National Health and Nutrition Examination Survey

2015-2016 Data Documentation, Codebook, and Frequencies

Chromium & Cobalt (CRCO_I)

Data File: CRCO_I.xpt

First Published: September 2017

Last Revised: NA

Component Description

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 (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 were eligible.

Description of Laboratory Methodology

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 [9]. 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 (September 2017)

Laboratory Quality Assurance and Monitoring

Whole blood samples 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 (-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 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 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 Environmental Health Laboratory Sciences’ quality control and quality assurance 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

Refer to the 2015 - 2016 Laboratory Data Overview for general information on NHANES laboratory data.

This is a newly released component in the NHANES 2015-2016 cycle.

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.

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. 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 other variable prefixed URX (ex., LBXBCR) provides the analytic result for that analyte.

The lower limit of detection (LLOD) in µg/L for Chromium and Cobalt:

Variable Name	SAS Label	LLOD
LBXBCR	Chromium	0.41 µg/L
LBXBCO	Cobalt	0.06 µg/L

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

- 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. Available from: http://www.atsdr.cdc.gov/toxprofiles/tp7.pdf
- Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for Cobalt. Atlanta, G.U.S.D.o.H.a.H.S., Public Health Service., Toxicological Profile for Cobalt, ATSDR, Editor. 2004. Available from: http://www.atsdr.cdc.gov/toxfaqs/tfacts33.pdf
- Anderson RA. Essentiality of chromium in humans. Sci. Total Environ.: 1989: 86: 75-81.
- Burtis CA, Ashwood ER, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 2012, St. Louis, MO: Elsevier, 944-948.
- 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.
- 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 6.24	Range of Values	3442	3442	
.	Missing	168	3610	

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 120	Range of Values	3442	3442	
.	Missing	168	3610	

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	610	610	
1	Below lower detection limit	2832	3442	
.	Missing	168	3610	

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
0.06 to 14.75	Range of Values	3454	3454	
.	Missing	156	3610	

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
1.02 to 250.31	Range of Values	3454	3454	
.	Missing	156	3610	

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	3454	3454	
1	Below lower detection limit	0	3454	
.	Missing	156	3610	