

National Health and Nutrition Examination Survey

2015-2016 Data Documentation, Codebook, and Frequencies

Perfluoroalkyl and Polyfluoroalkyl (PFAS_I)

Data File: PFAS_I.xpt

First Published: September 2018

Last Revised: NA

Component Description

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) are used in multiple commercial applications including surfactants, lubricants, paints, polishes, food packaging and fire-retarding foams. Certain PFAS are used in the manufacture of polymers used in many industrial and consumer products, including soil, stain, grease, and water resistant coatings on textiles and carpet; uses in the automotive, mechanical, aerospace, chemical, electrical, medical, and building/construction industries; personal care products; and non-stick coatings on cookware. Some PFASs are ubiquitous contaminants found in humans and animals worldwide.

Synthesis of PFAS employed electrochemical fluorination (ECF) or fluorotelomerization. ECF, used from the 1950s until the early 2000s, yielded branched and linear isomers. By contrast, fluorotelomerization produces almost exclusively linear compounds (Vyas, et al. 2007). The structural isomer patterns of perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) in humans may be useful for understanding routes and sources of exposure (Benskin, et al. 2010). Therefore, concentrations of linear PFOA (n-PFOA), sum of branched isomers of PFOA (Sb-PFOA, branched PFOA isomers), linear PFOS (n-PFOS), and sum of perfluoromethylheptane sulfonate isomers (Sm-PFOS, monomethyl branched PFOS isomers) were measured in serum.

The calculated sum of isomers in the PFAS (formerly PFC) dataset for the 2015-2016 cycle is comparable to the total levels reported in previous cycles of NHANES.

Eligible Sample

Examined participants aged 12 years and older from a one-third sample were eligible.

Description of Laboratory Methodology

Online solid phase extraction coupled to high performance liquid chromatography-turboionspray ionization-tandem mass spectrometry (online SPE-HPLC-TIS-MS/MS) is used for the quantitative detection of PFAS: 2-(N-methyl-perfluorooctane sulfonamido) acetate (Me-PFOSA-AcOH), perfluorohexane sulfonate (PFHxS), n-perfluorooctane sulfonate (n-PFOS), sum of perfluoromethylheptane sulfonate isomers (Sm-PFOS, monomethyl branched isomers of PFOS), n-perfluorooctanoate (n-PFOA), sum of branched perfluorooctanoate isomers (Sb-PFOA, branched PFOA isomers), perfluorononanoate (PFNA), perfluorodecanoate (PFDeA), perfluoroundecanoate (PFUA), and perfluorododecanoate (PFDoA)²¹. Briefly, after dilution with formic acid, one aliquot of 50 µL of serum is injected into a commercial column switching system allowing for concentration of the analytes on solid-phase extraction column. Separation of the analytes from each other and from other serum components is achieved with high-performance liquid chromatography. Detection and quantification are done using

negative-ion TurboIonSpray ionization, a variant of electrospray ionization, tandem mass spectrometry. This method allows for rapid detection of these PFAS in human serum with limits of detection in the low parts per billion (ppb or ng/mL) range.

Refer to the Laboratory Method Files section for a detailed description of the laboratory methods used.

They were no changes to the lab method, lab equipment, or lab site for this component in the NHANES 2015-2016 cycle.

Laboratory Method Files

[Perfluoroalkyl and Polyfluoroalkyl Substances \(PFAS\) Laboratory Procedure Manual](#) (September 2018)

Laboratory Quality Assurance and Monitoring

Serum specimens are processed, stored, and shipped to the Division of Laboratory Sciences, National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA for analysis.

Detailed instructions on specimen collection and processing are discussed in the NHANES [Laboratory Procedures Manual \(LPM\)](#). Vials are stored under appropriate frozen (-20°C) conditions until they are shipped to National Center for Environmental Health for testing.

The NHANES quality assurance and quality control (QA/QC) protocols meet the 1988 Clinical Laboratory Improvement Act mandates. Detailed QA/QC instructions are discussed in the [NHANES LPM](#).

