

# National Health and Nutrition Examination Survey

## 2017-March 2020 Data Documentation, Codebook, and Frequencies

### Perfluoroalkyl and Polyfluoroalkyl Substances (P\_PFAS)

**Data File: P\_PFAS.xpt**

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**Last Revised: NA**

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## Component Description

The NHANES program suspended field operation in March 2020 due to the coronavirus disease 2019 (COVID-19) pandemic. As a result, data collection for the NHANES 2019-2020 cycle was not completed and the collected data are not nationally representative. Therefore, data collected from 2019 to March 2020 were combined with data from the NHANES 2017-2018 cycle to form a nationally representative sample of NHANES 2017-March 2020 pre-pandemic data. These data are available to the public. Please refer to the Analytic Notes section for more details on the use of the data.

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 PFAS 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), the sum of branched isomers of PFOA (Sb-PFOA, branched PFOA isomers), linear PFOS (n-PFOS), and the 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 NHANES 2017-March 2020 pre-pandemic cycle is comparable to the total levels reported in previous cycles of NHANES.

## Eligible Sample

All examined participants aged 12 years and older from a one-third sample in the NHANES 2017-March 2020 pre-pandemic 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), the sum of perfluoromethylheptane sulfonate isomers (Sm-PFOS, monomethyl branched isomers of PFOS), n-perfluorooctanoate (n-PFOA), the 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 TurbolonSpray 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.

## Laboratory Method Files

[Perfluoroalkyl and Polyfluoroalkyl Substances \(PFAS\) Laboratory Procedure Manual](#) (January 2021)

[Perfluoroalkyl and Polyfluoroalkyl Substances \(PFAS\) Laboratory Procedure Manual](#) (May 2024)

## Laboratory Quality Assurance and Monitoring

Serum specimens were 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 [2017-2018](#) and [2019-2020](#) NHANES Laboratory Procedures Manual (LPMs). Vials were stored under appropriate frozen (-30°C) conditions until they are shipped to the National Center for Environmental Health for testing.

The NHANES quality assurance and quality control (QA/QC) protocols meet the 1988 Clinical Laboratory Improvement Amendments 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 during “dry run” sessions. In addition, contract laboratories randomly perform repeat testing on 2% of all specimens.

NCHS developed and distributed a QC protocol for all CDC and contract laboratories, which outlined the use of Westgard rules (Westgard, et. al., 1981) 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 Sciences' QA/QC performance criteria for accuracy and precision, similar to the 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

The COVID-19 pandemic required suspension of NHANES 2019-2020 field operations in March 2020 after data were collected in 18 of the 30 survey locations in the 2019-2020 sample. Data collection was cancelled for the remaining 12 locations. Because the collected data from 18 locations were not nationally representative, these data were combined with data from the previous cycle (2017-2018) to create a 2017-March 2020 pre-pandemic data file. A special weighting process was applied to the 2017-March 2020 pre-pandemic data file. The resulting sample weights in the present file should be used to calculate estimates from the combined cycles. These sample weights are not appropriate for independent analyses of the 2019-2020 data and will not yield nationally representative results for either the 2017-2018 data alone or the 2019-March 2020 data alone. Please refer to the NHANES website for additional information for the NHANES 2017-March 2020 pre-pandemic data, and for the previous 2017-2018 public use data file with specific weights for that 2-year cycle.

Refer to the [2017-2018](#) and [2019-2020](#) Laboratory Data Overview for general information on NHANES laboratory data.

There are over 800 laboratory tests performed on NHANES participants. However, not all participants provided biospecimens or enough volume for all the tests to be performed. The specimen availability can also vary by age or other population characteristics. For example, in 2017-March 2020, approximately 76% of children aged 1-17 years who were examined in the MEC provided a blood specimen through phlebotomy, while 95% of examined adults aged 18 and older provided a blood specimen. Analysts should evaluate the extent of missing data in the dataset related to the outcome of interest as well as any predictor variables used in the analyses to determine whether additional re-weighting for item non-response is necessary.

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.

### 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 [2017- March 2020 Pre-Pandemic Demographic 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, length of fast and the time of 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., LBXPFHS) provides the analytic result for that analyte.

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

| Variable Name | Analyte Description   | 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 |
| 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 |

## Codebook and Frequencies

### SEQN - Respondent sequence number

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

## WTSBAPRP - Subsample BA Weights Pre-Pandemic

**Variable Name:** WTSBAPRP  
**SAS Label:** Subsample BA Weights Pre-Pandemic  
**English Text:** Subsample BA Weights Pre-Pandemic  
**Target:** Both males and females 12 YEARS - 150 YEARS

| Code or Value               | Value Description | Count | Cumulative | Skip to Item |
|-----------------------------|-------------------|-------|------------|--------------|
| 8385.781276 to 1308993.8579 | Range of Values   | 3072  | 3072       |              |
| 0                           | No Lab Result     | 388   | 3460       |              |
| .                           | Missing           | 0     | 3460       |              |

## 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 7.3   | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## LBDFPFDEL - Perfluorodecanoic acid Comment Code

**Variable Name:** LBDFPFDEL  
**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 | 2479  | 2479       |              |
| 1             | Below lower detection limit     | 593   | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 48.8  | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |



## 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 | 3030  | 3030       |              |
| 1             | Below lower detection limit     | 42    | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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-methylperfluorooctanesulfonamido)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 4.5   | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## 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 | 1528  | 1528       |              |
| 1             | Below lower detection limit     | 1544  | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 7     | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## 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 | 2912  | 2912       |              |
| 1             | Below lower detection limit     | 160   | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 4.8   | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## LBDPFUAL - Perfluoroundecanoic acid Comment Code

**Variable Name:** LBDPFUAL  
**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 | 1796  | 1796       |              |
| 1             | Below lower detection limit     | 1276  | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 52.8  | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |



## 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 | 3058  | 3058       |              |
| 1             | Below lower detection limit     | 14    | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 0.7   | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## 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 | 192   | 192        |              |
| 1             | Below lower detection limit     | 2880  | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 95.1  | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## 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 | 3059  | 3059       |              |
| 1             | Below lower detection limit     | 13    | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |

## 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 19.3  | Range of Values   | 3072  | 3072       |              |
| .             | Missing           | 388   | 3460       |              |

## 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 | 3031  | 3031       |              |
| 1             | Below lower detection limit     | 41    | 3072       |              |
| .             | Missing                         | 388   | 3460       |              |