured 3 months after expected date of birth in 511 children. PFOS, PFHxS, PFNA and PFDA were associated with a decreased AGD in girls (p-trend<;0.05) after adjusting for age and weight-for-age standard deviation score. PFOS in the highest quartile was associated with a 2.8mm (95% confidence intervals -4.5; -1.1) reduction in AGD in girls. No such tendencies were seen in boys. However, a tendency toward increased birth weight in girls and reduced birth weight in boys suggests that sex-dimorphic effects may occur from endocrine disrupting effects of these substances.			1												1		1			B	B	PFNAと女児のAGDとの関連 全体中央値と四分位範囲 0.7 (0.5–0.9) 3rd (0.7–0.8)とtrendテストp=0.05、連続量の場合のみ有意。	
804	ヒト（生殖発生毒性）	Lum, K. J.; Sundaram, R.; Barr, D. B.; Louis, T. A.; Buck Louis, G. M.	Perfluoroalkyl Chemicals, Menstrual Cycle Len	2017	Epidemiology. 2017 Jan;28(1):90-98. doi: 10.1097/EDE.0000000000000552.	Background: Perfluoroalkyl substances have been associated with changes in menstrual cycle characteristics and fecundity, when modeled separately. However, these outcomes are biologically related, and we evaluate their joint association with exposure to perfluoroalkyl substances. Methods: We recruited 501 couples from Michigan and Texas in 2005-2009 upon their discontinuing contraception and followed them until pregnancy or 12 months of trying. Female partners provided a serum sample on enrollment and completed daily journals on menstruation, intercourse, and pregnancy test results. We measured seven perfluoroalkyl substances in serum using liquid chromatography-tandem mass spectrometry. We assessed the association between perfluoroalkyl substances and menstrual cycle length using accelerated failure time models and between perfluoroalkyl substances and fecundity using a Bayesian joint modeling approach to incorporate cycle length. Results: Menstrual cycles were 3% longer comparing women in the second versus first tertile of perfluorodecanoate (PFDeA; acceleration factor [AF] = 1.03, 95% credible interval [CrI] = [1.00, 1.05]), but 2% shorter for women in the highest versus lowest tertile of perfluorooctanoic acid (PFOA; AF = 0.98, 95% CrI = [0.96, 1.00]). When accounting for cycle length, relevant covariates, and remaining perfluoroalkyl substances, the probability of pregnancy was lower for women in second versus first tertile of perfluorononanoate (PFNA; odds ratio [OR] = 0.6, 95% CrI = [0.4, 1.0]) although not when comparing the highest versus lowest (OR = 0.7, 95% CrI = [0.3, 1.1]) tertile. Conclusions: In this prospective cohort study, we observed associations between two perfluoroalkyl substances and menstrual cycle length changes, and between select perfluoroalkyl substances and diminished fecundity at some (but not all) concentrations. See video abstract at,			1												1					B	B	PFNAは第一三分位と第二三分位の間のみ有意差で用量反応関係がない。	
805	ヒト（生殖発生毒性）	Manzano-Salgado, C. B.; Casas, M.; Lopez-Espinosa, M. J.; Ballester, F.; Iñiguez, C.; Martinez, D.; Costa, O.; Santa-Marina, L.; Pereda-Pereda, E.; Schettgen, T.; Sunyer, J.; Vrijheid, M.	Prenatal exposure to perfluoroalkyl substances	2017	Environ Int. 2017 Nov;108:278-284. doi: 10.1016/j.envint.2017.09.006.	Background: Prenatal perfluorooctanoate (PFOA) exposure has been associated with reduced birth weight but maternal glomerular filtration rate (GFR) may attenuate this association. Further, this association remains unclear for other perfluoroalkyl substances (PFAS), such as perfluorooctane sulfonate (PFOS), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA). We estimated associations between prenatal PFAS exposure and birth outcomes, and the influence of GFR, in a Spanish birth cohort. Methods: We measured PFHxS, PFOS, PFOA, and PFNA in 1st-trimester maternal plasma (years: 2003-2008) in 1202 mother-child pairs. Continuous birth outcomes included standardized weight, length, head circumference, and gestational age. Binary outcomes included low birth weight (LBW), small-for-gestational-age, and preterm birth. We calculated maternal GFR from plasma-creatinine measurements in the 1st-trimester of pregnancy (n=765) using the Cockcroft-Gault formula. We used mixed-effects linear and logistic models with region of residence as random effect and adjustment for maternal age, parity, pre-pregnancy BMI, and fish intake during pregnancy. Results: Newborns in this study weighted on average 3263g and had a median gestational age of 39.8weeks. The most abundant PFAS were PFOS and PFOA (median: 6.05 and 2.35ng/mL, respectively). Overall, PFAS concentrations were not significantly associated to birth outcomes. PFOA, PFHxS, and PFNA showed weak, non-statistically significant associations with reduced birth weights ranging from 8.6g to 10.3g per doubling of exposure. Higher PFOS exposure was associated with an OR of 1.90 (95% CI: 0.98, 3.68) for LBW (similar in births-at-term) in boys. Maternal GFR did not confound the associations. Conclusions: In this study, PFAS showed little association with birth outcomes. Higher PFHxS, PFOA, and PFNA concentrations were non-significantly associated with reduced birth weight. The association between PFOS and LBW seemed to be sex-specific. Finally, maternal GFR measured early during pregnancy had little influence on the estimated associations.			1												1		1			B	B	有意ではない出生体重の減少との関連。 Supplementary dataが見れないため濃度不明。	
806	ヒト（生殖発生毒性）	Robledo, Candace A; Yeung, Edwina; Mendola, Pauline; Sundaram, Rajeshwari; Maisog, Jose; Sweeney, Anne M; Barr, Dana Boyd; Louis, Germaine M Buck	Preconception maternal and paternal exposure	2015	Environ Health Perspect. 2015 Jan;123(1):88-94. doi: 10.1289/ehp.1308016. Epub 2014 Aug 5.	BACKGROUND: Persistent organic pollutants (POPs) are developmental toxicants, but the impact of both maternal and paternal exposures on offspring birth size is largely unexplored. OBJECTIVE: We examined associations between maternal and paternal serum concentrations of 63 POPs, comprising five major classes of pollutants, with birth size measures. METHODS: Parental serum concentrations of 9 organochlorine pesticides, 1 polybrominated biphenyl (PBB), 7 perfluoroalkyl chemicals (PFCs), 10 polybrominated diphenyl ethers (PBDEs), and 36 polychlorinated biphenyls (PCBs) were measured before conception for 234 couples. Differences in birth weight, length, head circumference, and ponderal index were estimated using multiple linear regression per 1-SD increase in natural log-transformed (ln-transformed) chemicals. Models were estimated separately for each parent and adjusted for maternal age, maternal prepregnancy body mass index (kilograms per meter squared) and other confounders, and all models included an interaction term between infant sex and each chemical. RESULTS: Among girls (n = 117), birth weight was significantly lower (range, 84-195 g) in association with a 1-SD increase in ln-transformed maternal serum concentrations of DDT, PBDE congeners 28 and 183, and paternal serum concentrations of PBDE-183 and PCB-167. Among boys (n = 113), maternal (PCBs 138, 153, 167, 170, 195, and 209 and perfluorooctane sulfonamide) and paternal (PCBs 172 and 195) serum concentrations of several POPs were statistically associated with lower birth weight (range, 98-170 g), whereas paternal concentrations of PBDEs (66, 99) were associated withhigher birth weight. Differences in offspring head circumference, length, and ponderal index were also associated with parental exposures. CONCLUSIONS: Preconceptional maternal and paternal concentrations of several POPs were associated with statistically significant differences in birth size among offspring.			1												1		1			B	D	PFNAはネガティブデータ。GMと95%CIはそれぞれ女児1.211 (1.127, 1.301)男児 1.566 (1.462, 1.677)	
807	ヒト（生殖発生毒性）	Romano, M. E.; Xu, Y.; Calafat, A. M.; Yolton, K.; Chen, A.; Webster, G. M.; Eliot, M. N.; Howard, C. R.; Lanphear, B. P.; Braun, J. M.	Maternal serum perfluoroalkyl substances duri	2016	Environ Res. 2016 Aug;149:239-246. doi: 10.1016/j.envres.2016.04.034. Epub 2016 May 11.	Background: Perfluoroalkyl substances (PFAS) may affect breast development and decrease duration of breastfeeding, thus interfering with the health benefits of breastfeeding. We investigated the association between maternal PFAS exposure and breastfeeding duration. Methods: We measured PFAS concentrations in maternal serum collected during pregnancy in 2003-2006. After delivery, women (n=336) completed standardized breastfeeding surveys every 3 months until ending breastfeeding or 36 months postpartum. We estimated relative risks (RRs) for ending any breastfeeding within 3-6 months postpartum by Poisson regression, adjusted for relevant confounding factors. Results: Women in the 4th quartile of perfluorooctanoic acid (PFOA) serum concentration had 1.77 times the risk of ending any breastfeeding by 3 months (95% confidence interval (CI): 1.23, 2.54; p-trend=0.003) and 1.41 times the risk of ending any breastfeeding by 6 months (95%CI: 1.06, 1.87; p-trend=0.038), compared with women in the first quartile. Women in the 4th quartile of perfluorooctane sulfonic acid serum concentration had a marginally increased risk of discontinuing any breastfeeding by 3 months (RR=1.32; 95%CI: 0.97, 1.79; p-trend=0.065). Conclusions: Maternal serum PFOA concentrations were inversely related to duration of any breastfeeding in this cohort, even after controlling for prior breastfeeding. These findings suggest that PFOA exposure may adversely affect breastfeeding duration and highlight the need to consider the potential adverse effects of maternal environmental chemical exposure on breastfeeding.			1												1					B	B	PFNAとbreastfeedingとの間はネガティブ 中央値と四分位範囲0.9(0.7–1.2)ng/mL	
808	ヒト（生殖発生毒性）	Sagiv, S. K.; Rifas-Shiman, S. L.; Fleisch, A. F.; Webster, T. F.; Calafat, A. M.; Ye, X.; Gillman, M. W.; Oken, E.	Early Pregnancy Perfluoroalkyl Substance Plas	2018	Am J Epidemiol. 2018 Apr 1;187(4):793-802. doi: 10.1093/aje/kwx332.	Associations of prenatal exposure to perfluoroalkyl substances (PFASs), ubiquitous chemicals used in stain and water resistant products, with adverse birth outcomes may be confounded by pregnancy hemodynamics. We measured plasma concentrations of four PFASs in early pregnancy (median, 9 weeks) among 1645 women in Project Viva, a Boston-area cohort recruited 1999-2002. We fit multivariable models to estimate PFAS associations with birth weight-for-gestational age z score and gestation length adjusting for sociodemographic confounders and two hemodynamic markers: 1) plasma albumin, a measure of plasma volume expansion, and 2) plasma creatinine, used to estimate glomerular filtration rate. Perfluorooctane sulfonate (PFOS) and perfluorononanoate (PFNA) were weakly inversely associated with birth weight-for-gestational age z scores (adjusted β = -0.04 (95% confidence interval (CI): -0.08, 0.1) and -0.06 (95% CI: -0.11, -0.01) per interquartile increase, respectively). PFOS and PFNA were also associated with higher odds of preterm birth (e.g., highest vs. lowest PFOS quartile adjusted odds ratio = 2.4 (95% CI: 1.3, 4.4)). Adjusting for markers of pregnancy hemodynamics (glomerular filtration rate and plasma albumin), to the extent that they accurately reflect underlying pregnancy physiology, did not materially impact associations. These results suggest that pregnancy hemodynamics may not confound associations with birth outcomes when PFASs are measured early inpregnancy.			1												1				1	A	A	四分位範囲0.4増えることに-28.2g(95%CI-52.0—-4.4）出生体重減少。ただし四分位ごとの比較では第三四分位のみ低下。 PFNA中央値と四分位範囲0.7 (0.4)	
809	ヒト（生殖発生毒性）	Shi, Y.; Yang, L.; Li, J.; Lai, J.; Wang, Y.; Zhao, Y.; Wu, Y.	Occurrence of perfluoroalkyl substances in cor	2017	Chemosphere. 2017 Feb;169:396-402. doi: 10.1016/j.chemosphere.2016.11.050. Epub 2016 Nov 23.	Perfluoroalkyl substances (PFASs), a group of environmental pollutants, persistently exist in the environment. To investigate the associations between PFASs levels in cord serum and birth weight, birth length and ponderal index, we measured PFASs in cord serum samples from 170 infants from Feb. 2012 to Jun. 2012 in Beijing, China. The mean concentrations in cord serum samples for perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA) and perfluoroundecanoic acid (PFUnA) were 1.285 ng/mL, 1.228 ng/mL, 0.230 ng/mL, 0.224 ng/mL, 0.100 ng/mL and 0.085 ng/mL, respectively. First-born children had slightly higher exposure levels of PFHxS ($p < 0.001$) and PFOA ($p = 0.03$) than second-born or third-born children. The spearman correlation coefficients with gestation time were individually 0.160 ($p = 0.038$) for PFHxS and 0.202 ($p = 0.008$) for PFOA. Both univariate and multivariate linear regression analysis showed that the exposure levels of PFASs had no statistically significant associations with birth weight, birth length or ponderal index in the present population. For male infants, we observed that PFHxS positively correlated with birth length, but the levels of PFUnA were negatively associated with birth length.			1												1		1			B	B	PFNAと出生体重、身長、ポンデラル指数との関連なし。 最小値、最大値、平均、25%tile, 50%tile, 75%tileはそれぞれ0.039, 0.801, 0.224, 0.139, 0.191, 0.277 ng/mL	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
810	ヒト（生殖発生毒性）	So, Man Ka; Yamashita, Nobuyoshi; Taniyasu, Sachi; Jiang, Qinting; Giesy, John P; Chen, Kun; Lam, Paul Kwan Sing	Health risks in infants associated with exposur	2006	Environ Sci Technol. 2006 May 1;40(9):2924-9. doi: 10.1021/es060031f.	Recent studies have reported the ubiquitous distribution of perfluorinated compounds (PFCs), especially perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA), in wildlife and human whole blood or serum. In 2003 a solid phase extraction method was developed, which allowed the measurement of PFCs in human breast milk. In the present study, PFCs in samples of human breast milk from 19 individuals from Zhoushan, China, were analyzed by modifying a previously established method, based on weak-anion exchange extraction. PFOS and PFOA were the two dominant chemicals detected in all the milk samples. Concentrations of PFOS and PFOA ranged from 45 to 360 ng/L and 47 to 210 ng/L, respectively. The maximum concentrations of other PFCs were 100 ng/L for perfluorohexanesulfonate (PFHxS), 62 ng/L for perfluorononanoate (PFNA), 15 ng/L for perfluorodecanoate (PFDA) and 56 ng/L for perfluoroundecanoate (PFUnDA). Statistically significant correlations between various PFCs suggested a common exposure source to humans. No statistically significant correlation was found between concentrations of either PFOS or PFOA and maternal age, weight, or infant weight. Rate of consumption of fish was found to be positively correlated with PFNA, PFDA, and PFUnDA concentrations. Daily intake of PFOS for the child via breast milk with greater PFOS concentrations exceeded the predicted conservative reference dose in 1 of 19 samples, indicating that there may be a small potential risk of PFOS for the infants in Zhoushan via the consumption of breast milk.			1	1												1						C	C	メインは曝露源の話	
