

National Health and Nutrition Examination Survey 2001–2002

Documentation, Codebook, and Frequencies

Laboratory Component:
Volatile Organic Compounds in
Blood and Water

Survey Years:
2001 to 2002

SAS Export File:
L04VOC_B.XPT



First Published: April 2008
Last revised: N/A

NHANES 2001-2002 Data Documentation

Laboratory Assessment: Lab 4 - Volatile Organic Compounds in Blood and Water (L04VOC_B)

Years of Coverage: 2001–2002

First Published: April 2008

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Component Description

Volatile Organic Compounds (Human Blood)

Exposure to volatile organic compounds (VOCs) is ubiquitous. Chronic exposure to extremely high levels of some VOCs can lead to cancer and neurocognitive dysfunction (1,2).

Nearly 200 air toxics have been associated with adverse health effects in occupational studies or laboratory studies, but have not been monitored in general population groups. Information on levels of exposure to these compounds as measured by their levels in blood is essential to determine the need for regulatory mechanisms to reduce the levels of hazardous air pollutants to which the general population is exposed.

Volatile Organic Compounds (Home Tap Water)

In addition to assessing levels of VOCs in blood, VOC levels will be measured in home tap water specimens provided by NHANES participants. Specifically, trihalomethanes (THMs) and the fuel additive methyl tertiary-butyl ether (MTBE) are measured in these samples.

Eligible Sample

Participants aged 20 to 59 years on a one-third sample were tested.

Description of Laboratory Methodology

Measurements of Trihalomethanes (THMs) and MTBE in Tap Water

The prevalence of water disinfection by-products in drinking water supplies has raised concerns about possible health effects from chronic exposure to these compounds. The objective is to support studies exploring the relationship between exposure to THMs and health effects.

This automated analytical method uses headspace solid-phase microextraction (SPME) coupled with capillary gas chromatography and mass spectrometry (3). This method quantifies trace levels of THMs (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) and MTBE in tap water. Detection limits of less

than 100 pg/mL for all analytes and linear ranges of three orders of magnitude are adequate for measuring the THMs in tap water samples tested from across the United States. THMs are stable for extended periods in tap water samples after quenching of residual chlorine and buffering to pH 6.5, thus enabling larger epidemiologic field studies with simplified sample collection protocols.

Measurements of THMs and MTBE in Whole Blood

The prevalence of water disinfection by-products (e.g. THMs) in tap water has raised concerns about possible health effects from chronic exposure to these compounds. Exposure to the fuel oxygenate MTBE has also raised concerns. People can be exposed to THMs and MTBE through a variety of sources, including use of household tap water that contains these chemicals. The objective of this study is to support studies exploring the relationship between health effects and exposure to THMs and MTBE. THMs and MTBE were quantified in human blood using capillary gas chromatography (GC) and high-resolution mass spectrometry (MS) with selected ion mass detection and isotope-dilution techniques (4). This method quantified trace levels of THMs (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) and MTBE in human blood. Analyte responses were adequate for measuring background levels after extraction of these volatile organic compounds with either purge-and-trap extraction or headspace SPME. Detection limits ranged from 0.3–2.4 pg/mL, with linear ranges of three orders of magnitude. This method provided adequate sensitivity for measuring the THMs and MTBE in most blood samples tested from diverse U.S. reference population.

Measurements of other VOCs in Whole Blood

An additional 11 VOCs were measured in human blood using SPME in conjunction with gas chromatography and bench top quadrupole mass spectrometer (5). A combination of SPME and multiple single-ion monitoring minimizes the interferences and chemical noise associated with whole-blood samples. Detection limits are below 50 ppt (pg/mL) for a majority of the VOCs tested.

Laboratory Quality Control and Monitoring

The NHANES quality control and quality assurance protocols (QA/QC) meet the 1988 Clinical Laboratory Improvement Act mandates. Detailed quality control and quality assurance instructions are discussed in the NHANES Laboratory/Medical Technologists Procedures Manual (LPM). Read the LABDOC file for detailed QA/QC protocols.

