

National Health and Nutrition Examination Survey

2017-March 2020 Data Documentation, Codebook, and Frequencies

Flame Retardants - Urine (P_FR)

Data File: P_FR.xpt

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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.

Flame retardants (FRs) are either additive or reactive ingredients applied to household and consumer products to reduce the products flammability, and to meet state and federal fire safety standards and regulations. Until recently, a dominant class of FR additives used for household products was polybrominated diphenyl ethers (PBDEs), which are persistent and can accumulate in the environment (de Wit 2002; Law et. al., 2006, Stapleton et. al., 2012). Flame retardant formulations containing chlorinated and non-chlorinated organophosphates and non-PBDE brominated chemicals have entered consumers' markets as PBDEs have been phased-out in many countries (van der Veen and de Boer 2012). Some of these compounds used in flame retardant formulations are: triphenyl phosphate, tris(1,3-dichloro-2-propyl) phosphate, tris(1-chloro-2-propyl) phosphate, tris(2-chloroethyl) phosphate, tri-cresyl phosphates, tributyl phosphate, tribenzyl phosphate, and 2-ethylhexyl-2,3,4,5-tetrabromobenzoate. NHANES recently developed a method to measure the metabolites of these compounds, which can be used as exposure biomarkers: diphenyl phosphate, bis(1,3-dichloro-2-propyl) phosphate, bis(1-chloro-2-propyl) phosphate, bis-2-chloroethyl phosphate, dibutyl phosphate, and 2,3,4,5-tetrabromobenzoic acid.

Eligible Sample

All examined participants aged 3 to 5 years and a one-third subsample of examined participants aged 6 years and older were eligible in the NHANES 2017-March 2020 pre-pandemic sample.

Description of Laboratory Methodology

The method uses 0.2 mL urine and is based on enzymatic hydrolysis of urinary conjugates of the target analytes, automated off-line solid phase extraction, reversed phase high-performance liquid chromatography separation, and isotope dilution-electrospray ionization tandem mass spectrometry detection (Jayatilaka et. al., 2019).

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

Laboratory Method Files

[Flame Retardants-Urine Laboratory Procedure Manual \(March 2022\)](#)

[Flame Retardants-Urine Laboratory Procedure Manual \(May 2023\)](#)

Laboratory Quality Assurance and Monitoring

Urine 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 [2017-2018](#) and [2019-2020](#) NHANES Laboratory Procedures Manuals (LPM). Vials were stored under appropriate frozen (-30°C) conditions until they were 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 QC 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. 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

Urinary flame retardants were measured in a full sample of examined participants aged 3-5 and a one-third subsample of participants 6 years and older. 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.

For participants aged 3-5, their sample weights in this dataset (i.e., WTSBPRP) are equivalent to their MEC exam sample weights. These participants have completed at least one physical exam component in the MEC; therefore, they all have an exam sample weight larger than "0," regardless of their lab test results. For participants 6 years and older in the dataset, special sample weights were created for the subsample and encoded in variable WTSBPRP. These special weights accounted for the additional probability of selection into the subsample, as well as the additional nonresponse to these lab tests. Therefore, if participants 6 years and older were selected as part of the one-third subsample, but did not provide a urine specimen, they would have the sample weight value assigned as "0" in their records.

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 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.

This laboratory data file can be linked to the other NHANES data files using the unique survey participant identifier 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 named ending in "LC" (ex., URDBCPLC) 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. The other variable prefixed URX (ex, URXBCPP) provides the analytic result for the analyte. For analytes with analytic results below the lower limit of detection (ex., URDBCPLC=1), an imputed fill value was placed in the analyte results field. This value is the lower limit of detection divided by the square root of 2 (LLOD/sqrt [2]).

The lower limit of detection (LLOD, in ng/mL) for urinary flame retardants:

VARIABLE NAME	ANALYTE DESCRIPTION	LLOD
URXBCPP	Bis(1-chloro-2-propyl) phosphate (ng/mL)	0.10
URXBCEP	Bis-2-chloroethyl phosphate (ng/mL)	0.10
URXBDCP	Bis(1,3-dichloro-2-propyl) phosphate (ng/mL)	0.10
URXDBUP	Dibutyl phosphate (ng/mL)	0.10
URXDPHP	Diphenyl phosphate (ng/mL)	0.10
URXTBBA	2,3,4,5-tetrabromobenzoic acid (ng/mL)	0.05