811	ヒト（生殖発生毒性）	Specht, Ina Olmer; Hougaard, Karin S; Spanò, Marcello; Bizzaro, Davide; Manicardi, Gian Carlo; Lindh, Christian H; Toft, Gunnar; Jönsson, Bo A G; Giwercman, Aleksander; Bonde, Jens Peter E	Sperm DNA integrity in relation to exposure to	2012	Reprod Toxicol. 2012 Jul;33(4):577-583. doi: 10.1016/j.reprotox.2012.02.008. Epub 2012 Mar 15.	Perfluoroalkyl substances (PFASs) can interfere with male reproductive function, but evidence in humans is limited. Six hundred four fertile men (199 from Greenland, 197 from Poland and 208 from Ukraine) were enrolled in the study. We measured four PFASs in serum (PFOS, PFOA, PFNA and PFHxS) and concurrent DNA damage in spermatozoa by sperm chromatin structure assay (SCSA) and in situ terminal deoxynucleotidyl transferase dUTP nick-end labeling (TUNEL) assay, apoptotic markers in semen (Fas-receptor and Bcl-xL), and reproductive hormones in serum. No association between PFASs and SCSA, apoptotic markers or reproductive hormones emerged. We observed a slight increase in SHBG and TUNEL-positivity with increased PFOA exposure in men from Greenland. Thus, consistent evidence that PFAS exposure interferes with sperm DNA fragmentation, apoptosis or reproductive hormones was not found.			1													1						B	B	ネガティブデータ PFNA平均、中央値、範囲 グリーンランド2.3, 1.4, 0.5-12 ポーランド1.3, 1.2, 0.5-6 ウクライナ1.1, 1.0, 0.2-4	
812	ヒト（生殖発生毒性）	Taylor, K. W.; Hoffman, K.; Thayer, K. A.; Daniels, J. L.	Polyfluoroalkyl chemicals and menopause amo	2014	Environ Health Perspect. 2014 Feb;122(2):145-50. doi: 10.1289/ehp.1306707. Epub 2013 Nov 26.	Background: Polyfluoroalkyl chemicals (PFCs) such as perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) have been associated with early menopause. However, previous cross-sectional studies have lacked adequate data to investigate possible reverse causality (i.e., higher serum concentrations due to decreased excretion after menopause). Objectives: We investigated the association between PFOS, PFOA, perfluorononanoate (PFNA), and perfluorohexane sulfonate (PFHxS) and age at natural menopause among women 20-65 years of age in NHANES (National Health and Nutrition Examination Survey). Methods: We used proportional hazard models to estimate hazard ratios (HRs) for the onset of natural menopause as a function of age and serum PFC levels, and to investigate reverse causation by estimating associations between PFC levels and the rate of hysterectomy. We also used multivariable linear regression to determine whether time since menopause predicted serum PFC levels. Results: After adjusting for age at survey, race/ethnicity, education, ever smoking, and parity, women with higher levels of PFCs had earlier menopause than did women with the lowest PFC levels. We observed a monotonic association with PFHxS: The HR was 1.42 (95% CI: 1.08, 1.87) for serum concentrations in tertile 2 versus tertile 1, and 1.70 (95% CI: 1.36, 2.12) for tertile 3 versus tertile 1. We also found evidence of reverse causation: PFCs were positively associated with rate of hysterectomy, and time since natural menopause was positively associated with serum PFCs. Conclusions: Our findings suggest a positive association between PFCs and menopause; however, at least part of the association may be due to reverse causation. Regardless of underlying cause, women appear to have higher PFC concentrations after menopause.			1													1			1			B	B	ネガティブデータ また、因果の逆転の指摘有。 PFNA濃度はPremenopause Menopause Hysterectomy群それぞれ、median (T1, T3) 0.90 (0.60, 1.40) 1.20 (0.80, 1.80) 1.30 (0.80, 2.10)ng/mL	
813	ヒト（生殖発生毒性）	Timmermann, C. A.; Budtz-Jørgensen, E.; Petersen, M. S.; Weihe, P.; Steuerwald, U.; Nielsen, F.; Jensen, T. K.; Grandjean, P.	Shorter duration of breastfeeding at elevated e	2017	Reprod Toxicol. 2017 Mar;68:164-170. doi: 10.1016/j.reprotox.2016.07.010. Epub 2016 Jul 12.	The aim of this study was to determine whether maternal exposure to persistent perfluoroalkyl substances (PFASs) affect the capability to breastfeed. In two Faroese birth cohorts (N=1130), concentrations of five PFASs were measured in maternal serum during pregnancy or two weeks after term. Duration of breastfeeding was assessed by questionnaire and clinical interview. In adjusted linear regression models, a doubling of maternal serum PFASs was associated with a reduction in duration of both total and exclusive breastfeeding, most pronounced for perfluorooctane sulfonic acid (PFOS) where a doubling was associated with a reduction in total breastfeeding of 1.4 (95% CI: 0.6; 2.1) months and perfluorooctanoic acid (PFOA) where a doubling was associated with a reduction in exclusive breastfeeding of 0.5 (0.3; 0.7) months. The associations were evident among both primiparous and multiparous women, and thus cannot be explained by confounding from previous breastfeeding.			1													1			1			B	B	olderコホートでPFNAが2倍になるとbreastfeeding期間が減少。そのコホートの中央値と四分位範囲0.59 (0.46; 0.79)。どこから有害影響と言えるのか。PFNA中央値と四分位範囲0.62 (0.48; 0.83)	
814	ヒト（生殖発生毒性）	Toft, G.; Jönsson, B. A. G.; Lindh, C. H.; Giwercman, A.; Spano, M.; Heederik, D.; Lenters, V.; Vermeulen, R.; Rylander, L.; Pedersen, H. S.; Ludwicki, J. K.; Zviezdai, V.; Bonde, J. P.	Exposure to perfluorinated compounds and hu	2012	Hum Reprod. 2012 Aug;27(8):2532-40. doi: 10.1093/humrep/des185. Epub 2012 May 30.	Background: Perfluorinated compounds (PFCs) have been suspected to adversely affect human reproductive health. The aim of this study was to investigate the associations between PFC exposure and male semen quality. Methods: PFCs were measured in serum from 588 partners of pregnant women from Greenland, Poland and Ukraine who provided a semen sample, using liquid chromatography tandem mass spectrometry. Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS) and perfluorononanoic acid (PFNA) could be detected in >97% of the samples. The associations between levels of these compounds and semen volume, sperm concentration, total sperm count, motility and morphology were assessed. Results: Across countries, sperm concentration, total sperm count and semen volume were not consistently associated with PFOS, PFOA, PFHxS or PFNA levels. The proportion of morphologically normal cells was 35% lower [95% confidence interval (CI): 4-66%) for the third tertile of PFOS exposure as compared with the first. A similar reduction was found in relation to increasing PFHxS levels. At the third PFOA exposure tertile, the percentage of motile spermatozoa was 19% (95% CI: 1 to 39%) higher than in the first. Conclusions: The most robust finding in the present study was the negative associations between PFOS exposure and sperm morphology suggesting adverse effects of PFOS on semen quality, possibly due to interference with the endocrine activity or sperm membrane function. It cannot be excluded that this association and the positive association between PFOA and semen motility, which was not consistent across countries, might represent a chance finding due to the multiple statistical tests being performed.			1													1			1		1	A→B	B	PFASが2倍になるとbreasteeding期間が減少。 PFNA中央値と四分位範囲0.62 (0.48; 0.83)ng/mL	
815	ヒト（生殖発生毒性）	Vagi, S. J.; Azziz-Baumgartner, E.; Sjödin, A.; Calafat, A. M.; Dumesic, D.; Gonzalez, L.; Kato, K.; Silva, M. J.; Ye, X.; Azziz, R.	Exploring the potential association between br	2014	BMC Endocrine Disorders. 2014 Oct 28;14:86. doi: 10.1186/1472-6823-14-86.	Background: Polycystic Ovary Syndrome (PCOS) is an endocrine-metabolic disorder that affects approximately 6-10% of women of child-bearing age. Although preliminary studies suggest that certain pollutants may act as endocrine disruptors in animals, little is known about their potential association with PCOS. The objective of this case-control pilot study is to determine whether women with PCOS have higher concentrations of specific environmental contaminants compared to women who have not developed PCOS. Methods: Fifty-two PCOS case-patients (diagnosed using the National Institutes of Health 1990 definition) and 50 controls were recruited in 2007-2008, from an urban academic medical center in Los Angeles, CA. Brominated diphenyl ethers, polychlorinated biphenyls (PCBs), organochlorine pesticides, and perfluorinated compounds (PFCs) were measured in serum, and phthalates metabolites and bisphenol A (BPA) in urine. Results: PCOS case-patients had significantly higher geometric mean (GM) serum concentrations of two PFCs: perfluorooctanoate (PFOA) (GMcases = 4.1 μg/L, GMcontrols = 2.3 μg/L; p = 0.001) and perfluorooctane sulfonate (PFOS) (GMcases = 8.2 μg/L, GMcontrols = 4.9 μg/L; p = 0.01), and lower urinary concentrations of monobenzyl phthalate (mBzP) (GMcases = 7.5 μg/g creatinine, GMcontrols = 11.7 μg/g creatinine; p = 0.02). Logistic regression, controlling for body mass index, age and race, identified an increased likelihood of PCOS in subjects with higher serum concentrations of PFOA and PFOS (adjusted-ORs = 5.8-6.9, p < 0.05), and with lower urine concentrations of mBzP and mono-n-butyl phthalate (mBP) (aORs = 0.14-0.25, p < 0.05). Conclusions: Our data suggest that PCOS case-patients may differ from controls in their environmental contaminant profile. PCOS subjects had higher serum concentrations of two PFCs, PFOA and PFOS, and lower urine concentrations of mBP and mBzP. Future studies are needed to confirm these preliminary findings and determine if these chemicals or their precursors may have a role in the pathogenesis of PCOS.			1													1						C	D	ネガティブデータ。平均鹿で曝露濃度データもない。	
816	ヒト（生殖発生毒性）	Vestergaard, Sonja; Nielsen, Flemming; Andersson, Anne-Maria; Hjøllund, Niels Henrik; Grandjean, Philippe; Andersen, Helle Raun; Jensen, Tina Kold	Association between perfluorinated compound	2012	Hum Reprod. 2012 Mar;27(3):873-80. doi: 10.1093/humrep/der450. Epub 2012 Jan 13.	BACKGROUND: Perfluorinated chemicals (PFCs) have been widely used and have emerged as important food contaminants. A recent study on pregnant women suggested that PFC exposure was associated with a longer time to pregnancy (TTP). We examined the association between serum concentrations of PFCs in females and TTP in 222 Danish first-time pregnancy planners during the years 1992-1995. METHODS: The couples were enrolled in the study when discontinuing birth control and followed for six menstrual cycles or until a clinically recognized pregnancy occurred. Fecundability ratio (FR) was calculated using discrete-time survival models. In addition, odds ratio (OR) for TTP >6 cycles was calculated. RESULTS: OR for TTP >6 cycles for those with PFC concentrations above the median were 0.96 [95% confidence interval (CI): 0.54-1.64] for perfluorooctane sulfonic acid (PFOS), the major PFC, compared with those below the median. FRs for those with PFOS concentrations above the median were 1.05 (95% CI: 0.74-1.48) compared with those below the median. Other PFCs showed the same lack of association with TTP. The results were not affected by adjustment for covariates. PFOS and perfluorooctanoic acid concentrations were similar to those observed in a previous Danish study. CONCLUSIONS: These findings suggest that exposure to PFCs affects TTP only to a small extent, if at all.			1													1			1			B	C	ネガティブデータ 非妊娠、妊娠群それぞれのPFNA平均値と四分位範囲 0.45 (0.36, 0.67) 0.51 (0.38, 0.65)	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
817	ヒト（生殖発生毒性）	Wang, Y.; Adgent, M.; Su, P. H.; Chen, H. Y.; Chen, P. C.; Hsiung, C. A.; Wang, S. L.	Prenatal exposure to perfluorocarboxylic acids	2016	Environ Health Perspect. 2016 Nov;124(11):1794-1800. doi: 10.1289/ehp.1509998. Epub 2016 Feb 19.	Background: Perfluorocarboxylic acids (PFCAs) are environmentally and biologically persistent synthetic chemicals. PFCAs include perfluorooctanoic acid (PFOA; C8) and long-chain PFCAs (C9-C20). Studies examining long-chain PFCAs and fetal and postnatal growth are limited. Objectives: We investigated the associations of prenatal exposure to long-chain PFCAs with fetal and postnatal growth. Methods: For 223 Taiwanese mothers and their term infants, we measured PFOA and four long-chain PFCAs (ng/mL) in third-trimester maternal serum; infant weight (kg), length and head circumference (cm) at birth; and childhood weight and height at approximately 2, 5, 8, and 11 years of age. For each sex, we used multivariable linear regression to examine associations between ln-transformed prenatal PFCAs and continuous infant measures, and logistic regression to examine small for gestational age (SGA). Linear mixed models were applied to prenatal PFCAs and childhood weight and height z-scores. Results: In girls, prenatal perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDeA), perfluoroundecanoic acid (PFUnDA), and perfluorododecanoic acid (PFDoDA) concentrations were inversely associated with birth weight [e.g., β birth weight (kg) = -0.06, 95% CI: -0.11, -0.01 per 1 ln-unit PFUnDA increase]; prenatal PFDeA and PFUnDA were associated with elevated odds of SGA; and PFDeA, PFUnDA, and PFDoDA were associated with lower average childhood height z-score. In boys, prenatal PFNA, and PFDoDA were associated with reductions in height at certain ages in childhood, but not with size at birth. Conclusions: Prenatal exposure to long-chain PFCAs may interfere with fetal and childhood growth in girls, and childhood growth in boys. Citation: Wang Y, Adgent M, Su PH, Chen HY, Chen PC, Hsiung CA, Wang SL. 2016. Prenatal exposure to perfluorocarboxylic acids (PFCAs) and fetal and postnatal growth in the Taiwan Maternal and Infant Cohort Study.			1												1		1			1	B	A	女児で出生体重減少との関連(beta=-0.08)。 PFNAの幾何平均（95%CI）、最小値、25%tile, 50%tile, 75%tile, 905tile, 最大値はそれぞれ、女児1.44 (1.19, 1.74) 0.08 0.84 1.58 2.42 4.54 10.30 男児1.39 (1.16, 1.66) 0.08 0.92 1.55 2.60 4.24 10.25	
818	ヒト（生殖発生毒性）	Whitworth, Kristina W; Haug, Line S; Sabaredzovic, Azemira; Eggesbo, Merete; Longnecker, Matthew P	Brief Report: Plasma Concentrations of Perfluo	2016	Epidemiology. 2016 Sep;27(5):712-5. doi: 10.1097/EDE.0000000000000524.	BACKGROUND: A previous study reported a negative association between perfluorooctane sulfonamide (PFOSA) concentrations and fecundability. METHODS: We examined this association among women enrolled in the Norwegian Mother and Child Cohort Study (MoBa), in 2003-2004. This analysis was restricted to 451 primiparous women to avoid bias due to previous pregnancy. Self-reported time-to-pregnancy (TTP) and plasma were obtained around 18 weeks of gestation. Approximately half of the women had measurable PFOSA levels; missing values were multiply imputed. We used the logistic analogue of discrete-time survival analysis to examine the adjusted association between PFOSA, other perfluoroalkyl substances, and TTP. RESULTS: The median-measured PFOSA concentration was 0.03 ng/ml (interquartile range = 0.02, 0.07). The age and body mass index-adjusted association between an interquartile distance increase in PFOSA and TTP was 0.91 (95% confidence interval = 0.71, 1.17). Imputation of missing PFOSA resulted in similar estimates. No association was observed with other perfluoroalkyl substances. CONCLUSION: Based on a weakly decreased fecundability odds ratio, we found only limited support for an association between plasma PFOSA concentrations and TTP among primiparous women.			1												1						C	C	ネガティブデータ。PFNAは調整因子として検討。PFNA中央値と四分位範囲0.43 (0.32, 0.57) ng/mL	