Data Processing and Editing

Specimens were processed, stored and shipped to Division of Laboratory Sciences, National Center for Environmental Health, National Centers for Disease Control and Prevention, Atlanta, Georgia. Detailed specimen collection and processing instructions are discussed in the NHANES Laboratory/Medical Technologists Procedures Manual (LPM). Read the LABDOC file for detailed data processing and editing protocols. The analytical methods are described in the Description of the Laboratory Methodology section.

Analytic Notes

Measures of volatile organic compounds in blood and water were assessed in participants aged 20 to 59 on a one-third sample. Use the special weights included in this data file when analyzing data. See the following paragraphs before beginning analysis.

The analysis of NHANES 2001-2002 laboratory data must be conducted with the key survey design and basic demographic variables. The NHANES 2001-2002 Household Questionnaire Data Files contain demographic data, health indicators, and other related information collected during household interviews. They also contain all survey design variables and sample weights for these age groups. The phlebotomy file includes auxiliary information such as the conditions precluding venipuncture. The household questionnaire and phlebotomy files may be linked to the laboratory data file using the unique survey participant identifier SEQN.

The detection limit was variable for many of the analytes in the data set. In addition two variables are provided for each of these analytes. The variable named LBD__LC indicates whether the result was below the limit of detection. There are three values: "0", "1", and "2". "0" means that the result was at or above the limit of detection. "1" indicates that the result was below the limit of detection. "2" means the result was above the limit of detection. The other variable named LBX__ provides the analytic result for that analyte. In cases, where the result was below the limit of detection, the value for that variable is the detection limit divided by the square root of two.

Special sample weights are required to analyze these data properly. Use the special weights included in this data file when analyzing data. Please refer to the Analytic Guidelines for further details on the use of sample weights and other analytic issues.

References TBD

Locator Fields

Title: Volatile Organic Compounds in Blood and Water

Contact Number: 1-866-441-NCHS

Years of Content: 2001–2002

First Published: March 2008

Revised: N/A

Access Constraints: None

Use Constraints: None

Geographic Coverage: National

Subject: Volatile Organic Compounds in Blood and Water

Record Source: NHANES 2001–2002

Survey Methodology: NHANES 2001–2002 is a stratified multistage probability sample of the civilian non-institutionalized population of the U.S.

Medium: NHANES Web site; SAS transport files

**National Health and Nutrition Examination Survey
Codebook for Data Production (2001-2002)**

**Volatile Organic Compounds in Blood and Water (L04VOC_B)
Person Level Data**

First Published: April 2008

Last Revised: N/A



SEQN	Target
	B(20 Yrs. to 59 Yrs.)
Hard Edits	SAS Label
	Respondent sequence number
English Text: Respondent sequence number.	
English Instructions:	

WTSVOC2Y	Target
	B(20 Yrs. to 59 Yrs.)
Hard Edits	SAS Label
	VOC subsample 2 yr MEC Weight
English Text: VOC subsample 2 yr MEC Weight	
English Instructions:	

Code or Value	Description	Count	Cumulative	Skip to Item
0 to 576402.46313	Range of Values	1449	1449	
.	Missing	0	1449	

WTSVOC4Y	Target
	B(20 Yrs. to 59 Yrs.)
Hard Edits	SAS Label
	VOC subsample 4 yr MEC Weight
English Text: VOC subsample 2 yr MEC Weight	
English Instructions:	

Code or Value	Description	Count	Cumulative	Skip to Item
0 to 345630.72173	Range of Values	1449	1449	
.	Missing	0	1449	

LBXWBF	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Water Bromoform (ng/mL)			
English Text: Water Bromoform Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0337 to 41	Range of Values	1153	1153	
.	Missing	296	1449	

LBDWBFLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Water Bromoform Comment Code			
English Text: Water Bromoform Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	696	696	
1	below detectable limit	456	1152	
2	detectable result and exceeds the calibrated range of assay	1	1153	
.	Missing	296	1449	