Mobile Examination Centers (MECs)

Laboratory team performance is monitored using several techniques. NCHS and contract consultants use a structured competency assessment evaluation during visits to evaluate both the quality of the laboratory work and the quality-control procedures. Each laboratory staff member is observed for equipment operation, specimen collection and preparation; testing procedures and constructive feedback are given to each staff member. Formal retraining sessions are conducted annually to ensure that required skill levels were maintained.

Analytical Laboratories

NHANES uses several methods to monitor the quality of the analyses performed by the contract laboratories. In the MEC, these methods include performing blind split samples collected on "dry run" sessions. In addition, contract laboratories randomly perform repeat testing on 2% of all specimens.

NCHS developed and distributed a quality control protocol for all CDC and contract laboratories, which outlined the Westgard rules (Westgard, et al. 1981) used when running NHANES specimens. Progress reports containing any problems encountered during shipping or receipt of specimens, summary statistics for each control pool, QC graphs, instrument calibration, reagents, and any special considerations are submitted to NCHS quarterly. The reports are reviewed for trends or shifts in the data. The laboratories are required to explain any identified areas of concern.

All QC procedures recommended by the manufacturers were followed. Reported results for all assays meet the Division of Laboratory Science's quality control and quality assurance performance criteria for accuracy and precision, similar to specifications outlined by Westgard rules (Caudill, et al. 2008).

Data Processing and Editing

The data were reviewed. Incomplete data or improbable values were sent to the performing laboratory for confirmation.

Analytic Notes

Refer to the [2015-2016 Laboratory Data Overview](#) for general information on NHANES laboratory data.

Subsample weights

Serum PFAS were measured in a one-third subsample of persons 12 years and over. Special sample weights are required to analyze these data properly. Specific sample weights for this subsample are included in this data file and should be used when analyzing these data.

Demographic and Other Related Variables

The analysis of NHANES laboratory data must be conducted using the appropriate survey design and demographic variables. The [NHANES 2015-2016 Demographics File](#) contains demographic data, health indicators, and other related information collected during household interviews as well as the sample design variables. The recommended procedure for variance estimation requires use of stratum and PSU variables (SDMVSTRA and SDMVPSU, respectively) in the demographic data file.

The [Fasting Questionnaire File](#) includes auxiliary information, such as fasting status, the time of venipuncture, and the conditions precluding venipuncture.

This laboratory data file can be linked to the other NHANES data files using the unique survey participant identifier (i.e., SEQN).

Detection Limits

The detection limits were constant for all of the analytes in the data set. Two variables are provided for each of these analytes. The variable name ending in "L" (ex., LBDPFHSL) indicates whether the result was below the limit of detection: the value "0" means that the result was at or above the limit of detection, "1" indicates that the result was below the limit of detection. For analytes with analytic results below the lower limit of detection (ex., LBDPFHSL=1), an imputed fill value was placed in the analyte results field. This value is the lower limit of detection divided by square root of 2 ($LLOD/\sqrt{2}$). The other variable prefixed LBX (ex., LBXPFHSL) provides the analytic result for that analyte.

The lower limit of detection (LLOD, in ng/mL) for each PFAS:

Variable Name	SAS Label	LLOD
LBXPFDE	Perfluorodecanoic acid (PFDeA) (ng/mL)	0.10
LBXPFHS	Perfluorohexane sulfonic acid (PFHxS) (ng/mL)	0.10
LBXMPAH	2-(N-methylperfluorooctanesulfonamido)acetic acid (Me-PFOSA-AcOH) (ng/mL)	0.10
LBXPFNA	Perfluorononanoic acid (PFNA) (ng/mL)	0.10
LBXPFUA	Perfluoroundecanoic acid (PFUA) (ng/mL)	0.10
LBXPFDO	Perfluorododecanoic acid (PFDoA) (ng/mL)	0.10
LBXNFOA	n-perfluorooctanoic acid (n-PFOA) (ng/mL)	0.10
LBXBFOA	Branch perfluorooctanoic acid isomers (Sb-PFOA) (ng/mL)	0.10
LBXNFOS	n-perfluorooctane sulfonic acid (n-PFOS) (ng/mL)	0.10
LBXMFOS	Perfluoromethylheptane sulfonic acid isomers (Sm-PFOS) (ng/mL)	0.10

Please refer to the [NHANES Analytic Guidelines](#) and the on-line [NHANES Tutorial](#) for further details on the use of sample weights and other analytic issues.