819	ヒト（生殖発生毒性）	Bach, C.; Matthiesen, B.; Olsen,; Henriksen, B.	Conditioning on parity in studies of perfluoroall	2018	Environ Health Perspect. 2018 Nov;126(11):117003. doi: 10.1289/EHP1493.	Background: Previous studies have investigated the associations between perfluoroalkyl acids (PFAAs) in women and time to pregnancy (TTP). Inconsistent results may be explained by differences in conditioning on parity. Objectives: We used causal directed acyclic graphs to illustrate potential confounding related to previous pregnancies and exposure measurement error due to differences in the interpregnancy interval in pregnancy-based studies that include parous women. We exemplified the potential importance of these issues using data from the Danish National Birth Cohort. Methods: We used discrete time survival models to estimate associations between maternal plasma PFAAs in early pregnancy and TTP in 638 nulliparous and 613 parous women. Results: PFAA quartiles were not associated with the TTP in nulliparous women. In parous women, higher PFAA quartiles were associated with longer TTP. The strongest associations were estimated for perfluorohexane sulfonate and perfluorooctane sulfonate. PFAA concentrations were higher in women with longer interpregnancy intervals. Accounting for the interpregnancy interval attenuated the estimated associations. Conclusions: Associations between PFAAs and TTP in parous women may be biased by confounders related to previous pregnancies and exposure measurement error. To avoid these biases, studies that include parous women may need to condition on a) common causes of PFAAs and the TTP in the index pregnancy, b) previous births (a descendant of a collider), c) PFAA levels or common causes of PFAA levels and the TTP in the previous pregnancy (to alleviate collider stratification bias caused by conditioning on previous births), and d) the interpregnancy interval (in pregnancy-based studies). Alternatives would be to restrict studies to nulliparous women or to use toxicokinetic modeling to correct exposure estimates in parous women. These recommendations may be extended to studies of other chemicals with similar toxicokinetic properties.			1															1			B	D	用量依存的な反応ではなく、評価が難しい。また、PFNAはほぼネガティブデータ。	
820	ヒト（生殖発生毒性）	Buck Louis, G. M.; Zhai, S.; Smarr, M. M.; Grewal, J.; Zhang, C.; Grantz, K. L.; Hinkle, S. N.; Sundaram, R.; Lee, S.; Honda, M.; Oh, J.; Kannan, K.	Endocrine disruptors and neonatal anthropome	2018	Environ Int. 2018 Oct;119:515-526. doi: 10.1016/j.envint.2018.07.024. Epub 2018 Jul 26.	Background: Intrauterine exposure to endocrine disrupting chemicals (EDCs) has been equivocally associated with birth weight, length and head circumference with limited attention to anthropometric endpoints such as umbilical circumference and limb lengths. Objective: To explore 76 prenatal maternal plasma EDC concentrations in a healthy obstetric cohort and 7 neonatal anthropometric endpoints by maternal race/ethnicity. Methods: The study cohort comprised 2106 (564 White, 549 Black, 590 Hispanic, 403 Asian) healthy pregnant women recruited from 12 U.S. clinical sites between 2009 and 2012 who were followed through delivery. Neonates underwent standardized anthropometric assessment (weight, length, head and umbilical circumference, and mid- upper arm and thigh length). Plasma EDC concentrations were quantified using high resolution gas chromatography-high resolution mass spectrometry and liquid chromatography-tandem mass spectrometry. EDCs were log-transformed and rescaled by their deviations (SD) when modeled relative to neonatal endpoints using linear regression adjusting for age, education, pre-pregnancy body mass index (BMI), serum cotinine, serum lipids for lipophilic chemicals, and a race/ethnicity interaction term; p-values had false discovery rate correction (<0.05). Results: The cohort comprised women aged 28 (SD = 5) years with normal BMIs (23.6 kg/m2, SD = 3). Maternal EDC concentrations varied by self-identified race/ethnicity and neonatal outcomes, though no specific EDC was consistently associated with neonatal anthropometric outcomes across racial/ethnic groups. For the overall cohort, perfluorooctanoic acid was negatively associated with birth length per SD increase in concentration (β = -0.23 cm; 95% CI -0.35, -0.10), while perfluorohexanesulfonic acid was negatively associated with umbilical circumference (β = -0.26 cm; 95% CI -0.40, -0.13), perfluorodecanoic acid with arm length (-0.09 cm; 95% CI -0.14, -0.04), and PCBs congeners 118/106 (-0.12 cm; 95% CI -0.20, -0.04) and 146/161 (-0.14 cm; 95% CI -0.23, -0.05) with thigh length, as were 7 other poly-and-perfluorinated alkyl substances (PFASs). Conclusions: Among healthy pregnant women with low risk antenatal profiles and relatively low EDC concentrations, reductions in umbilical circumference and bone lengths may be a sensitive marker of intrauterine EDC exposure, particularly for PFAS.			1															1			B	B	PFNAとupper thigh lengthと負の関連　中央値と四分位範囲0.763 (0.531, 1.155)	
821	ヒト（生殖発生毒性）	Ernst, A.; Brix, N.; Lauridsen, L. L. B.; Olsen, J.; Parner, E. T.; Liew, Z.; Olsen, L. H.; Ramlau-Hansen, C. H.	Exposure to perfluoroalkyl substances during f	2019	Environ Health Perspect. 2019 Jan;127(1):17004. doi: 10.1289/EHP3567.	Background: It remains unsettled whether prenatal exposure to perfluoroalkyl substances (PFASs) affects human reproductive health through potential endocrine disruption. Objectives: We aimed to explore the associations between prenatal exposure to several PFASs and various aspects of pubertal development in boys and girls. Methods: We studied two samples ([Formula: see text] and 445) from the Puberty Cohort, nested within the Danish National Birth Cohort (DNBC), measuring PFAS in maternal plasma from early gestation. Data on pubertal development were collected biannually from the age of 11 y until full maturation, using web-based questionnaires. Outcomes were age at menarche, voice break, first ejaculation, and Tanner stages 2 to 5 for pubic hair, breast, genital development, and a combined puberty indicator. A regression model for censored data was used to estimate mean difference (months) in age at achieving the pubertal outcomes across tertiles of PFAS concentrations and with a doubling of PFAS concentrations (continuous). For perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), a meta-analysis was used to provide a weighted average of the point estimates from samples 1 and 2. Results: Overall, prenatal exposure to PFOS, perfluorohexane sulfonate (PFHxS), perfluoroheptane sulfonate (PFHpS), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA) (girls) and PFHxS and PFHpS (boys) was associated with lower mean age at puberty marker onset. PFDA and PFNA exposure was associated with higher mean age at onset of puberty in boys. Nonmonotonic associations in girls (PFOS, PFHpS, PFDA) and boys (PFDA, PFNA) were observed, showing larger mean age differences for the combined puberty indicator in the middle tertile [girls: PFOS: [Formula: see text] mo, 95% confidence interval (CI): [Formula: see text], [Formula: see text]; PFHpS: [Formula: see text] mo, 95% CI: [Formula: see text], 1.85; PFDA: [Formula: see text] mo, 95% CI: [Formula: see text], 1.83; and boys: PFNA: 4.45 mo, 95% CI: [Formula: see text], 10.21; PFDA: 4.59 mo, 95% CI: [Formula: see text], 10.11] than in the highest tertile with the lowest as reference. Conclusions: Our population-based cohort study suggests sex-specific associations of altered pubertal development with prenatal exposure to PFASs. These findings are novel, and replication is needed.			1															1			A	B	PFNAは統合思春期指標では有意差がないものの、Tanner G2など一部の指標では女児の思春期開始早期化と男児の晩期化との関連あり。第２三分位から影響あり。ただし、ざっと見た感じ三分位の濃度不明	
822	ヒト（生殖発生毒性）	Kwon, E. J.; Shin, J. S.; Kim, B. M.; Shah-Kulkarni, S.; Park, H.; Kho, Y. L.; Park, E. A.; Kim, Y. J.; Ha, E. H.	Prenatal exposure to perfluorinated compound	2016	J Occup Environ Med. 2016 Jun;58(6):e198-205. doi: 10.1097/JOM.0000000000000739.	Objective: The aim of this study was to investigate the effect of genetic polymorphisms on the association of prenatal exposure to perfluorinated compounds (PFCs) with birth weight. Methods: We analyzed the level of eight PFCs in cord blood and two genetic polymorphisms in maternal blood of 268 subjects. Results: Concentrations of perfluorooctanoic acid, perfluorooctane sulfonate, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA) showed significant association with a decrease in birth weight ($P < 0.05$). In mothers with glutathione S-transferase M1 (GSTM1) null genotype, concentrations of PFNA, PFDA, and PFUnDA showed significantly negative association with birth weight ($P < 0.05$). Conclusion: Our findings indicated that GSTM1 polymorphism might affect the association between exposure to PFCs and birth weight, suggesting the effect of genetic susceptibility on the relationship between prenatal PFCs exposure and birth outcomes.			1															1			B	D	臍帯血PFNAと新生児の出生体重との負の関連、PFNA分布情報あり。βのみで閾値が不明	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
823	ヒト（生殖発生毒性）	Marks, K. J.; Cutler, A. J.; Jeddy, Z.; Northstone, K.; Kato, K.; Hartman, T. J.	Maternal serum concentrations of perfluoroalk	2019	Int J Hyg Environ Health. 2019 Jun;222(5):889-895. doi: 10.1016/j.ijheh.2019.03.008. Epub 2019 Apr 9.	Per- and polyfluoroalkyl substances (PFAS) have been widely used in commercial and industrial manufacturing processes since the 1950s. Inverse associations between prenatal exposure to PFAS and birth size have been found in populations around the globe. This study examined the association of prenatal maternal serum concentrations of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA) and birth size in British boys. The study included 457 mother-son dyads participating in the Avon Longitudinal Study of Parents and Children (ALSPAC). Birth weight (g), crown to heel length (cm), and head circumference (cm) were collected at delivery. PFAS were detected in all maternal serum samples during pregnancy (median: 30 weeks gestation (interquartile range: 12-33)). Median concentrations (interquartile range) were 13.8 ng/mL (11.0, 17.7), 3.0 ng/mL (2.3, 3.8), 1.9 ng/mL (1.4, 2.5), and 0.4 ng/mL (0.3, 0.5) for PFOS, PFOA, PFHxS, and PFNA, respectively. In multivariable linear regression models, inverse associations were detected between PFOS (continuous) and birth weight (β = -8.50 g, 0.95 CI = -15.93, -1.07 g), crown to heel length (β = -0.04 cm, 0.95 CI = -0.08, -0.01 cm), and head circumference (β = -0.02 cm, 0.95 CI = -0.04, -0.002 cm). In conclusion, prenatal exposure to high levels of PFOS may be associated with reduced birth size in male infants.			1															1		1	A	B	PFNA第３三分位0.4–1.6において出生体重減少との関連。PFNA中央値と四分位範囲0.4 (0.3, 0.5)	
824	ヒト（生殖発生毒性）	Meng, Qi; Inoue, Kosuke; Ritz, Beate; Olsen, Jørn; Liew, Zeyan	Prenatal Exposure to Perfluoroalkyl Substance	2018	Int J Environ Res Public Health. 2018 Aug 24;15(9):1832. doi: 10.3390/ijerph15091832.	Perfluoroalkyl substances (PFASs) are widespread industrial pollutants that are extremely persistent in the environment. A previous study in the Danish National Birth Cohort (DNBC) found prenatal perfluorooctanoate (PFOA) exposure was associated with decreased birth weight, but had insufficient statistical power to evaluate adverse birth outcomes. Here, we conducted additional analyses in three samples originating from the DNBC for 3535 mothers and infant pairs to evaluate associations between prenatal PFASs exposures and low birth weight and preterm birth. Maternal plasma concentrations were measured for six types of PFASs in early pregnancy. Several PFASs were associated with a reduction in birth weight and gestational age. We estimated a nearly 2-fold increase in risks of preterm birth for the higher quartiles of PFOA and perfluorooctanesulfonate (PFOS) exposure. In spline models, risk of preterm birth was increased for perfluorononanoic acid (PFNA), perfluoroheptane sulfonate (PFHpS) and perfluorodecanoic acid (PFDA) in higher exposure ranges. We also observed some elevated risks for low birth weight but these estimates were less precise. Our findings strengthen the evidence that in-utero PFASs exposures affect fetal growth. Future studies are needed to evaluate whether these associations persist with the decline of PFOA and PFOS in populations and should also investigate newer types of fluorinated compounds introduced more recently.			1															1		1	A	A	妊娠週数減少はQ2とQ4,出生体重減少はQ4のみ 中央値と四分位範囲0.5 (0.4–0.6)の情報もありリスク評価に有用	
825	ヒト（生殖発生毒性）	Singer, A. B.; Whitworth, K. W.; Haug, L. S.; Sabaredzovic, A.; Impinen, A.; Papadopoulou, E.; Longnecker, M. P.	Menstrual cycle characteristics as determinant	2018	Environ Res. 2018 Oct;166:78-85. doi: 10.1016/j.envres.2018.05.019. Epub 2018 Jun 4.	Introduction: Perfluoroalkyl substances (PFASs) are fluorinated organic compounds that have been used in a variety of industrial and consumer applications. Menstruation is implicated as a possible route of elimination for PFASs in women. The overall purpose of this study was to examine menstrual cycle characteristics as determinants of plasma PFAS concentrations in women. Methods: Our study sample consisted of 1977 pregnant women from the Norwegian Mother and Child Cohort (MoBa) study. The women were asked about menstrual cycle regularity in the year before the pregnancy and typical menstrual cycle length as well as other demographic and reproductive characteristics in a questionnaire completed during the pregnancy. Blood samples were collected around 17-18 weeks gestation and PFAS concentrations were measured in plasma. We examined the association between menstrual cycle characteristics and seven PFASs (perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluorohexane sulfonate (PFHxS), perfluoroheptane sulfonate (PFHpS), and perfluorooctane sulfonate (PFOS)) using multiple linear regression, adjusted for age, pre-pregnancy body mass index, smoking, education, income, parity, oral contraceptive use, inter-pregnancy interval, and breastfeeding duration. Results: Irregular cycles were not associated with PFAS concentrations. Overall, we found no evidence of associations between menstrual cycle length and PFAS concentrations. In subgroup analyses we found some evidence, among parous women, of decreased PFHpS and PFOS with short menstrual cycles; we also found, among recent OC users (in the 12 months before the questionnaire) increased PFNA and PFUnDA with long cycle length. Limitations of our study include misclassification of menstrual cycle characteristics, small sample sizes in the sub-group analyses, and a lack of information on duration and volume of menses. Conclusions: In the entire study sample, we found little evidence of menstrual cycle characteristics as determinants of PFAS concentrations. However, we observed some associations between cycle length and PFAS concentrations with some select PFAS compounds in subgroup analyses. Keywords: Cycle length; Irregularity; Menstrual; MoBa; Perfluoroalkyl substances.			1															1			B	B	Recent OC userでlong cycle群のPFNA17 (2, 34)%増 中央値と四分位範囲0.45（0.33, 0.63）	
