National Health and Nutrition Examination Survey

2017-March 2020 Data Documentation, Codebook, and Frequencies

Perchlorate, Nitrate & Thiocyanate - Urine (P_PERNT)

Data File: P_PERNT.xpt

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Component Description

The NHANES program suspended field operations 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.

Urinary Perchlorate

Perchlorate has been used as an oxidant in solid fuel propellants for rockets and missiles since the 1950s. Lesser amounts of perchlorate are used in matches and fireworks. Perchlorate can also form naturally in the environment and can accumulate in nitrate-rich mineral deposits mined for use in fertilizers. Drinking water, milk, and certain plants with high water content (e.g., lettuce) can be the main sources of perchlorate intake for humans. Perchlorate has been used medically to treat hyperthyroidism. Its inhibitory effect on thyroid hormone production has led to concerns that exposure even to low levels of perchlorate in the environment might affect vulnerable groups, such as pregnant women with inadequate iodine intake and infants for whom thyroid hormone levels must be maintained adequately for normal brain development. Perchlorate taken into the body is rapidly eliminated in the urine, within a matter of hours. Measurement of urinary perchlorate is useful to assess recent human exposure.

Urinary Nitrate and Thiocyanate

Nitrate and thiocyanate are polyatomic anions that can disrupt thyroid function by competitively inhibiting iodide uptake, similar to the action of perchlorate. Nitrate, thiocyanate, and perchlorate can reversibly bind to the sodium-iodide symporter (NIS) protein resulting in reduced iodine absorption by the thyroid. Nitrate, thiocyanate, and perchlorate interact additively to impair iodide uptake by the thyroid. Therefore, assessment of the impact of perchlorate exposure on thyroid function should include assessment of nitrate and thiocyanate exposure. By assessing exposure to each of the three physiologically relevant NIS-inhibitors, the relative impact of each chemical on thyroid function can be estimated and appropriate regulatory action taken if exposures are negatively impacting thyroid hormone levels. Impaired thyroid function can lead to hypothyroidism, proliferative thyroid lesions, and impaired neurodevelopment in infants.

Nitrate poisoning can also lead to methemoglobinemia, primarily in infants. The prevalence of nitrate exposure is likely due to nitrate intake from both food and drinking water, with foods (e.g., vegetables, milk, dairy products) thought to account for the majority of nitrate intake for typical American adults. Nitrate anion can also form endogenously. Public health prevention efforts have reduced the prevalence of methemoglobinemia in the United States. A reference range for urinary nitrate will provide useful information relevant to nitrate poisoning and subclinical methemoglobinemia in the U.S.

Thiocyanate is also a biomarker of cyanide exposure from tobacco smoke or diet. Thiocyanate primarily forms in the body as a metabolite of cyanide from tobacco smoke or cyanogenic foods, such as cassava. Exposure to toxic levels of cyanide can result from numerous chemical reactions. Lower levels of thiocyanate

can also be found in milk, dairy products, and some vegetables. Therefore, a defined reference range for thiocyanate will provide useful benchmark data in case of a cyanide exposure event.

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

This method is a quantitative procedure for the measurement of nitrate, perchlorate, and thiocyanate in human urine using ion chromatography coupled with electrospray tandem mass spectrometry. Chromatographic separation is achieved using an IonPac AS16 column with sodium hydroxide as the eluent. The eluent from the column is ionized using an electrospray interface to generate and transmit negative ions into the mass spectrometer. Comparison of relative response factors (ratio of native analyte to stable isotope labeled internal standard) with known standard concentrations yields individual analyte concentrations.

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

Laboratory Method Files

Urinary Perchlorate, Nitrate, and Thiocyanate Laboratory Procedure Manual (2017-2018) (September 2022)

Urinary Perchlorate, Nitrate, and Thiocyanate Laboratory Procedure Manual (2019-2020) (September 2023)

Laboratory Quality Assurance and Monitoring

Urine 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. Vials were stored under appropriate frozen (–30°C) conditions until they were 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 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 on “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 testing 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. The 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

Perchlorate, nitrate, and thiocyanate in urine were measured in 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.

The analytes included in this dataset were measured for all examined participants aged 3 to 5 years, and in a one-third subsample of participants 6 years and older. For participants aged 3 to 5 their WTSAPRP 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, special sample weights were created for the subsample. 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 participant 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 record.

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 Data 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 (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 named ending in “LC” (ex., URDUP8LC) 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., URXUP8) provides the analytic result for that analyte. For analytes with analytic results below the lower limit of detection (ex., URDUP8LC=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 limits of detection (LLOD, in ng/mL) for urinary perchlorate, nitrate, and thiocyanate:

VARIABLE NAME	ANALYTE DESCRIPTION	LLOD
URXUP8	Perchlorate, urine (ng/mL)	0.05
URXNO3	Nitrate, urine (ng/mL)	700
URXSCN	Thiocyanate, urine (ng/mL)	20

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.
- Westgard J.O., Barry P.L., Hunt M.R., Groth T. A multi-rule Shewhart chart for quality control in clinical chemistry. Clin Chem (1981) 27:493-501.

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

WTSAPRP - Subsample A Weights Pre-Pandemic

Variable Name: WTSAPRP

SAS Label: Subsample A Weights Pre-Pandemic

English Text: Subsample A Weights

Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
2395.195359 to 955677.30961	Range of Values	4727	4727	
0	Participants 3+ years with no Lab Result	163	4890	
.	Missing	0	4890	

URXUP8 - Perchlorate, urine (ng/mL)

Variable Name: URXUP8

SAS Label: Perchlorate, urine (ng/mL)

English Text: Perchlorate, urine (ng/mL)

Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.109 to 200	Range of Values	4499	4499	
.	Missing	391	4890	

URDUP8LC - Perchlorate, urine Comment Code

Variable Name: URDUP8LC

SAS Label: Perchlorate, urine Comment Code

English Text: Perchlorate, urine 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	4499	4499	
1	Below lower detection limit	0	4499	
.	Missing	391	4890	

URXNO3 - Nitrate, urine (ng/mL)

Variable Name: URXNO3

SAS Label: Nitrate, urine (ng/mL)

English Text: Nitrate, urine (ng/mL)

Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
495 to 656000	Range of Values	4498	4498	
.	Missing	392	4890	

URDNO3LC - Nitrate, urine Comment Code

Variable Name: URDNO3LC

SAS Label: Nitrate, urine Comment Code

English Text: Nitrate, urine 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	4491	4491	
1	Below lower detection limit	7	4498	
.	Missing	392	4890	

URXSCN - Thiocyanate, urine (ng/mL)

Variable Name: URXSCN

SAS Label: Thiocyanate, urine (ng/mL)

English Text: Thiocyanate, urine (ng/mL)

Target: Both males and females 3 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
14.1421 to 93700	Range of Values	4499	4499	
.	Missing	391	4890	

URDSCNLC - Thiocyanate, urine Comment Code

Variable Name: URDSCNLC

SAS Label: Thiocyanate, urine Comment Code

English Text: Thiocyanate, urine 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	4496	4496	
1	Below lower detection limit	3	4499	
.	Missing	391	4890	