National Health and Nutrition Examination Survey

2017-March 2020 Data Documentation, Codebook, and Frequencies

Chromium & Cobalt (P_CRCO)

Data File: P_CRCO.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.

Chromium

Chromium (Cr) is a naturally occurring element whose nutritional bioavailability and toxicity depends on its oxidation state. Trivalent chromium is considered an essential nutrient while hexavalent chromium is a human carcinogen and a commonly encountered occupational hazard for humans (Anderson 1989, ATSDR 2000).

Cobalt

Cobalt (Co) is considered essential because it is part of the B12 vitamin, which is important for the human brain and nervous center functioning and cell metabolism (ATSDR 2000, Burtis et. al., 2012). While it is essential at certain lower levels, exposures to high levels of cobalt can affect the heart and/or lungs. Elevated exposures in animals have been shown to affect the liver and kidneys. The Agency for Toxic Substances and Disease Registry (ATSDR) lists cobalt as a possible carcinogen to animals due to research performed by the International Agency for Research on Cancer where direct contact with cobalt occurred (ATSRD 2000). It is uncertain whether or not the effects seen in animals will also be seen in humans, and this uncertainty adds additional concerns with a problem seen with failed metal-on-metal (MoM) hip implants.

Eligible Sample

Examined participants aged 40 years and older in the NHANES 2017-March 2020 pre-pandemic sample were eligible.

Description of Laboratory Methodology

Chromium and Cobalt

The concentrations of chromium (^{52}Cr) and cobalt (^{59}Co) in whole blood specimens are directly measured using inductively coupled plasma mass spectrometry (ICP-MS). This analytical technique is based on analyte detection using quadrupole ICP-MS technology, including Kinetic Energy Discrimination (KED) technology which minimizes or eliminates many argon-based polyatomic interferences. Although it is unnecessary to measure cobalt in KED mode, both cobalt and chromium are measured in KED mode to reduce the stabilization time between modes (Sampson et. al., 2012). The sample goes through a nebulizer where it is converted into aerosol upon entering the spray chamber. Carried by a stream of argon gas, a portion of the aerosol is transported through the spray chamber and then through the central channel of the plasma where it is heated to temperatures of approximately 6000-8000°K. This thermal energy atomizes and ionizes the sample. The ions and the argon enter the mass spectrometer through an interface that separates the ICP (operating at atmospheric pressure of approximately 760 torr), from the mass spectrometer (operating at

approximately 10^{-5} torr). Once inside the mass spectrometer, the ions pass through the ion optics, which uses an electrical field to focus the ion beam into the collision cell (QCell™). The QCell™ is pressurized with an appropriate reaction gas (in this case helium) and contains a flatapole quadrupole system. Elimination or reduction of argon-based polyatomic interferences takes place through the interaction of the reaction gas with the interfering polyatomic species in the incoming ion beam. The ions go from the collision cell to the mass-analyzing quadrupole before striking the surface of the detector. Once ions pass through the cell and are electrically selected for passage through the analytical quadrupole, electrical signals resulting from the ions striking the detector are processed into digital information that is used to indicate the intensity of the ions. The intensity of ions detected while aspirating an unknown sample is translated into an elemental concentration through comparison of the analyte to internal standard signal ratio of the unknown with the ratio obtained when aspirating calibration standards. This method is a variation of IRAT's method used to analyze lead, cadmium, mercury, manganese, and selenium in whole blood, which was originally based on the method by Lutz et. al.

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

Laboratory Method Files

Chromium and Cobalt (June 2020)

Chromium and Cobalt (November 2021)

Laboratory Quality Assurance and Monitoring

Whole blood 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 NHANES 2017-2018 and 2019-2020 Laboratory Procedures Manuals (LPMs). Vials are stored under appropriate frozen (-30°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 LPMs.

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 Environmental Health 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.

Two variables were created in this data file. The variables were created using the following formulas:

LBDBCRSI: The chromium value in mg/L (LBXBCR) was converted to nmol/L (LBDCRSI) by multiplying LBXBCR by 19.23 (rounded to 2 decimal points).

LBDBCOSI: The cobalt value in mg/L (LBXBC0) was converted to nmol/L (LBDCOSI) by multiplying LBXBCO by 16.97 (rounded to 2 decimal points).

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 demographic data 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 documents 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 age 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.

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 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, 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 “LC” (ex., LBXBCRLC) 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 LBX (ex., LBXBCR) provides the analytic result for that analyte. For analytes with analytic results below the lower limit of detection (ex., LBXBCRLC=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 µg/L for Chromium and Cobalt:

Variable Name	Analyte Description	LLOD
LBXBCR	Chromium	0.41 µg/L
LBXBCO	Cobalt	0.06 µg/L

References

- Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for Chromium. Atlanta, G.U.S.D.o.H.a.H.S., Public Health Service. , Toxicological Profile for Chromium, ATSDR, http://www.atsdr.cdc.gov/toxprofiles/tp7.pdf.
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- Lutz TM, Nirel PMV, and Schmidt B, Whole-blood analysis by ICP-MS. Applications of Plasma Source Mass Spectrometry, ed. G. Holland and A.N. Eaton: 1991, Cambridge: Royal Soc Chemistry. 96-100.
- Sampson B and Hart A. Clinical usefulness of blood metal measurements to assess the failure of metal-on-metal hip implants. Annals of Clinical Biochemistry. 2012: 49: 118-131.
- 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 40 YEARS - 150 YEARS

LBXBCR - Chromium (ug/L)

Variable Name: LBXBCR

SAS Label: Chromium (ug/L)

English Text: Chromium (ug/L)

Target: Both males and females 40 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.29 to 18.81	Range of Values	5647	5647	
.	Missing	302	5949	

LBDBCRSI - Chromium (nmol/L)

Variable Name: LBDBCRSI

SAS Label: Chromium (nmol/L)

English Text: Chromium (nmol/L)

Target: Both males and females 40 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
5.58 to 361.72	Range of Values	5647	5647	
.	Missing	302	5949	

LBDBCRLC - Chromium Comment Code

Variable Name: LBDBCRLC

SAS Label: Chromium Comment Code

English Text: Chromium Comment Code

Target: Both males and females 40 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	1011	1011	
1	Below lower detection limit	4636	5647	
.	Missing	302	5949	

LBXBCO - Cobalt (ug/L)

Variable Name: LBXBCO

SAS Label: Cobalt (ug/L)

English Text: Cobalt (ug/L)

Target: Both males and females 40 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.04 to 29.71	Range of Values	5650	5650	
.	Missing	299	5949	

LBDBCOSI - Cobalt (nmol/L)

Variable Name: LBDBCOSI

SAS Label: Cobalt (nmol/L)

English Text: Cobalt (nmol/L)

Target: Both males and females 40 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0.68 to 504.18	Range of Values	5650	5650	
.	Missing	299	5949	

LBDBCOLC - Cobalt Comment Code

Variable Name: LBDBCOLC

SAS Label: Cobalt Comment Code

English Text: Cobalt Comment Code

Target: Both males and females 40 YEARS - 150 YEARS

Code or Value	Value Description	Count	Cumulative	Skip to Item
0	At or above the detection limit	5399	5399	
1	Below lower detection limit	251	5650	
.	Missing	299	5949	