826	ヒト（生殖発生毒性）	Wang, Wei; Zhou, Wei; Wu, Shaowei; Liang, Fan; Li, Yan; Zhang, Jun; Cui, Linlin; Feng, Yan; Wang, Yan	Perfluoroalkyl substances exposure and risk of	2019	Environ Pollut. 2019 Apr;247:824-831. doi: 10.1016/j.envpol.2019.01.039. Epub 2019 Jan 11.	Perfluoroalkyl substances (PFASs) are a family of synthetic, fluorinated organic compounds. They have been widely used in industrial applications and consumer products and widespread in the environment, wildlife and human. Experimental and epidemiologic evidence suggested that PFASs are capable of interfering with endocrine processes and have potential reproductive and developmental toxicities. Polycystic ovarian syndrome (PCOS), one of the main reasons of female infertility, is a common endocrine disorder in reproductive age women. We performed a case-control study to evaluate associations between PCOS-related infertility and PFASs concentrations in plasma. A total of 180 infertile PCOS-cases and 187 healthy controls were recruited from the Center for Reproductive Medicine of Shandong University. Blood specimens were collected at enrollment and analyzed for ten PFASs using liquid chromatography-tandem mass spectrometry. Multivariable logistic regression procedure was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for each PFAS. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) were the dominant PFASs in the plasma of participants, with the median concentration of 5.07 ng/mL and 4.05 ng/mL, respectively. The median levels of individual PFAS were not significantly different between PCOS-cases and controls. While adjusted for the potential confounders (age, BMI, household income, education level, employment status, age at menarche, menstrual volume), the plasma concentration of perfluorododecanoic acid (PFDoA), a 12 carbons lengths of perfluorocarboxylicacids, was associated with a significantly increased risk of PCOS-related infertility (medium vs low tertile: OR = 2.36, 95% CI: 1.12, 4.99, P = 0.02; high vs low tertile: OR = 3.04, 95% CI: 1.19, 7.67, P = 0.02), with the P trend 0.01. No significant relationship was observed between PCOS-related infertility and other PFAS analytes in the adjusted model, despite perfluoroundecanoic acid showed a negative association (P trend 0.03). The potential reproductive health effects of PFASs and the underlying mechanisms merit further investigation in the future.			1	1														1		1	A	B	PFBS 3rd(>0.11,2.56) PFNA 3rd (>0.75,4.63)までPCOS関連不妊症について有意差無し	
827	ヒト（発達神経毒性）	Román, GC; Ghassabian, A; Bongers-Schokking, JJ; Jaddoe, VW; Hofman, A; de Rijke, YB; Verhulst, FC; Tiemeier, H.	Association of gestational maternal hypothyrox	2013	Ann Neurol 74: 733-742. doi: 10.1002/ana.23976	Objective: Transient gestational hypothyroxinemia in rodents induces cortical neuronal migration brain lesions resembling those of autism. We investigated the association between maternal hypothyroxinemia (gestational weeks 6-18) and autistic symptoms in children. Methods: The mother-and-child cohort of the Generation R Study (Rotterdam, the Netherlands) began prenatal enrollment between 2002 and 2006. At a mean gestational age of 13.4 weeks (standard deviation=1.9, range=5.9-17.9), maternal thyroid function tests (serum thyrotropin [TSH], free thyroxine [fT4], and thyroid peroxidase [TPO] antibodies) were assessed in 5,100 women. We defined severe maternal hypothyroxinemia as fT4<5th percentile with normal TSH. Six years later, parents reported behavioral and emotional symptoms in 4,039 children (79%) using the Pervasive Developmental Problems (PDP) subscale of the Child Behavior Checklist and/or the Social Responsiveness Scale (SRS). We defined a probable autistic child by a PDP score>98th percentile and SRS score in the top 5% of the sample (n=81, 2.0%). Results: Severe maternal hypothyroxinemia (n=136) was associated with an almost 4-fold increase in the odds of having a probable autistic child (adjusted odds ratio=3.89, 95% confidence interval [CI]=1.83-8.20, p<0.001). Using PDP scores, children of mothers with severe hypothyroxinemia had higher scores of autistic symptoms by age 6 years (adjusted B=0.23, 95% CI=0.03-0.37); SRS results were similar. No risk was found for children of TPO-antibody-positive mothers (n=308). Interpretation: We found a consistent association between severe, early gestation maternal hypothyroxinemia and autistic symptoms in offspring. Findings are concordant with epidemiological, biological, and experimental data on autism. Although these findings cannot establish causality, they open the possibility of preventive interventions.							1													C	C	全く関係のない論文	
828	ヒト（発達神経毒性）	Braun, J. M.; Kalkbrenner, A. E.; Just, A. C.; Yolton, K.; Calafat, A. M.; Sjödin, A.; Hauser, R.; Webster, G. M.; Chen, A.; Lanphear, B. P.	Gestational exposure to endocrine-disrupting c	2014	Environ Health Perspect. 2014 May;122(5):513-20. doi: 10.1289/ehp.1307261. Epub 2014 Mar 12.	Background: Endocrine-disrupting chemicals (EDCs) may be involved in the etiology of autism spectrum disorders, but identifying relevant chemicals within mixtures of EDCs is difficult. Objective: Our goal was to identify gestational EDC exposures associated with autistic behaviors. Methods: We measured the concentrations of 8 phthalate metabolites, bisphenol A, 25 polychlorinated biphenyls (PCBs), 6 organochlorine pesticides, 8 brominated flame retardants, and 4 perfluoroalkyl substances in blood or urine samples from 175 pregnant women in the HOME (Health Outcomes and Measures of the Environment) Study (Cincinnati, OH). When children were 4 and 5 years old, mothers completed the Social Responsiveness Scale (SRS), a measure of autistic behaviors. We examined confounder-adjusted associations between 52 EDCs and SRS scores using a two-stage hierarchical analysis to account for repeated measures and confounding by correlated EDCs. Results: Most of the EDCs were associated with negligible absolute differences in SRS scores (≤ 1.5). Each 2-SD increase in serum concentrations of polybrominated diphenyl ether-28 (PBDE-28) (β = 2.5; 95% CI: -0.6, 5.6) or trans-nonachlor (β = 4.1; 95% CI: 0.8-7.3) was associated with more autistic behaviors. In contrast, fewer autistic behaviors were observed among children born to women with detectable versus nondetectable concentrations of PCB-178 (β = -3.0; 95% CI: -6.3, 0.2), β-hexachlorocyclohexane (β = -3.3; 95% CI: -6.1, -0.5), or PBDE-85 (β = -3.2; 95% CI: -5.9, -0.5). Increasing perfluorooctanoate (PFOA) concentrations were also associated with fewer autistic behaviors (β = -2.0; 95% CI: -4.4, 0.4). Conclusions: Some EDCs were associated with autistic behaviors in this cohort, but our modest sample size precludes us from dismissing chemicals with null associations. PFOA, β-hexachlorocyclohexane, PCB-178, PBDE-28, PBDE-85, and trans-nonachlor deserve additional scrutiny as factors that may be associated with childhood autistic behaviors.			1														1	1			B	C	PFNAネガティブデータ 中央値と四分位範囲0.9(0.7-1.2) 95%tile 1.9	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献ランク（委員①）	文献ランク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
829	ヒト（発達神経毒性）	Gump, Brooks B; Wu, Qian; Dumas, Amy K; Kannan, Kurunthachalam	Perfluorochemical (PFC) exposure in children:	2011	Environ Sci Technol. 2011 Oct 1;45(19):8151-9. doi: 10.1021/es103712g. Epub 2011 Jun 17.	BACKGROUND: Perfluorinated chemicals (PFCs) have been used widely in consumer products since the 1950s and are currently found at detectable levels in the blood of humans and animals across the globe. In stark contrast to this widespread exposure to PFCs, there is relatively little research on potential adverse health effects of exposure to these chemicals. OBJECTIVES: We performed this cross-sectional study to determine if specific blood PFC levels are associated with impaired response inhibition in children. METHODS: Blood levels of 11 PFCs were measured in children (N = 83) and 6 PFCs: perfluorooctane sulfonate (PFOS), perfluorohexane sulfate (PFHxS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctanesulfonamide (PFOSA), and perfluorodecanoic acid (PFDA) - were found at detectable levels in most children (87.5% or greater had detectable levels). These levels were analyzed in relation to the differential reinforcement of low rates of responding (DRL) task. This task rewards delays between responses (i.e., longer inter-response times; IRTs) and therefore constitutes a measure of response inhibition. RESULTS: Higher levels of blood PFOS, PFNA, PFDA, PFHxS, and PFOSA were associated with significantly shorter IRTs during the DRL task. The magnitude of these associations was such that IRTs during the task decreased by 29-34% for every 1 SD increase in the corresponding blood PFC. CONCLUSIONS: This study suggests an association between PFC exposure and children's impulsivity. Although intriguing, there is a need for further investigation and replication with a larger sample ofchildren.			1												1		1			B	D	differential reinforcement of low rates of respondingに対して PFNA　beta -0.24 95%CI[－0.46, －0.02] βしかなくリスク評価に用いにくい	
830	ヒト（発達神経毒性）	Hoffman, K.; Webster, T. F.; Weisskopf, M. G.; Weinberg, J.; Vieira, V. M.	Exposure to polyfluoroalkyl chemicals and atte	2010	Environ Health Perspect. 2010 Dec;118(12):1762-7. doi: 10.1289/ehp.1001898. Epub 2010 Jun 15.	Background: Polyfluoroalkyl chemicals (PFCs) have been widely used in consumer products. Exposures in the United States and in world populations are widespread. PFC exposures have been linked to various health impacts, and data in animals suggest that PFCs may be potential developmental neurotoxicants. Objectives: We evaluated the associations between exposures to four PFCs and parental report of diagnosis of attention deficit/hyperactivity disorder (ADHD). Methods: Data were obtained from the National Health and Nutrition Examination Survey (NHANES) 1999-2000 and 2003-2004 for children 12-15 years of age. Parental report of a previous diagnosis by a doctor or health care professional of ADHD in the child was the primary outcome measure. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) levels were measured in serum samples from each child. Results: Parents reported that 48 of 571 children included in the analysis had been diagnosed with ADHD. The adjusted odds ratio (OR) for parentally reported ADHD in association with a 1-μg/L increase in serum PFOS (modeled as a continuous predictor) was 1.03 [95% confidence interval (CI), 1.01-1.05]. Adjusted ORs for 1-μg/L increases in PFOA and PFHxS were also statistically significant (PFOA: OR = 1.12; 95% CI, 1.01-1.23; PFHxS: OR = 1.06; 95% CI, 1.02-1.11), and we observed a nonsignificant positive association with PFNA (OR = 1.32; 95% CI, 0.86-2.02). Conclusions: Our results, using cross-sectional data, are consistent with increased odds of ADHD in children with higher serum PFC levels. Given the extremely prevalent exposure to PFCs, follow-up of these data with cohort studies is needed.			1												1					B	B	ネガティブデータ。１ug/L上昇ごとにADHDのOR＝1.32; 95% CI, 0.86-2.02 中央値と四分位範囲0.6,0.5（範囲ND-5.9）	
831	ヒト（発達神経毒性）	Jeddy, Z.; Hartman, T. J.; Taylor, E. V.; Poteete, C.; Kordas, K.	Prenatal concentrations of perfluoroalkyl subst	2017	Early Hum Dev. 2017 Jun;109:15-20. doi: 10.1016/j.earlhumdev.2017.04.004. Epub 2017 Apr 12.	Perfluoroalkyl substances (PFAS), found in many household products and classed as endocrine disrupting chemicals, can be transferred through the placenta and are associated with multiple developmental deficits in offspring. Using data from the Avon Longitudinal Study of Parents and Children (ALSPAC), we investigated the association between intrauterine exposure to PFAS and early communication development in 432 mother-daughter dyads at 15 and 38months of age. Concentrations of perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA), perfluorohexane sulfonate (PFHxS), and perfluorononanoate (PFNA) were measured in maternal serum collected during pregnancy. Early communication development was measured with the ALSPAC-adapted MacArthur Communicative Development Inventories for Infants and Toddlers. The infant questionnaire measured verbal comprehension, vocabulary comprehension and production, nonverbal communication, and social development. The toddler questionnaire measured language, intelligibility, and communicative sub-scores. Multivariable linear regression was used to examine associations between each PFAS exposure and each communication sub-scale score. The association between maternal PFAS concentrations and early communication development at 15 and 38months of age varied by maternal age at delivery. In daughters of younger mothers (<25years of age), every 1ng/mL of PFOS was associated with a 3.82 point (95% confidence interval (CI): -6.18, -1.47) lower vocabulary score at 15months and a 0.8 point (95% CI: -1.74,0.14) lower language score at 38months. Prenatal exposure to select PFAS was positively and negatively associated with communication development among girls, with inconsistent pattern of association across all measured PFAS and endpoints.			1												1				1	B	A	娘が15か月時点で出産時年齢30歳より大きい群でコミュニケーション発達に正の関連。38か月時点で出産時年齢25歳未満群でIntelligibilityとCommunicativeに僅かな正の関連。ベータのみの報告。 中央値と四分位範囲0.5, 0.4-0.7	
832	ヒト（発達神経毒性）	Lien, G. W.; Huang, C. C.; Shiu, J. S.; Chen, M. H.; Hsieh, W. S.; Guo, Y. L.; Chen, P. C.	Perfluoroalkyl substances in cord blood and at	2016	Chemosphere. 2016 Aug;156:118-127. doi: 10.1016/j.chemosphere.2016.04.102. Epub 2016 May 9.	Objective: The effect of perfluoroalkyl substances (PFASs) on the development of neurotoxicity in children is still controversial. This study aimed to evaluate the association between in utero exposure to four PFASs and the development of neurobehavioral symptoms related to attention deficit hyperactivity disorder (ADHD) in early childhood. Methods: Eligible study subjects were selected from the Taiwan Birth Panel Study and the Taiwan Early-Life Cohort, which enrolled a total of 1526 mother-infant pairs during 2004 and 2005. We collected umbilical cord blood and analyzed perfluorooctanoic acid (PFOA), perfluorooctanyl sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluoroundecanoic acid (PFUA) levels. When a child was 7 years old, to evaluate ADHD related neurobehavioral symptoms, their parents completed the Swanson, Nolan, and Pelham IV scale (SNAP-IV), the Child Behavior Checklist (CBCL), and the Strengths and Difficulties Questionnaire (SDQ) questionnaires. We used linear regression models with inverse probability weighting to explore the association between prenatal exposure to four PFASs and ADHD rating scores. Results: A total of 282 subjects have completed the PFASs analysis and questionnaire survey. After adjusted for potential confounders, we observed that PFNA is inversely associated with inattention and oppositional defiant disorder of SNAP-IV, and hyperactivity/inattention of SDQ. No association between PFOA, PFOS, or PFUA and ADHD symptoms was found. Conclusions: Prenatal exposure to PFNA was found to associate with neurobehavioral symptoms related to ADHD among Asian seven-year-old children. Further studies are needed to elucidate the causal relationship.			1												1		1			B	B	Oppositional defiant disorderがPFNA75%-89%tile群から、 inattentkonは90%tileより大きいが群でSNAP-IVスコア低下、SDQの注意欠陥多動スコアも減少トレンド。有害性影響ではない。 PFNAの75%tile, 90%tile値4.69, and 14.2 ng/mL 平均（SD）4.49 (4.51)	