References

- Benskin JP, De Silva AO, Martin JW. 2010. Isomer Profiling of Perfluorinated Substances as a Tool for Source Tracking: A Review of Early Findings and Future Applications. *Rev Environ Contam Toxicol*:111-160.
- Caudill SP, Schleicher RL, Pirkle JL. Multi-rule quality control for the age-related eye disease study. *Statist Med* 2008;27:4094-4106.
- Vyas SM, Kania-Korwel I, Lehmler HJ. 2007. Differences in the isomer composition of perfluorooctanesulfonyl (PFOS) derivatives. *J Environ Sci Health A Tox Hazard Subst Environ Eng* 42:249-255.
- Westgard JO, Barry PL, Hunt MR, Groth T. A multi-rule Shewhart chart for quality control in clinical chemistry. *Clin Chem.* 1981 Mar;27(3):493-501.


Codebook and Frequencies

SEQN - Respondent sequence number

Variable Name:	SEQN
SAS Label:	Respondent sequence number
English Text:	Respondent sequence number.
Target:	Both males and females 12 YEARS - 150 YEARS

WTSB2YR - Subsample B weights

Variable Name: WTSB2YR
SAS Label: Subsample B weights
English Text: Subsample B weights
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
16425.326175 to 874638.01159	Range of Values	2143	2143	
0 	No Lab Result	27	2170	
.	Missing	0	2170	

LBXPFDE - Perfluorodecanoic acid (ng/mL)

Variable Name: LBXPFDE
SAS Label: Perfluorodecanoic acid (ng/mL)
English Text: Perfluorodecanoic acid (PFDeA) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 6.5	Range of Values	1993	1993	
.	Missing	177	2170	

LBDPFDEL - Perfluorodecanoic acid Comment Code

Variable Name: LBDPFDEL
SAS Label: Perfluorodecanoic acid Comment Code
English Text: Perfluorodecanoic acid (PFDeA) Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1318	1318	
1	Below lower detection limit	675	1993	
.	Missing	177	2170	

LBXPFHS - Perfluorohexane sulfonic acid (ng/mL)

Variable Name: LBXPFHS
SAS Label: Perfluorohexane sulfonic acid (ng/mL)
English Text: Perfluorohexane sulfonic acid (PFHxS) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 23.3	Range of Values	1993	1993	
.	Missing	177	2170	

LBDPFHSL - Perfluorohexane sulfonic acid Comt Code

Variable Name: LBDPFHSL
SAS Label: Perfluorohexane sulfonic acid Comt Code
English Text: Perfluorohexane sulfonic acid (PFHxS) Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1962	1962	
1	Below lower detection limit	31	1993	
.	Missing	177	2170	

LBXMPAH - 2-(N-methyl-PFOSA)acetic acid (ng/mL)

Variable Name: LBXMPAH**SAS Label:** 2-(N-methyl-PFOSA)acetic acid (ng/mL)**English Text:** 2-(N-methylperfluoroctanesulfonamido)acetic acid (Me-PFOSA-AcOH)
(ng/mL)**Target:** Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 4.2	Range of Values	1993	1993	
.	Missing	177	2170	

LBDMPAHL - 2-(N-methyl-PFOSA) acetic acid Comt Code

Variable Name: LBDMPAHL
SAS Label: 2-(N-methyl-PFOSA) acetic acid Comt Code
English Text: 2-(N-methylperfluorooctanesulfonamido)acetic acid (Me-PFOSA-AcOH)
Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	783	783	
1	Below lower detection limit	1210	1993	
.	Missing	177	2170	

LBXPFNA - Perfluorononanoic acid (ng/mL)

Variable Name: LBXPFNA
SAS Label: Perfluorononanoic acid (ng/mL)
English Text: Perfluorononanoic acid (PFNA) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 11	Range of Values	1993	1993	
.	Missing	177	2170	

LBDFPFNAL - Perfluorononanoic acid Comment Code

Variable Name: LBDFPFNAL
SAS Label: Perfluorononanoic acid Comment Code
English Text: Perfluorononanoic acid (PFNA) Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1968	1968	
1	Below lower detection limit	25	1993	
.	Missing	177	2170	