References

- Caudill, S.P., Schleicher, R.L., Pirkle, J.L. Multi-rule quality control for the age-related eye disease study. *Statist. Med.* (2008) 27(20):4094-40106.
- de Wit CA (2002). An overview of brominated flame retardants in the environment. *Chemosphere* 46 (5):583-624.
- Jayatilaka NK, Restrepo P, Davis Z, Vidal M, Calafat AM, Ospina M. (2019). Quantification of 16 urinary biomarkers of exposure to flame retardants, plasticizers, and organophosphate insecticides by solid phase extraction- high performance liquid chromatography-tandem mass spectrometry. Submitted for publication.
- Law RJ, Allchin CR, de Boer J, Covaci A, Herzke D, Lepom P, et al. (2006). Levels and trends of brominated flame retardants in the European environment. *Chemosphere* 64:187–208.
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- van der Veen I, de Boer J (2012). Phosphorus flame retardants: Properties, production, environmental occurrence, toxicity and analysis. *Chemosphere* 88 (10):1119-1153.
- 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 3 YEARS - 150 YEARS

WTSBPRP - Subsample B Weights Pre-Pandemic

Variable Name: WTSBPRP
SAS Label: Subsample B Weights Pre-Pandemic
English Text: Subsample B Weights Pre-Pandemic
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
2462.026927 to 981259.61533	Range of Values	4646	4646	
0	Participants 3+ years with no lab specimen	283	4929	
.	Missing	0	4929	

URXBCPP - Bis (1-chloro-2-propyl) Phosphate

Variable Name: URXBCPP
SAS Label: Bis (1-chloro-2-propyl) Phosphate
English Text: Bis (1-chloro-2-propyl) Phosphate
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.0707 to 26.1	Range of Values	4617	4617	
.	Missing	312	4929	

URDBCPLC - Bis (1-chloro-2-propyl) Phosphate Comt

Variable Name: URDBCPLC
SAS Label: Bis (1-chloro-2-propyl) Phosphate Comt
English Text: Bis (1-chloro-2-propyl) Phosphate Comment Code
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	2006	2006	
1	Below lower detection limit	2611	4617	
.	Missing	312	4929	

URXBCEP - Bis-2-chloroethyl Phosphate

Variable Name: URXBCEP
SAS Label: Bis-2-chloroethyl Phosphate
English Text: Bis-2-chloroethyl Phosphate
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.0707 to 268	Range of Values	4618	4618	
.	Missing	311	4929	

URDCEPLC - Bis-2-chloroethyl Phosphate Comt Code

Variable Name: URDCEPLC
SAS Label: Bis-2-chloroethyl Phosphate Comt Code
English Text: Bis-2-chloroethyl Phosphate Comt Code
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	3420	3420	
1	Below lower detection limit	1198	4618	
.	Missing	311	4929	

URXBDCP - Bis (1,3-dichloro-2-propyl) Phosphate

Variable Name: URXBDCP
SAS Label: Bis (1,3-dichloro-2-propyl) Phosphate
English Text: Bis (1,3-dichloro-2-propyl) Phosphate
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.0707 to 260	Range of Values	4599	4599	
.	Missing	330	4929	

URDBDCLC - Bis (1,3-dichloro-2-propyl) Phosph Comt

Variable Name: URDBDCLC
SAS Label: Bis (1,3-dichloro-2-propyl) Phosph Comt
English Text: Bis (1,3-dichloro-2-propyl) Phosphate Comment Code
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	4485	4485	
1	Below lower detection limit	114	4599	
.	Missing	330	4929	

URXDBUP - Dibutyl Phosphate

Variable Name: URXDBUP
SAS Label: Dibutyl Phosphate
English Text: Dibutyl Phosphate
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.0707 to 62.3	Range of Values	4614	4614	
.	Missing	315	4929	

URDDUPLC - Dibutyl Phosphate Comment Code

Variable Name: URDDUPLC
SAS Label: Dibutyl Phosphate Comment Code
English Text: Dibutyl Phosphate Comment Code
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	2463	2463	
1	Below lower detection limit	2151	4614	
.	Missing	315	4929	

URXDPHP - Diphenyl Phosphate

Variable Name: URXDPHP
SAS Label: Diphenyl Phosphate
English Text: Diphenyl Phosphate
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.0707 to 270	Range of Values	4622	4622	
.	Missing	307	4929	

URDDPHLC - Diphenyl Phosphate Comment Code

Variable Name: URDDPHLC
SAS Label: Diphenyl Phosphate Comment Code
English Text: Diphenyl Phosphate Comment Code
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	4485	4485	
1	Below lower detection limit	137	4622	
.	Missing	307	4929	

URXTBBA - 2,3,4,5-tetrabromobenzoic Acid

Variable Name: URXTBBA
SAS Label: 2,3,4,5-tetrabromobenzoic Acid
English Text: 2,3,4,5-tetrabromobenzoic Acid
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.0354 to 1.36	Range of Values	4622	4622	
.	Missing	307	4929	

URDBBALC - 2,3,4,5-tetrabromobenzoic Acid Comt Code

Variable Name: URDBBALC
SAS Label: 2,3,4,5-tetrabromobenzoic Acid Comt Code
English Text: 2,3,4,5-tetrabromobenzoic Acid Comment Code
Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	353	353	
1	Below lower detection limit	4269	4622	
.	Missing	307	4929	