833	ヒト（発達神経毒性）	Liew, Z.; Ritz, B.; von Ehrenstein, O. S.; Bech, B. H.; Nohr, E. A.; Fei, C.; Bossi, R.; Henriksen, T. B.; Bonefeld-Jørgensen, E. C.; Olsen, J.	Attention deficit/hyperactivity disorder and chi	2015	Environ Health Perspect. 2015 Apr;123(4):367-73. doi: 10.1289/ehp.1408412. Epub 2014 Dec 19.	Background: Perfluoroalkyl substances (PFASs) are persistent pollutants found to be endocrine disruptive and neurotoxic in animals. Positive correlations between PFASs and neurobehavioral problems in children were reported in cross-sectional data, but findings from prospective studies are limited. Objectives: We investigated whether prenatal exposure to PFASs is associated with attention deficit/hyperactivity disorder (ADHD) or childhood autism in children. Methods: Among 83,389 mother-child pairs enrolled in the Danish National Birth Cohort during 1996-2002, we identified 890 ADHD cases and 301 childhood autism cases from the Danish National Hospital Registry and the Danish Psychiatric Central Registry. From this cohort, we randomly selected 220 cases each of ADHD and autism, and we also randomly selected 550 controls frequency matched by child's sex. Sixteen PFASs were measured in maternal plasma collected in early or mid-pregnancy. We calculated risk ratios (RRs) using generalized linear models, taking into account sampling weights. Results: Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) were detected in all samples; four other PFASs were quantified in ≥ 90% of the samples. We did not find consistent evidence of associations between mother's PFAS plasma levels and ADHD [per natural log nanograms per milliliter increase: PFOS RR = 0.87 (95% CI: 0.74, 1.02); PFOA RR = 0.98 (95% CI: 0.82, 1.16)] or autism [per natural log nanograms per milliliter increase: PFOS RR = 0.92 (95% CI: 0.69, 1.22); PFOA RR = 0.98 (95% CI: 0.73, 1.31)]. We found positive as well as negative associations between higher PFAS quartiles and ADHD in models that simultaneously adjusted for all PFASs, but these estimates were imprecise. Conclusions: In this study we found no consistent evidence to suggest that prenatal PFAS exposure increases the risk of ADHD or childhood autism in children.			1												1		1		1	A	B	母体の血漿PFNA0.36-0.43ng/mL群からADHDの調整リスク比上昇（reference群は<LLOQ-0.35 ng/mL）。	
834	ヒト（発達神経毒性）	Ode, A.; Källén, K.; Gustafsson, P.; Rylander, L.; Jönsson, B. A.; Olofsson, P.; Ivarsson, S. A.; Lindh, C. H.; Rignell-Hydbom, A.	Fetal exposure to perfluorinated compounds ar	2014	PLoS ONE. 2014 Apr 23;9(4):e95891. doi: 10.1371/journal.pone.0095891. eCollection 2014.	Background: The association between exposure to perfluorinated compounds (PFCs) and attention deficit hyperactivity disorder (ADHD) diagnosis has been sparsely investigated in humans and the findings are inconsistent. Objectives: A matched case-control study was conducted to investigate the association between fetal exposure to PFCs and ADHD diagnosis in childhood. Methods: The study base comprised children born in Malmö, Sweden, between 1978 and 2000 that were followed up until 2005. Children with ADHD (n = 206) were identified at the Department of Child and Adolescent Psychiatry. Controls (n = 206) were selected from the study base and were matched for year of birth and maternal country of birth. PFC concentrations were measured in umbilical cord serum samples. The differences of the PFC concentrations between cases and controls were investigated using Wilcoxon's paired test. Possible threshold effects (above the upper quartile for perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) and above limit of detection [LOD] for perfluorononanoic acid (PFNA)) were evaluated by conditional logistic regression. Results: The median umbilical cord serum concentrations of PFOS were 6.92 ng/ml in the cases and 6.77 ng/ml in the controls. The corresponding concentrations of PFOA were 1.80 and 1.83 ng/ml. No associations between PFCs and ADHD were observed. Odds ratios adjusted for smoking status, parity, and gestational age were 0.81 (95% confidence interval [CI] 0.50 to 1.32) for PFOS, 1.07 (95% CI 0.67 to 1.7) for PFOA, and 1.1 (95% CI 0.75 to 1.7) for PFNA. Conclusions: The current study revealed no support for an association between fetal exposure to PFOS, PFOA, or PFNA and ADHD.			1												1					B	B	ネガティブデータ。PFNA LOD未満に対してLOD以上群はADHDの調整OR 1.1 (95% CI 0.75 to 1.7)	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
835	ヒト（発達神経毒性）	Oulhote, Y.; Steuerwald, U.; Debes, F.; Weihe, P.; Grandjean, P.	Behavioral difficulties in 7-year old children in	2016	Environ Int. 2016 Dec;97:237-245. doi: 10.1016/j.envint.2016.09.015. Epub 2016 Sep 29.	Background: Perfluorinated alkyl substances (PFAS) are suspected endocrine disruptors that are highly persistent and neurotoxic in animals. Human epidemiological studies of exposure-related deviations of children's behaviors are sparse. We assessed the associations between prenatal, 5- and 7-year PFAS exposures and behavioral problem scores in 7-year Faroese children. Methods: Concentrations of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFDA), perfluorooctane sulfonate (PFOS), and perfluorohexane sulfonic acid (PFHxS) were measured in maternal serum and in serum from children at ages 5 and 7years (n=539, 508, and 491, respectively). We used multivariable regressions and structural equations models to estimate the covariate-adjusted associations between serum-PFAS concentrations and behavioral difficulties, as assessed by the strengths and difficulties questionnaire (SDQ) at age 7. Results: Serum-PFOS and PFHxS concentrations declined over time, whereas PFOA, PFNA, and PFDA tended to increase. No associations were observed between prenatal PFAS concentrations and SDQ scores. However, a two-fold increase in 5-year serum-PFOA, PFNA, and PFDA concentrations was associated with increases in total SDQ scores by 1.03 (95% CI: 0.11, 1.95), 0.72 (95% CI: 0.07, 1.38) and 0.78 points (95% CI: 0.01, 1.55), respectively. For SDQ subscales, significant associations were found in regard to hyperactivity, peer relationship, and conduct problems, as well as internalizing and externalizing problems and autism screening composite scores. Cross-sectional analyses at age 7years showed possible sex-dimorphic associations between PFAS concentrations and SDQ scores, where girls had consistently positive associations with SDQ scores whereas boys exhibited a pattern of negative or null associations. Conclusions: Higher serum PFAS concentrations at ages 5- and 7-years, but not prenatally, were associated with parent-reported behavioral problems at age 7.			1												1		1			1	B	A	PFNAが2倍になった時5歳時点のtotal SDQスコア、externalizing problems, hyperactivity/inattention, conduct problemsの調整平均さと正の関連とアプストラクトに記載されているが、TableS6, 7を見ると、どちらもp=0.05	
836	ヒト（発達神経毒性）	Quaak, Ilona; de Cock, Marijke; de Boer, Michiel; Lamoree, Marja; Leonards, Pim; van de Bor, Margot	Prenatal Exposure to Perfluoroalkyl Substance	2016	Int J Environ Res Public Health. 2016 May 19;13(5):511. doi: 10.3390/ijerph13050511.	BACKGROUND: In recent years, prevalence rates of behavioral disorders in children have increased. One factor possibly implied in the etiology of behavioral disorders is exposure to perfluoroalkyl substances (PFASs). The use of PFASs is highly integrated into everyday life, and exposure is ubiquitous. Exposure to PFASs during early life may be particularly harmful, as it represents a critical time window for brain development. However, research in the area is limited, especially among preschool children. The objective of the current study was to explore the relationship between prenatal exposure to several PFASs and behavioral development at the age of 18 months. METHODS: Data from the Dutch cohort LINC (Linking Maternal Nutrition to Child Health) were used. Perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were measured in cord plasma. The total exposure of PFASs was also calculated (Σ PFASs). Behavioral development was assessed with the Child Behavior Checklist 1.5-5 (CBCL 1.5-5). The CBCL scales "Attention Deficit Hyperactivity Disorder" (ADHD) and "Externalizing problems" were used for further analysis. Separate regression models were composed for each combination, in which exposure levels were classified in tertiles. Both whole population and sex-stratified analyses were performed. A family history of ADHD, the educational level, smoking or using alcohol or illicit drugs during pregnancy were considered as confounders. In total, data from 76 mother-child pairs was included. RESULTS: No significant associations were found between prenatal PFAS exposure and ADHD scores in thewhole population and in the sex-stratified analyses. With regard to externalizing behavior, a significant negative association was found between the highest levels of Σ PFAS exposure and externalizing problem behavior in the whole population, but only in the crude model. After stratifying for sex, boys in the second and third tertile of exposure to PFOA presented significantly lower scores on the Externalizing Problem Scale than boys with the lowest exposure levels in the adjusted model. Girls exposed to higher levels of Σ PFAS exposure (T2) showed significantly lower scores on the Externalizing Problem Scale, in both crude and adjusted models. No significant associations with PFOS were found. CONCLUSIONS: RESULTS from the current study show that prenatal exposure to PFOA was negatively related to externalizing behavior in boys. RESULTS were different for boys and girls, emphasizing that mechanisms at work might be sex-dependent. However, results should be interpreted with caution as the sample size was small.			1												1		1				C	D	PFNAはPFAS合計の計算のために用いられているだけで単独の結果がない。またサンプルサイズも非常に小さく適当ではない。	
837	ヒト（発達神経毒性）	Stein, C. R.; Savitz, D. A.; Bellinger, D. C.	Perfluorooctanoate and neuropsychological ou	2013	Epidemiology. 2013 Jul;24(4):590-9. doi: 10.1097/EDE.0b013e3182944432.	Background: In animal studies, perfluorinated compounds affect fetal growth, development, viability, and postnatal growth. The limited epidemiologic findings on child neurobehavioral development are mixed. Methods: We recruited and evaluated 320 children who participated in the C8 Health Project, a 2005-2006 survey in a Mid-Ohio Valley community highly exposed to perfluorooctanoate (PFOA) through contaminated drinking water. We examined associations among estimated in utero PFOA exposure, measured childhood PFOA serum concentration, and subsequent performance on neuropsychological tests 3-4 years later at ages 6-12 years. We assessed Intelligence Quotient (IQ) reading and math skills, language, memory and learning, visual-spatial processing, and attention. All multivariable linear regression models were adjusted for age, sex, home environment, test examiner, and maternal IQ. Models with measured childhood PFOA were additionally adjusted for child body mass index. Results: Children in the highest as compared with lowest quartile of estimated in utero PFOA had increases in Full Scale IQ (β 4.6, 95% confidence interval [CI] = 0.7-8.5) and decreases in characteristics of attention deficit/hyperactivity disorder as measured by the Clinical Confidence Index of Connors' Continuous Performance Test-II (β -8.5, 95% CI = -16.1 to -0.8). There were negligible associations between PFOA and reading or math skills or neuropsychological functioning. Conclusion: These results do not suggest an adverse association between the levels of PFOA exposure experienced by children in this cohort and their performance on neuropsychological tests.			1												1					C	D	PFOAの影響評価のための調整因子としてPFNAを使用。	
838	ヒト（発達神経毒性）	Stein, Cheryl R; Savitz, David A; Bellinger, David C	Perfluorooctanoate exposure in a highly expos	2014	Paediatr Perinat Epidemiol. 2014 Mar;28(2):146-56. doi: 10.1111/ppe.12097. Epub 2013 Dec 9.	BACKGROUND: In toxicology studies, perfluorinated compounds affect fetal growth, development, viability, and postnatal growth. There are limited epidemiologic studies on child development. METHODS: We recruited and evaluated 321 children who participated in the C8 Health Project, a 2005-06 survey in a mid-Ohio Valley community highly exposed to perfluorooctanoate (PFOA) through contaminated drinking water. We examined associations between measured childhood PFOA serum concentration and mother and teacher reports of executive function (Behaviour Rating Inventory of Executive Function), attention deficit hyperactivity disorder (ADHD)-like behaviour (Conner's ADHD Diagnostic and Statistical Manual of Mental Disorders IV Scales), and behavioural problems (Behaviour Assessment System for Children) assessed 3 to 4 years later at ages 6-12 years. RESULTS: Overall, neither reports from mothers nor teachers provided clear associations between exposure and child behaviour. Mother reports, however, did suggest favourable associations between exposure and behaviour among boys and adverse associations among girls. On the composite scale from the Behaviour Rating Inventory of Executive Function (n = 318), PFOA exposure had a favourable association among boys (highest vs. lowest quartile β = -6.39; 95% confidence interval [CI] -11.43, -1.35) and an adverse association among girls (highest vs. lowest quartile β = 4.42; 95% CI -0.03, 8.87; interaction P = 0.01). Teacher reports (n = 189) replicated some, but not all of the sex interactions observed in mothers' reports. CONCLUSIONS: Aggregate results did not suggest adverse effects of PFOAon behaviour, but sex-specific results raise the possibility of differing patterns by sex. Results are not consistent between mothers' and teachers' reports. Effect modification by sex may warrant further investigation.			1												1					C	D	PFOAの影響評価のための調整因子としてPFNAを使用。	
839	ヒト（発達神経毒性）	Stein, Cheryl R; Savitz, David A	Serum perfluorinated compound concentration	2011	Environ Health Perspect. 2011 Oct;119(10):1466-71. doi: 10.1289/ehp.1003538. Epub 2011 Jun 10.	BACKGROUND: Perfluorinated compounds (PFCs) are persistent environmental pollutants. Toxicology studies demonstrate the potential for perfluorooctanoic acid (PFOA) and other PFCs to affect human growth and development. Attention deficit/hyperactivity disorder (ADHD) is a developmental disorder with suspected environmental and genetic etiology. OBJECTIVES: We examined the cross-sectional association between serum PFC concentration and parent or self-report of doctor-diagnosed ADHD with and without current ADHD medication. METHODS: We used data from the C8 Health Project, a 2005-2006 survey in a Mid-Ohio Valley community highly exposed to PFOA through contaminated drinking water, to study non-Hispanic white children 5-18 years of age. Logistic regression models were adjusted for age and sex. RESULTS: Of the 10,546 eligible children, 12.4% reported ADHD and 5.1% reported ADHD plus ADHD medication use. We observed an inverted J-shaped association between PFOA and ADHD, with a small increase in prevalence for the second quartile of exposure compared with the lowest, and a decrease for the highest versus lowest quartile. The prevalence of ADHD plus medication increased with perfluorohexane sulfonate (PFHxS) levels, with an adjusted odds ratio of 1.59 (95% confidence interval, 1.21-2.08) comparing the highest quartile of exposure to the lowest. We observed a modest association between perfluorooctane sulfonate and ADHD with medication. CONCLUSIONS: The most notable finding for PFOA and ADHD, a reduction in prevalence at the highest exposure level, is unlikely to be causal, perhaps reflecting a spurious findingrelated to the geographic determination of PFOA exposure in this population or to unmeasured behavioral or physiologic correlates of exposure and outcome. Possible positive associations between other PFCs and ADHD, particularly PFHxS, warrant continued investigation.			1												1		1			B	B	12-15歳：第４四分位2.0 to 24.1で学習障害の調整ORが減る0.73 (0.55–0.98)という結果 5-18歳：第３四分位1.5 to < 2.0から学習障害の調整ORが減る0.81 (0.69–0.95) 第4四分位2.0 to 24.1でも同様0.74 (0.62–0.87) 有害影響とは言えない。	