LBXPFUA - Perfluoroundecanoic acid (ng/mL)

Variable Name: LBXPFUA
SAS Label: Perfluoroundecanoic acid (ng/mL)
English Text: Perfluoroundecanoic acid (PFUA) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 4.2	Range of Values	1993	1993	
.	Missing	177	2170	

LBDFPFUAL - Perfluoroundecanoic acid Comment Code

Variable Name: LBDFPFUAL
SAS Label: Perfluoroundecanoic acid Comment Code
English Text: Perfluoroundecanoic acid (PFUA) Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	751	751	
1	Below lower detection limit	1242	1993	
.	Missing	177	2170	

LBXPFDO - Perfluorododecanoic acid (ng/mL)

Variable Name: LBXPFDO
SAS Label: Perfluorododecanoic acid (ng/mL)
English Text: Perfluorododecanoic acid (PFDoA) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 0.3	Range of Values	1993	1993	
.	Missing	177	2170	

LBDPFDOL - Perfluorododecanoic acid comment

Variable Name: LBDPFDOL
SAS Label: Perfluorododecanoic acid comment
English Text: Perfluorododecanoic acid (PFDoA) Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	46	46	
1	Below lower detection limit	1947	1993	
.	Missing	177	2170	

LBXNFOA - n-perfluorooctanoic acid (ng/mL)

Variable Name: LBXNFOA
SAS Label: n-perfluorooctanoic acid (ng/mL)
English Text: n-perfluorooctanoic acid (n-PFOA) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 20.4	Range of Values	1993	1993	
.	Missing	177	2170	

LBDNFOAL - n-perfluorooctanoic acid Comment Code

Variable Name: LBDNFOAL
SAS Label: n-perfluorooctanoic acid Comment Code
English Text: n-perfluorooctanoic acid (n-PFOA) Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1977	1977	
1	Below lower detection limit	16	1993	
.	Missing	177	2170	

LBXBFOA - Br. perfluorooctanoic acid iso (ng/mL)

Variable Name: LBXBFOA**SAS Label:** Br. perfluorooctanoic acid iso (ng/mL)**English Text:** Branch perfluorooctanoic acid isomers (Sb-PFOA) (ng/mL)**Target:** Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 0.5	Range of Values	1993	1993	
.	Missing	177	2170	

LBDBFOAL - Br. perfluorooctanoic acid iso Comt Code

Variable Name: LBDBFOAL
SAS Label: Br. perfluorooctanoic acid iso Comt Code
English Text: Branch perfluorooctanoic acid isomers Comment Code
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	40	40	
1	Below lower detection limit	1953	1993	
.	Missing	177	2170	

LBXNFOS - n-perfluorooctane sulfonic acid (ng/mL)

Variable Name: LBXNFOS
SAS Label: n-perfluorooctane sulfonic acid (ng/mL)
English Text: n-perfluorooctane sulfonic acid (n-PFOS) (ng/mL)
Target: Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 109.9	Range of Values	1993	1993	
.	Missing	177	2170	

LBDNFOSL - n-perfluorooctane sulfonic Comt Code

Variable Name: LBDNFOSL**SAS Label:** n-perfluorooctane sulfonic Comt Code**English Text:** n-perfluorooctane sulfonic acid (n-PFOS) Comment Code**Target:** Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1982	1982	
1	Below lower detection limit	11	1993	
.	Missing	177	2170	

LBXMFOS - Sm-PFOS (ng/mL)

Variable Name: LBXMFOS**SAS Label:** Sm-PFOS (ng/mL)**English Text:** Perfluoromethylheptane sulfonic acid isomers (Sm-PFOS) (ng/mL)**Target:** Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.07 to 19.2	Range of Values	1993	1993	
.	Missing	177	2170	

LBDMFOSL - Sm-PFOS Comment Code

Variable Name: LBDMFOSL**SAS Label:** Sm-PFOS Comment Code**English Text:** Perfluoromethylheptane sulfonic acid isomers (Sm-PFOS) Comment Code**Target:** Both males and females 12 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1970	1970	
1	Below lower detection limit	23	1993	
.	Missing	177	2170	