840	ヒト（発達神経毒性）	Vuong, A. M.; Yolton, K.; Wang, Z.; Xie, C.; Webster, G. M.; Ye, X.; Calafat, A. M.; Braun, J. M.; Dietrich, K. N.; Lanphear, B. P.; Chen, A.	Childhood perfluoroalkyl substance exposure a	2018	Environ Int. 2018 Oct;119:212-219. doi: 10.1016/j.envint.2018.06.028. Epub 2018 Jul 4.	Background: Toxicological studies highlight the potential neurotoxicity of perfluoroalkyl substances (PFAS) during fetal development. However, few epidemiological studies have examined the impact of childhood PFAS on neurodevelopment. Methods: We employed data from 208 children in the Health Outcomes and Measures of the Environment Study, a birth cohort (Cincinnati, OH), to examine associations of six serum PFAS concentrations measured at 3 and 8 years with executive function assessed at 8 years using the validated parent-completed Behavior Rating Inventory of Executive Function survey. We used multiple informant models to identify susceptible windows of neurotoxicity to PFAS and executive function. We investigated trajectories of PFAS concentrations and whether sex modified these associations. Results: Each ln-increase in perfluorononanoate (PFNA) at 8 years was associated with a 3.4-point increase (95% CI 0.4, 6.3) in metacognition score, indicating poorer function. Children with PFNA above the median at 8 years had poorer global executive functioning compared to children with concentrations consistently below median levels (β = 6.5, 95% CI 0.2, 12.9). Higher concurrent PFNA was associated with poorer behavior regulation among males, while associations among females were null (pPFNA × sex = 0.018). Children with higher concurrent perfluorooctanoate (PFOA) had increased odds of being at risk of having clinical impairments in metacognition (OR = 3.18, 95% CI 1.17, 8.60). There were no associations between perfluorooctane sulfonate and perfluorohexane sulfonate and executive function. Conclusions: PFNA and PFOA at 8 years, but not 3 years, may be related to poorer executive function at 8 years. Results need to be confirmed in cohort studies with larger sample sizes.			1												1					1	A	A	PFNA 1Ln上昇で8歳時点でBehavior Regulation Index, Metacognition Index, Global Executive Composite の調整OR2.75 (1.30, 5.79), 2.94 (1.52, 5.69), 3.07 (1.60, 5.90)。濃度分布情報もありリスク評価値に有用。 PFNAのGMとGSD0.8 (1.8)TableS1では8歳中央値1.2 ng/mLとなっているが、TableS3の8歳50%tile値は0.7	
841	ヒト（発達神経毒性）	Vuong, A.; Yolton, K.; Webster, G. M.; Sjodin, A.; Calafat, A. M.; Braun, J. M.; Dietrich, K.; Lanphear, B. P.; Chen, A.	Prenatal polybrominated diphenyl ether and pe	2016	Environ Res. 2016 May;147:556-64. doi: 10.1016/j.envres.2016.01.008. Epub 2016 Jan 28.	Executive function is a critical behavioral trait rarely studied in relation to potential neurotoxicants. Prenatal exposure to polybrominated diphenyl ethers (PBDEs) and perfluoroalkyl substances (PFASs) has been associated with adverse neurodevelopment, but there is limited research on executive function. Data from 256 mother-child pairs in the Health Outcomes and Measures of the Environment Study, a prospective birth cohort (2003-2006, Cincinnati, OH), was used to examine maternal serum PBDEs and PFASs and executive function in children ages 5 and 8 years. Maternal serum PBDEs and PFASs were measured at 16 ± 3 weeks gestation. Executive function was assessed with the parent-rated Behavior Rating Inventory of Executive Function (BRIEF), which yields composite measures: behavioral regulation index, metacognition index, and global executive composite. Higher BRIEF scores indicate executive function impairments. Linear mixed models and generalized estimating equations were used to estimate covariate-adjusted associations between PBDEs and PFASs and executive function. A 10-fold increase in BDE-153 was associated with poorer behavior regulation (β=3.23, 0.95 CI 0.60, 5.86). Higher odds of having a score ≥60 in behavior regulation (OR=3.92, 0.95 CI 1.76, 8.73) or global executive functioning (OR=2.34, 0.95 CI 1.05, 5.23) was observed with increased BDE-153. Each ln-unit increase in perfluorooctane sulfonate (PFOS) was associated withpoorer behavior regulation (β=3.14, 0.95 CI 0.68, 5.61), metacognition (β=3.10, 0.95 CI 0.62, 5.58), and global executive functioning (β=3.38, 0.95 CI 0.86, 5.90). However, no association was observed between perfluorooctanoate (PFOA) and executive function. Prenatal exposures to BDE-153 and PFOS may be associated with executive function deficits in school-age children.			1												1					B	D	ネガティブデータ。PFAS最小、25%tile, 50%tile, 75%tile, 95%tile, Maxは0.1, 0.7, 0.9, 1.1, 1.9, 2.9 ng/mL	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レンク（委員①）	文献レンク（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
842	ヒト（発達神経毒性）	Wang, Y.; Rogan, W. J.; Chen, H. Y.; Chen, P. C.; Su, P. H.; Chen, H. Y.; Wang, S. L.	Prenatal exposure to perfluroalkyl substances	2015	Int J Hyg Environ Health. 2015 Oct;218(7):639-44. doi: 10.1016/j.ijheh.2015.07.002. Epub 2015 Jul 9.	Background: Perfluoroalkyl substances (PFASs) are a group of fluorinated organic substances that are widely used in consumer products and are often detectable in human tissues. Human studies on prenatal exposure to PFASs and neurodevelopment in children are few and inconsistent. Methods: In the Taiwan Maternal and Infant Cohort Study, we collected serum samples from pregnant women during the third trimester and measured concentrations of 9 PFASs using a high performance liquid chromatography system. A subsample of their children was assessed with full scale intelligence quotient (FSIQ), verbal IQ (VIQ) and performance IQ (PIQ) at both age 5 (n=120) and 8 years (n=120). We used multivariate linear regression models to examine prenatal PFAS exposure in relation to IQ scores at each age period. Results: Prenatal perfluoroundecanoic acid (PFUnDA) concentrations were inversely associated with children's PIQ scores at age 5 years, with an adjusted coefficient (β) of -1.6 (95% confidence interval [CI]: (-3.0, -0.2). When children reached 8 years, most of the prenatal PFASs showed inverse association with children's FSIQ, VIQ and PIQ scores. Among them, prenatal perfluorononanoic acid (PFNA) reached significance. Children with higher prenatal PFNA levels had lower VIQ with an adjusted β of -2.1 (95% CI: -3.9, -0.2). Conclusions: We found two prenatal PFAS exposure, both long-chain PFASs, in association with decreased IQ test scores in children. Our findings suggest more studies on long-chain PFASs and children's neurodevelopment.			1											1		1			1	B	A	8歳時点PFNA2倍でverbal IqβのPFNAの低下 ベータの報告のみ	
843	ヒト（発達神経毒性）	Zhang, H.; Yolton, K.; Webster, G. M.; Ye, X.; Calafat, A. M.; Dietrich, K. N.; Xu, Y.; Xie, C.; Braun, J. M.; Lanphear, B. P.; Chen, A.	Prenatal and childhood perfluoroalkyl substanc	2018	Environ Int. 2018 Feb;111:224-231. doi: 10.1016/j.envint.2017.11.031. Epub 2017 Dec 20.	Background: Exposure to perfluoroalkyl substances (PFASs) may impact children's neurodevelopment. Objective: To examine the association of prenatal and early childhood serum PFAS concentrations with children's reading skills at ages 5 and 8years. Methods: We used data from 167 mother-child pairs recruited during pregnancy (2003-2006) in Cincinnati, OH, quantified prenatal serum PFAS concentrations at 16±3weeks of gestation and childhood sera at ages 3 and 8years. We assessed children's reading skills using Woodcock-Johnson Tests of Achievement III at age 5years and Wide Range Achievement Test-4 at age 8years. We used general linear regression to quantify the covariate-adjusted associations between natural log-transformed PFAS concentrations and reading skills, and used multiple informant model to identify the potential windows of susceptibility. Results: Median serum PFASs concentrations were PFOS>PFOA>PFHxS>PFNA in prenatal, 3-year, and 8-year children. The covariate-adjusted general linear regression identified positive associations between serum PFOA, PFOS and PFNA concentrations and children's reading scores at ages 5 and 8years, but no association between any PFHxS concentration and reading skills. The multiple informant model showed: a) Prenatal PFOA was positively associated with higher children's scores in Reading Composite (β: 4.0, 95% CI: 0.6, 7.4 per a natural log unit increase in exposure) and Sentence Comprehension (β: 4.2, 95% CI: 0.5, 8.0) at age 8years; b) 3-year PFOA was positively associated with higher children's scores in Brief Reading (β: 7.3, 95% CI: 0.9, 13.8), Letter Word Identification (β: 6.6, 95% CI: 1.1, 12.0), and Passage Comprehension (β: 5.9, 95% CI: 1.5, 10.2) at age 5years; c) 8-year PFOA was positively associated with higher children's Word Reading scores (β: 5.8, 95% CI: 0.8, 10.7) at age 8years. Prenatal PFOS and PFNA were positively associated with children's reading abilities at age 5years, but not at age 8years; 3-year PFOS and PFNA were positively associated with reading scores at age 5years. But PFHxS concentrations, at any exposure windows, were not associated with reading skills. Conclusion: Prenatal and childhood serum PFOA, PFOS and PFNA concentrations were positively associated with better children's reading skills at ages 5 and 8years, but no association was found between serum PFHxS and reading skills.			1											1					1	B	A	胎児期のPFNAは5歳、8歳で読解力と正の関連。 3歳時点のPFNAと5歳時点のWord attackとも正の関連。有害性影響とは言えない。 PFNAの中央値と四分位範囲胎児期0.9 (0.7, 1.1)3歳 1.2 (1.0, 1.8) 8歳0.7 (0.5, 1.1)ng/mL	
844	ヒト（神経毒性）	Gallo, V.; Leonardi, G.; Brayne, C.; Armstrong, B.,en; Fletcher, T.	Serum perfluoroalkyl acids concentrations and	2013	BMJ Open. 2013 Jun 20;3(6):e002414. doi: 10.1136/bmjopen-2012-002414.	Objectives: To examine the cross-sectional association between serum perfluorooctanate (PFOA), perfuorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA) and perfluorohexane sulfonate (PFHxS) concentrations with self-reported memory impairment in adults and the interaction of these associations with diabetes status. Design: Cross-sectional study. Setting: Population-based in Mid-Ohio Valley, West Virginia following contamination by a chemical plant. Participants: The C8 Health Project collected data and measured the serum level of perfluoroalkyl acids (PFAAs) of 21 24 adults aged 50+ years. Primary outcome measure: Self-reported memory impairment as defined by the question have experienced short-term memory loss?' Results: A total of 4057 participants self-reported short-term memory impairment. Inverse associations between PFOS and PFOA and memory impairment were highly statistically significant with fully adjusted OR=0.93 (95% CI 0.9 to 0.96) for doubling PFOS and OR=0.96 (95% CI 0.94 to 0.98) for doubling PFOA concentrations. Comparable inverse associations with PFNA and PFHxS were of borderline statistical significance. Inverse associations of PFAAs with memory impairment were weaker or non-existent in patients with diabetes than overall in patients without diabetes. Conclusions: An inverse association between PFAA serum levels and self-reported memory impairment has been observed in this large population-based, cross-sectional study that is stronger and more statistically significant for PFOAand PFOS. The associations can be potentially explained by a preventive anti-inflammatory effect exerted by a peroxisome proliferator-activated receptor agonist effect of these PFAAs, but confounding or even reverse causation cannot be excluded as an alternative explanation.			1											1		1				B	B	PFNAが2倍になると self-report memory impairmentの調整ORが第１五分位0.25-0.90 ng/mLから下がる。有害影響とは言えない。	
845	ヒト（神経毒性）	Power, Melinda C; Webster, Thomas F; Baccarelli, Andrea A; Weisskopf, Marc G	Cross-sectional association between polyfluor	2013	Neuroepidemiology. 2013;40(2):125-32. doi: 10.1159/000342310. Epub 2012 Oct 24.	BACKGROUND/AIMS: Our limited understanding of how polyfluoroalkyl chemicals (PFCs) may impact on human health suggests the potential for a protective impact on brain health. This study was designed to explore the association between PFCs and cognitive ability in older adults. METHODS: We assessed the association between four PFCs, perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA) and perfluorohexane sulfonic acid (PFHxS), and self-reported limitation due to difficulty remembering or periods of confusion using data from participants aged 60-85 years from the 1999-2000 and 2003-2008 National Health and Nutrition Examination Surveys. We also considered whether diabetic status or diabetic medication use modifies this association in light of in vitro evidence that PFCs may act on the same receptors as some diabetic medications. RESULTS: In multivariable adjusted models, point estimates suggest a protective association between PFCs and self-reported cognitive limitation (odds ratio, OR; 95% confidence interval, CI) for a doubling in PFC concentration: PFOS (OR, 0.90; 95% CI, 0.78, 1.03), PFOA (OR, 0.92; 95% CI, 0.78, 1.09), PFNA (OR, 0.91; 95% CI, 0.79, 1.04) and PFHxS (OR, 0.93; 95% CI, 0.82, 1.06). The protective association was concentrated in diabetics, with strong, significant protective associations in nonmedicated diabetics. CONCLUSIONS: This cross-sectional study suggests that there may be a protective association between exposure to PFCs and cognition in older adults, particularly diabetics.			1											1		1				B	B	薬を服用していない糖尿病群でPFNAの濃度が2倍になると記憶困難や混乱によるlimitationの調整ORが下がる。有害影響とは言えない。PFNAのGMとGSDは1.01 (2.35)ug/L	
846	ヒト（発がん性）	Ducatman, Alan; Zhang, Jianjun; Fan, Hongmin	Prostate-specific antigen and perfluoroalkyl ac	2015	J Occup Environ Med. 2015 Jan;57(1):111-4. doi: 10.1097/JOM.0000000000000319.	PURPOSE: To inform questions raised by inconsistent findings regarding an association between perfluoroalkyl acids (PFAAs) and prostate cancer by assessing the relationship of PFAAs in human serum to prostate-specific antigen (PSA). MATERIALS AND METHODS: Using 2005 to 2006 survey data from a large survey population, we compared serum PFAA concentrations in adult males with PSA concentrations adjusted for risk factors including age, body mass index, smoking status, and socioeconomic status. RESULTS: Perfluoroalkyl acids are not consistently associated with PSA concentration in general, or with PSA more than 4.0. DISCUSSION: These findings do not provide evidence that PFAA exposure is associated with PSA.			1											1						C	-	アウトカムがPSAである	
847	ヒト（発がん性）	Innes KE, Wimsatt JH, Frisbee S, et al.	Inverse association of colorectal cancer prevali	2014	BMC Cancer. 2014 Jan 27:14:45. doi: 10.1186/1471-2407-14-45.	Background: Perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) are persistent environmental contaminants that affect metabolic regulation, inflammation, and other factors implicated in the development and progression of colorectal cancer (CRC). However, the link between these compounds and CRC remains unknown. In this cross-sectional study, we investigated the association of CRC diagnosis to PFOA and PFOS blood levels in a large Appalachian population. Methods: Participants were 47,359 adults ≥ 21 years of age and residing in six PFOA-contaminated water districts in the mid-Ohio Valley (N = 47,151 cancer-free adults, 208 cases of primary CRC). All participants completed a comprehensive health survey between 2005 and 2006; serum levels of PFOA, PFOS, and a range of other blood markers were also measured. Medical history was assessed via self report and cancer diagnosis confirmed via chart review. Results: CRC showed a strong inverse, dose-response association with PFOS serum levels (odds ratio (OR) adjusted for potential confounders = 0.2, 95% confidence interval (CI) 0.2,0.3) for highest vs. lowest quartile of PFOS, P-trend < 0.00001) and a significant, but more modest inverse association with PFOA (adjusted OR = 0.6 (CI 0.4, 0.9) for highest vs. lowest quartile, P-trend = 0.001). These inverse associations were stronger in those diagnosed within the previous 6 years and resident in the same water district for a minimum of 10-15 years preceding assessment. The relationship between PFOA and CRC was also more pronounced in men and leaner adults, and showed a stronger linear trend at lower exposure levels. Conclusions: In this large cross-sectional study, we found a strong, inverse association between PFOS and likelihood of CRC diagnosis and a significant, although more modest inverse association between PFOA and CRC. If confirmed in prospective investigations, these findings may aid in identifying new strategies for CRC prevention and treatment and inform future studies regarding mechanisms underlying CRC pathogenesis.			1											1						C	-	今回評価対象の物質を測定していない	
848	ヒト（発がん性）	Mastrantonio, Marina; Bai, Edoardo; Uccelli, Raffaella; Cordiano, Vincenzo; Screpanti, Augusto; Crosignani, Paolo	Drinking water contamination from perfluoroall	2018	Eur J Public Health. 2018 Feb 1;28(1):180-185. doi: 10.1093/eurpub/ckx066.	BACKGROUND: Perfluoroalkyl substances (PFAS), a heterogeneous group of highly stable man-made chemicals, have been widely used since 1960s and can be detected almost ubiquitously in all environmental matrices. In Italy, on January 2014, drinking water contamination in an area of the Veneto Region was detected mainly due to the drain of fluorinated chemicals by a manufacturing company operating since 1964. METHODS: The present ecological mortality study was aimed at comparing mortality for some causes of death selected on the basis of previous reported associations, during the period 1980-2013, in municipalities with PFAS contaminated and uncontaminated drinking water on the basis of the levels indicated by the Italian National Health Institute (ISS). Sex-specific number, standardized mortality rates and rate ratios (RR) for PFAS contaminated and uncontaminated areas were computed for each cause of death through the ENEA epidemiological database. RESULTS: In both sexes, statistically significant RRs were detected for all causes mortality, diabetes, cerebrovascular diseases, myocardial infarction and Alzheimer's disease. In females, RRs significantly higher than 1.0 were also observed for kidney and breast cancer, and Parkinson's disease. Increased risk, although not statistically significant, was observed for bladder cancer in both sexes, and for testicular cancer, pancreatic cancer and leukemia in males only. CONCLUSIONS: Higher mortality levels for some causes of death, possibly associated with PFAS exposure, were detected in contaminated municipalities in comparison with uncontaminated ones with similar socioeconomicstatus and smoking habits. These results warrant further individual level analytic studies to delineate casual associations.	1	1	1	1										1						C	-	地域相関研究である	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
849	ヒト（発がん性）	Hurley, Susan; Goldberg, Debbie; Wang, Miaomiao; Park, June-Soo; Petreas, Myrto; Bernstein, Leslie; Anton-Culver, Hoda; Nelson, David O; Reynolds, Peggy	Breast cancer risk and serum levels of per- and	2018	Environ Health. 2018 Nov 27;17(1):83. doi: 10.1186/s12940-018-0426-6.	BACKGROUND: Per- and poly- fluoroalkyl substances (PFASs) are a large family of synthetic chemicals, some of which are mammary toxicants and endocrine disruptors. Their potential as breast carcinogens is unclear. Our objective was to evaluate the risk of breast cancer associated with serum PFAS concentrations in a nested case-control study within the California Teachers Study. METHODS: Participants were 902 women with invasive breast cancer (cases) and 858 with no such diagnosis (controls) who provided 10 mL of blood and were interviewed during 2011-2015, an average of 35 months after case diagnosis. PFASs were measured using automated online SPE-HPLC-MS/MS methods. Statistical analyses were restricted to six PFASs with detection frequencies ≥ 95%: PFOA (Perfluorooctanoic acid), PFNA (Perfluorononanoic acid), PFUnDA (Perfluoroundecanoic acid), PFHxS (Perfluorohexane sulfonic acid), PFOS (Perfluorooctane sulfonic acid), and MeFOSAA (2-(N-Methyl-perfluorooctane sulfonamido) acetic acid. Unconditional logistic regression was used to calculate adjusted odds ratios (ORs), estimating the breast cancer risk associated with each PFAS. RESULTS: For all cases of invasive breast cancer, none of the adjusted ORs were statistically significant but marginally significant ORs < 1.0 were observed for PFUnDA and PFHxS (p-trend = 0.08). Adjusted ORs < 1.0 for PFUnDA and PFHxS were statistically significant (p ≤ 0.05) among the 107 cases with hormone-negative tumors but not the 743 with hormone-positive tumors. CONCLUSION: Overall, these findings do not provide evidence that serum PFAS levels measured after diagnosis are related tobreast cancer risk. The few inverse associations found may be due to chance or may be artifacts of study design. Future studies should incorporate information about genetic susceptibility, endogenous estrogen levels, and measurements of PFASs prior to diagnosis and treatment.			1													1		1	A	-	前向き、血中測定	
850	ヒト（心血管系）	Bao, W. W.; Qian, Z. M.; Geiger, S. D.; Liu, E.; Liu, Y.; Wang, S. Q.; Lawrence, W. R.; Yang, B. Y.; Hu, L. W.; Zeng, X. W.; Dong, G. H.	Gender-specific associations between serum i	2017	Sci Total Environ. 607-608: 1304-1312. doi: 10.1016/j.scitotenv.2017.07.124.	Previous studies have demonstrated associations of perfluoroalkyl substances (PFASs), a group of highly persistent chemicals ubiquitous in wildlife and humans, with hypertension, but the relationships are mixed. Furthermore, academic literature on the relationship between isomers of PFASs and blood pressure (BP) and hypertension in populations from a higher pollution area is scant. We studied 1612 Chinese adults, ages 22-96years old, from Shenyang, China, utilizing high performance liquid chromatography-mass spectrometry to analyze isomers of perfluorooctanesulfonate (PFOS), perfluorooctanoate (PFOA), and other PFASs in blood serum. We used a mercury sphygmomanometer to measure BP. Hypertension was defined as a mean systolic BP (SBP) of at least 140mmHg, and/or diastolic BP (DBP) of at least 90mmHg, and/or use of antihypertensive medications. The results showed that increased serum concentrations of all (both branched and linear) isomers of PFASs were associated with higher prevalence of hypertension. Adjusted odds ratios for hypertension per ln-unit (ng/mL) increase in PFASs ranged from 1.1 (95%CI: 1.04, 1.17) for perfluorobutanoic acid (PFBA) to 1.26 (95%CI: 1.12, 1.42) for 3+4+5m PFOS, and the estimated increases in mean SBP and DBP ranged from 0.80mmHg (95%CI: 0.25, 1.34) for PFBA to 4.51mmHg (95%CI: 3.52, 5.51) for 3+4+5m PFOS, and from 0.51mmHg (95%CI: 0.01, 1.01) for perfluorodecanesulfonate (PFDS) to 2.48 (1.80, 3.16) for perfluorononanoic acid (PFNA), respectively. Compared with linear PFASs isomers, we identified more and stronger associations among branched PFASs isomers and blood pressure. Furthermore, females exhibited consistently stronger effects than males. In conclusion, this study is the first of its kind to show that not only PFASs positively associated with elevated blood pressure, but also that branched PFAS isomers are more frequently associated with blood pressure than linear PFAS isomers.	1					1	1	1							1		1			1	A	-	評価機関への収載多い	
851	ヒト（心血管系）	Huang, M.; Jiao, J.; Zhuang, P.; Chen, X.; Wang, J.; Zhang, Y.	Serum polyfluoroalkyl chemicals are associate	2018	Environ Int. 2018 Oct;119:37-46. doi: 10.1016/j.envint.2018.05.051. Epub 2018 Jun 19.	Background: Perfluoroalkyl chemicals (PFCs) as possible cardiovascular disrupters are universally detected in humans. However, evidence from epidemiological studies appears insufficient and ambiguous. Objectives: We aim to examine the serum PFCs levels and their associations with the prevalence of cardiovascular diseases (CVD) and related outcomes in general US population. Methods: We investigated the serum levels of 12 major PFCs, including perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), 2-(N-ethyl-perfluorooctane sulfonamido) acetate (EPAH), 2-(N-methyl-perfluorooctane sulfonamido) acetate (MPAH), perfluorodecanoic acid (PFDE), perfluorobutane sulfonate (PFBS), perfluoroheptanoic acid (PFHP), perfluorononanoic acid (PFNA), perfluorooctane sulfonamide (PFSA), perfluoroundecanoic acid (PFUA), and perfluorododecanoic acid (PFDO), in 10,859 participants from the National Health and Nutritional Examination Survey (NHANES) 1999-2014. Logistic regression models were used to estimate the associations between serum PFCs and 5 self-reported CVD outcomes, including congestive heart failure, coronary heart disease, angina pectoris, heart attack, and stroke. Linear regression analyses were used to estimate the PFCs and their associations with 8 traditional CVD risk factors like serum triglyceride and total cholesterol. Results: In multivariable-adjusted models, total PFCs were positively associated with total CVD (p for trend = 0.0166), independent of traditional CVD risk factors, such as smoking status, diabetes, hypertension and serum cholesterol level. Compared with reference quartile of total PFCs levels, the multivariable adjusted odds ratios in increasing quartiles were 1.23 [95% confidence interval (CI): 0.91-1.66], 1.47 (95% CI: 1.14-1.89) and 1.45 (95% CI: 1.06-1.98) for total CVD. Similar positive associations were found if considering individual PFCs including PFOS, PFUA, MPAH, EPAH, PFDO, PFSA and PFBS. In addition, serum levels of MPAH and PFDO were positively associated with congestive heart failure; PFNA, PFDE, and PFUA were positively associated with coronary heart disease; PFUA and PFDO were positively associated with angina pectoris; and PFNA was positively associated with heart attack. Conclusions: Our findings suggested that exposure to PFCs was positively associated with risk of CVD. Further longitudinal studies are needed to increase our understanding about the role of PFCs exposure in the prevalence of CVD.				1				1								1		1	A	-	前向き、血中測定	
852	ヒト（心血管系）	Huang, R.; Chen, Q.; Zhang, L.; Luo, K.; Chen, L.; Zhao, S.; Feng, L.; Zhang, J.	Prenatal exposure to perfluoroalkyl and polyflu	2019	Environ Health 18: 5. doi: 10.1186/s12940-0180445-3	Background: Perfluoroalkyl and polyfluoroalkyl substances (PFAS) have been reported to disrupt endocrine system and reproduction. However, epidemiological evidence on the association between PFAS and preeclampsia is inconsistent. We aimed to investigate the association between prenatal PFAS exposure and hypertensive disorders of pregnancy (HDP) in humans. Methods: PFAS were measured by liquid chromatography system coupled with tandem mass spectrometry in 687 umbilical cord plasma samples collected between 2011 and 2012 in Shanghai, China. Information on HDP including gestational hypertension and preeclampsia was abstracted from medical records. Multiple logistic regression was used to examine the association of each PFAS with gestational hypertension, preeclampsia, and overall HDP in separate models. Elastic net regression with logit link was used to identify independent associations between exposures and outcomes. Logistic regression was used to obtain the unpenalized estimates of the selected PFAS components for the associations with outcomes, adjusting for age, education level, pre-pregnancy BMI, parity, and mutual adjustment of selected PFAS. Results: The risk of gestational hypertension and preeclampsia was 3.3% and 2.8% in our subjects, respectively. Perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perfluoroundecanoic acid (PFUA) were associated with preeclampsia based on elastic net penalty regression. In the fully adjusted statistical model, women with a higher level of standardized ln-transformed PFBS had an increased odds of preeclampsia [adjusted odds ratio (AOR): 1.81, 95% confidence interval (CI): 1.03-3.17], and overall HDP (AOR: 1.64, 95% CI: 1.09-2.47). Conclusions: Prenatal exposure to PFBS was positively associated with the risk of preeclampsia and overall HDP.				1				1			1							B	-	測定指標：臍帯血、アウトカム：妊娠性高血圧と子癇	
853	ヒト（心血管系）	Koshy, T. T.; Attina, T. M.; Ghassabian, A.; Gilbert, J.; Burdine, L. K.; Marmor, M.; Honda, M.; Chu, D. B.; Han, X.; Shao, Y.; Kannan, K.; Urbina, E. M.; Trasande, L.	Serum perfluoroalkyl substances and cardiome	2017	Environ Int. 2017 Dec;109:128-135. doi: 10.1016/j.envint.2017.08.003. Epub 2017 Sep 8.	Background: Large amounts of various chemical contaminants, including perfluoroalkyl substances (PFASs), were released at the time of the World Trade Center (WTC) disaster. Thousands of children who lived and/or attended school near the disaster site were exposed to these substances but few studies have examined the possible consequences related to these exposures. Objectives: To examine the relationship of PFASs serum levels with cardiometabolic profile in children and adolescents enrolled in the World Trade Center Health Registry (WTCHR) and a matched comparison group. Methods: We evaluated WTCHR enrollees who resided in New York City and were born between September 11, 1993 and September 10, 2001, and a matched comparison group consisting of individuals who were ineligible for WTCHR participation upon distance of their home, school or work from the WTC and lack of participation in rescue and recovery activities. Matching was based on date of birth, sex, race, ethnicity, and income. We assessed exposure to PFASs, as measured by serum levels and association with cardiometabolic profile as measured by arterial wall stiffness, body mass index, insulin resistance, fasting total cholesterol, HDL, LDL and triglycerides. Results: A total of 402 participants completed the study and serum samples were analyzed from 308 participants, 123 in the WTCHR group and 185 in the comparison group. In multivariable regression analysis, after adjusting for relevant confounders, we observed a significant, positive association of perfluorooctanoic acid (PFOA) with triglycerides (beta coefficient=0.14, 95% CI: 0.02, 0.27, 15.1% change), total cholesterol (beta coefficient=0.09, 95% CI: 0.04, 0.14, 9.2% change), and LDL cholesterol (beta coefficient=0.11, 95% CI: 0.03, 0.19, 11.5% change). Perfluorohexanesulfonic acid levels were associated with decreased insulin resistance (beta coefficient=-0.09, 95% CI: -0.18, -0.003, -8.6% change); PFOA and perfluorononanoic acid were associated with increased brachial artery distensibility. Conclusions: This research adds to our knowledge of the physical health impacts in a large group of children exposed to the WTC disaster. Abnormal lipid levels in young adults might be an early marker of atherosclerosis and cardiovascular diseases and our findings highlight the importance of conducting longitudinal studies in this population.				1											1		1	A	-	小児、思春期、308名数は少ないが（動脈硬化、肥満度、インスリン抵抗性、空腹時総コレステロール、HDL、LDL、トリグリセリド）として将来的な縦断研究の必要性を示すもの	
854	ヒト（心血管系）	Lin, C. Y.; Lin, L. Y.; Wen, T. W.; Lien, G. W.; Chien, K. L.; Hsu, S. H.; Liao, C. C.; Sung, F. C.; Chen, P. C.; Su, T. C.	Association between levels of serum perfluoroc	2013	Int J Cardiol. 2013 Oct 9;168(4):3309-16. doi: 10.1016/j.ijcard.2013.04.042. Epub 2013 May 7.	Background: Perfluorinated chemicals (PFCs) have been widely used for years in a variety of products worldwide. Although epidemiological findings have shown that PFC levels are positively associated with cholesterol and uric acid levels, it is unknown whether PFCs are associated with atherosclerosis. Methods: We recruited 664 subjects (12-30 years) from a population-based sample of adolescents and young adults based on a mass urine screening to determine the relationship between serum levels of PFCs and carotid intima-media thickness (CIMT). Results: The median concentrations and ranges of perfluorooctanoic acid (PFOA), perfluorooctane sulfate (PFOS), perfluorononanoic acid (PFNA), and perfluorodecanoic acid (PFUA) were 3.49 (0.75-52.2) ng/mL, 8.65 (0.11-85.90) ng/mL, 0.38 (0.38-25.4) ng/mL, and 6.59 (1.50-105.7) ng/mL, respectively. After controlling for age, gender, smoking status, systolic blood pressure, body mass index, low-density lipoprotein cholesterol, triglyceride, high-sensitivity C-reactive protein, and homeostasis model assessment of insulin resistance, multiple linear regression analysis revealed that CIMT increased significantly across quartiles of PFOS (0.434 mm, 0.446 mm, 0.458 mm, 0.451 mm; P for trend <0.001). Subpopulation analysis showed the association between PFOS and CIMT was more evident and significant in females, non-smokers, subjects of age 12-19 years, BMI<24, and those with APOE genotype of E2 carrier and E3/E3. Conclusions: Higher serum concentrations of PFOS were associated with an increase of carotid IMT in this cohort of adolescents and young adults. Further studies are warranted to clarify the causal relationship between PFOS and atherosclerosis.				1											1	1	1	A	-	12−30歳、664名、多くの要因で調整、遺伝子多型でもわけている、として将来的な縦断研究の必要性を示すもの	

No.	分野（参考）	著者	タイトル	発行年	書誌情報	要旨（原文）	調査対象PFAS（要約中の記載に基づく）					評価書引用													備考	情報抽出対象	文献レビュー（委員①）	文献レビュー（委員②）	コメント（委員①）	コメント（委員②）
							PFBA	PFHxA	PFNA	PFBS	GenX	EPA_PFBA	EPA_PFHxA	EPA_PFBS	EPA_GenX	EPA_MCLG	ECHA_PFBS	ECHA_PFHxA	ECHA_GenX	ANSES	Health Canada	ATSDR	FSANZ	EFSA						
855	ヒト（心血管系）	Lind, P. M.; Salihovic, S.; van Bavel, B.; Lind, L.	Circulating levels of perfluoroalkyl substances	2017	Environ Res. 2017 Jan;152:157-164. doi: 10.1016/j.envres.2016.10.002. Epub 2016 Oct 20.	Background and objective: During recent years, some persistent organic pollutants (POPs) have been linked to atherosclerosis. One group of POPs, the poly- and perfluoroalkyl substances (PFASs) have not been investigated with regard to atherosclerotic plaques. Methods: Carotid artery atherosclerosis was assessed by ultrasound in 1016 subjects aged 70 years in the Prospective Investigation of the Vasculature in Uppsala Seniors (PIVUS) study. Eight PFASs were detected in >75% of participants' plasma by ultra-performance liquid chromatography coupled to tandem mass spectrometry (UPLC-MS/MS). Results: No significant linear associations were observed between the PFASs and intima-media thickness (IMT), or the echogenicity in the intima-media complex (IM-GSM, a marker of lipid infiltration in the artery) when men and women were analyzed together. Neither was occurrence of carotid plaques related to PFASs levels. However, highly significant interactions were observed between some PFASs and sex regarding both IM-GSM and plaque prevalence. Perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnDA), were all related to IM-GSM in a positive fashion in women (p=0.002-0.003), while these relationships were negative in men. The levels of PFUnDA were significantly related to carotid plaque in women (OR 1.59, 95%CI 1.03-2.43, p=0.03), but not in men (OR 0.93, 95%CI 0.62-1.42, p=0.75). Conclusions: In this cross-sectional study, a pronounced gender difference was observed regarding associations between some PFASs, especially the long-chain PFUnDA, and markers of atherosclerosis, with more pronounced relationships found in women. These findings suggest a sex-specific role for PFASs in atherosclerosis.			1	1													1		1			1	A	-	1000人規模、PFH x Aの結果あり	
856	ヒト（心血管系）	Starling, A. P.; Engel, S. M.; Richardson, D. B.; Baird, D. D.; Haug, L. S.; Stuebe, A. M.; Klungsoyr, K.; Harmon, Q.; Becher, G.; Thomsen, C.; Sabaredzovic, A.; Eggesbo, M.; Hoppin, J. A.; Travlos, G. S.; Wilson, R. E.; Trogstad, L. I.; Magnus, P.,er; Longnecker, M. P.	Perfluoroalkyl Substances During Pregnancy a	2014	Am J Epidemiol. 2014 Apr 1;179(7):824-33. doi: 10.1093/aje/kwt432. Epub 2014 Feb 20.	Perfluoroalkyl substances (PFAS) are persistent and ubiquitous environmental contaminants, and human exposure to these substances may be related to preeclampsia, a common pregnancy complication. Previous studies have found serum concentrations of PFAS to be positively associated with pregnancy-induced hypertension and preeclampsia in a population with high levels of exposure to perfluorooctanoate. Whether this association exists among pregnant women with background levels of PFAS exposure is unknown. Using data from the Norwegian Mother and Child Cohort Study conducted by the Norwegian Institute of Public Health, we carried out a study of nulliparous pregnant women enrolled in 20032007 (466 cases, 510 noncases) to estimate associations between PFAS concentrations and an independently validated diagnosis of preeclampsia. We measured levels of 9 PFAS in maternal plasma extracted midpregnancy; statistical analyses were restricted to 7 PFAS that were quantifiable in more than 50 of samples. In proportional hazards models adjusted for maternal age, prepregnancy body mass index (weight (kg)/height (m)(2)), educational level, and smoking status, we observed no strongly positive associations between PFAS levels and preeclampsia. We found an inverse association between preeclampsia and the highest quartile of perfluoroundecanoic acid concentration relative to the lowest quartile (hazard ratio 0.55, 95 confidence interval: 0.38, 0.81). Overall,our findings do not support an increased risk of preeclampsia among nulliparous Norwegian women with background levels of PFAS exposure.				1													1					1	A	-	一般集団（466 cases, 510 noncases）、妊娠中期の血中レベルと子癇	
857	ヒト（心血管系）	Lin, C. Y.; Chen, P. C.; Lo, S. C.; Torng, P. L.; Sung, F. C.; Su, T. C.	The association of carotid intima-media thickn	2016	Environ Int. 2016 Sep;94:292-299. doi: 10.1016/j.envint.2016.06.004. Epub 2016 Jun 9.	Perfluorinated chemicals (PFCs) have been widely used in a variety of products worldwide. Our previous study has documented a close association of higher serum level of perfluorooctane sulfonate (PFOS) with an increased carotid intima-media thickness (CIMT) in a cohort of adolescents and young adults. Herein, we further investigated the association of oxidative stress, circulating endothelial microparticles (EMPs) and platelet microparticles (PMPs) with PFCs and CIMT in humans. We recruited 848 subjects (12-30years old) from a population-based sample to determine the relationship between serum levels of PFCs, EMPs (CD62E and CD31+/CD42a-), PMPs (CD62P and CD31+/CD42a+), and the urine levels of 8-hydroxydeoxyguanosine (8-OHdG) and CIMT. The results showed that CD31+/CD42a- (endothelial apoptosis marker) and CD31+/CD42a+ (platelet apoptosis marker) increased significantly across quartiles of PFOS in multiple linear regression analysis. Furthermore, the elevation of CD31+/CD42a- and CD31+/CD42a+ corresponded to the increase of the odds ratios of thicker CIMT (greater than 50th percentile) with higher serum PFOS concentration (greater than 50%) (OR=2.86, 0.95 C.I.=1.69-4.84, P<;0.001) in logistic regression models. There was no association between PFC concentration and 8-OHdG. In conclusion, we found the positive association between PFOS and CIMT that was more evident when serum levels of EMPs (CD31+/CD42a-) and PMPs (CD31+/CD42a+) were elevated.Further studies are warranted to investigate the causal inference of PFOS exposure on endothelial cell damage and atherosclerosis.				1															1			B	-	12ー30歳、848人だが、内皮細胞や血小板アポトーシスマーカーなど間接的な指標	
858	ヒト（骨毒性）	Khalil, N.; Chen, A.; Lee, M.; Czerwinski, S. A.; Ebert, J. R.; Dewitt, J. C.; Kannan, K.	Association of Perfluoroalkyl Substances, Bone	2016	Environ Health Perspect. 2016 Jan;124(1):81-7. doi: 10.1289/ehp.1307909. Epub 2015 Jun 9.	Methods: The association between serum PFAS concentration and bone mineral density at total femur (TFBMD), femoral neck (FNBMD), lumbar spine (LSBMD), and physician-diagnosed osteoporosis was assessed in 1,914 participants using data from the National Health and Nutritional Examination Survey 2009-2010. Results: The mean age of the participants was 43 years. Men had higher serum PFAS concentrations than women ($p < 0.001$) except for PFNA. In both sexes, serum PFOS concentrations were inversely associated with FNBMD ($p < 0.05$). In women, significant negative associations were observed for natural log (ln)-transformed PFOS exposure with TFBMD and FNBMD, and for ln-transformed PFOA exposure with TFBMD ($p < 0.05$). In postmenopausal women, serum PFOS was negatively associated with TFBMD and FNBMD, and PFNA was negatively associated with TFBMD, FNBMD, and LSBMD (all $p < 0.05$). With one log unit increase in serum PFOA, PFHxS, and PFNA, osteoporosis prevalence in women increased as follows: [adjusted odds ratios (aORs)] 1.84 (95% CI: 1.17, 2.905), 1.64 (95% CI: 1.14, 2.38), and 1.45 (95% CI: 1.02, 2.05), respectively. In women, the prevalence of osteoporosis was significantly higher in the highest versus the lowest quartiles of PFOA, PFHxS, and PFNA, with aORs of 2.59 (95% CI: 1.01, 6.67), 13.20 (95% CI: 2.72, 64.15), and 3.23 (95% CI: 1.44, 7.21), respectively, based on 77 cases in the study sample. Conclusion: In a representative sample of the U.S. adult population, serum PFAS concentrations were associated with lower bone mineral density, which varied according to the specific PFAS and bone site assessed. Most associations were limited to women. Osteoporosis in women was also associated with PFAS exposure, based on a small number of cases.				1													1		1			1	A	-	1914人、NHANESデータ	
859	ヒト（骨毒性）	Khalil, N.; Ebert, J. R.; Honda, M.; Lee, M.; Nahhas, R. W.; Koskela, A.; Hangartner, T.; Kannan, K.	Perfluoroalkyl substances, bone density, and c	2018	Environ Res. 2018 Jan;160:314-321. doi: 10.1016/j.envres.2017.10.014. Epub 2017 Oct 15.	Background and objective: Perfluoroalkyl substances (PFASs), including perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), and perfluorononanoic acid (PFNA), have been associated with adverse bone, and metabolic changes in adults. However association of PFASs with bone health in children is understudied. Considering their role as endocrine disruptors, we examined relationships of four PFASs with bone health in children. Methods: In a cross sectional pilot study, 48 obese children aged 8-12 years were enrolled from Dayton's Children Hospital, Ohio. Anthropometric, clinical and biochemical assessments of serum were completed. Serum PFASs were measured by UPLC-ESI-MS/MS. In a subset of 23 children, bone health parameters were measured using calcaneal quantitative ultrasound (QUS). Results: While PFASs exposure was associated with a consistent negative relationship with bone health parameters, among four PFASs tested, only PFNA showed a significant negative relationship with bone parameter (β [95% CI], = - 72.7 [- 126.0, - 19.6], p = .010). PFNA was also associated with raised systolic blood pressure (p = .008), low density lipoprotein cholesterol (LDL-C; p < .001), and total cholesterol (TC; p = .014). In addition, both PFOA and PFOS predicted elevation in LDL-C, and PFOA predicted increased TC, as well. In this analysis, PFASs were not strongly related to thyroid hormones, 25-hydroxy vitamin D, liver enzymes, or glucose homeostasis. Conclusion: PFASs exposure in obese children may play a role in adverse skeletal and cardiovascular risk profiles.				1													1						B	-	48人、8－12歳小児肥満児、骨パラメーター、血圧・脂質、パイロットスタディ限定的	
860	用量反応解析	Thompson, Chad M; Fitch, Seneca E; Ring, Caroline; Rish, William; Cullen, John M; Haws, Laurie C	Development of an oral reference dose for the	2019	J Appl Toxicol. 2019 Sep;39(9):1267-1282. doi: 10.1002/jat.3812. Epub 2019 Jun 18.	Ammonium 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy)-propanoate, also known as GenX, is a processing aid used in the manufacture of fluoropolymers. GenX is one of several chemistries developed as an alternative to long-chain poly-fluoroalkyl substances, which tend to have long clearance half-lives and are environmentally persistent. Unlike poly-fluoroalkyl substances, GenX has more rapid clearance, but has been detected in US and international water sources. There are currently no federal drinking water standards for GenX in the USA; therefore, we developed a non-cancer oral reference dose (RfD) for GenX based on available repeated dose studies. The review of the available data indicate that GenX is unlikely to be genotoxic. A combination of traditional frequentist benchmark dose models and Bayesian benchmark dose models were used derive relevant points of departure from mammalian toxicity studies. In addition, deterministic and probabilistic RfD values were developed using available tools and regulatory guidance. The two approaches resulted in a narrow range of RfD values for liver lesions observed in a 2-year bioassay in rats (0.01-0.02 mg/kg/day). The probabilistic approach resulted in the lower, i.e., more conservative RfD. The probabilistic RfD of 0.01 mg/kg/day results in a maximum contaminant level goal of 70 ppb. It is anticipated that these values, along with the hazard identification and dose-response modeling described herein, should be informative for risk assessors and regulators interested in setting health-protective drinking water guideline values for GenX.					1				1												1	A	-		
861	複合影響	Carr, Caroline K; Watkins, Andrew M; Wolf, Cynthia J; Abbott, Barbara D; Lau, Christopher; Gennings, Chris	Testing for departures from additivity in mixtur	2013	Toxicology. 2013 Apr 5;306:169-75. doi: 10.1016/j.tox.2013.02.016. Epub 2013 Mar 5.	This study is a follow-up to a paper by Carr et al. that determined a design structure to optimally test for departures from additivity in a fixed ratio mixture of four perfluoroalkyl acids (PFAAs) using an in vitro transiently-transfected COS-1 PPARα reporter model with a mixing ratio that is based on average serum levels in NHANES subjects. Availability of information regarding potential for additivity of PFAAs in mixtures is critically important for risk assessors who are concerned with the ability of the compounds to affect human health and impact ecological systems. It is clear that exposures are not to single compounds, but to mixtures of the PFAAs. This paper presents the results from the data collected using the design from Carr et al. along with subsequent analyses that were performed to classify the relationships among mixtures of PFAAs. A non-linear logistic additivity model was employed to predict relative luciferase units (RLU), an indicator of PPARα activation. The results indicated a less than additive relationship among the four PFAAs. To determine if the possible "antagonism" is from the competition among or between carboxylates and sulfonates, four different binary mixtures were also studied. There was a less than additive relationship in all four binary mixtures. These findings are generally similar to two other reports of interfering interactions between PFAAs in mixtures. The most conservative interpretation for our data would be an assumption of additivity (and lack of a greater than additive interaction), with a potential for antagonistic interactions.				1													1						B	-		