LBXWCF	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Water Chloroform (ng/mL)			
English Text: Water Chloroform Result				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0849 to 147	Range of Values	1153	1153	
.	Missing	296	1449	

LBDWCFLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Water Chloroform Comment Code			
English Text: Water Chloroform Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	1003	1003	
1	below detectable limit	150	1153	
2	detectable result and exceeds the calibrated range of assay	0	1153	
.	Missing	296	1449	

LBXWBM	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Water Bromodichloromethane (ng/mL)			
English Text: Water Bromodichloromethane Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0354 to 32	Range of Values	1144	1144	
.	Missing	305	1449	

LBDWBMLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Water Bromodichloromethane Comment Code			
English Text: Water Bromodichloromethane Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	1018	1018	
1	below detectable limit	126	1144	
2	detectable result and exceeds the calibrated range of assay	0	1144	
.	Missing	305	1449	

LBXWCM	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Water Dibromochloromethane (ng/mL)			
English Text: Water Dibromochloromethane Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0707 to 36.2	Range of Values	1170	1170	
.	Missing	279	1449	

LBDWCMLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Water Dibromochloromethane Comment Code			
English Text: Water Dibromochloromethane Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	1014	1014	
1	below detectable limit	156	1170	
2	detectable result and exceeds the calibrated range of assay	0	1170	
.	Missing	279	1449	

LBXWME	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Water MTBE (ng/mL)			
English Text: Water Methyl tert. butyl ether (MTBE) Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0499 to 1.9	Range of Values	1139	1139	
.	Missing	310	1449	

LBDWMELC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Water MTBE Comment Code			
English Text: Water Methyl tert. butyl ether (MTBE) Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	277	277	
1	below detectable limit	862	1139	
2	detectable result and exceeds the calibrated range of assay	0	1139	
.	Missing	310	1449	

LBXV4C	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Tetrachloroethene (ng/mL)			
English Text: Blood Tetrachloroethene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0187 to 33.8	Range of Values	1109	1109	
.	Missing	340	1449	

LBDV4CLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Tetrachloroethene Comment Code			
English Text: Blood Tetrachloroethene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	418	418	
1	below detectable limit	689	1107	
2	detectable result and exceeds the calibrated range of assay	2	1109	
.	Missing	340	1449	

LBXVBF	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Bromoform (pg/mL)			
English Text: Blood Bromoform Result (pg/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.3451 to 132	Range of Values	807	807	
.	Missing	642	1449	

LBDVBFLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Bromoform Comment Code			
English Text: Blood Bromoform Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	671	671	
1	below detectable limit	136	807	
2	detectable result and exceeds the calibrated range of assay	0	807	
.	Missing	642	1449	

LBXVBM	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Bromodichloromethane (pg/mL)			
English Text: Blood Bromodichloromethane Result (pg/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.1499 to 85.9	Range of Values	812	812	
.	Missing	637	1449	

LBDVBMLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Bromodichloromethane Comment Code			
English Text: Blood Bromodichloromethane Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	801	801	
1	below detectable limit	11	812	
2	detectable result and exceeds the calibrated range of assay	0	812	
.	Missing	637	1449	

LBXVBZ	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Benzene (ng/mL)			
English Text: Blood Benzene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.017 to 1.3	Range of Values	934	934	
.	Missing	515	1449	

LBDVBZLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Benzene Comment Code			
English Text: Blood Benzene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	493	493	
1	below detectable limit	441	934	
2	detectable result and exceeds the calibrated range of assay	0	934	
.	Missing	515	1449	

LBXVCF		Target		
		B(20 Yrs. to 59 Yrs.)		
Hard Edits		SAS Label		
0 to 99999.9999		Blood Chloroform (pg/mL)		
English Text: Blood Chloroform Result (pg/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
1.5415 to 22000	Range of Values	763	763	
.	Missing	686	1449	

LBDVCFLC		Target		
		B(20 Yrs. to 59 Yrs.)		
Hard Edits		SAS Label		
		Blood Chloroform Comment Code		
English Text: Blood Chloroform Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	732	732	
1	below detectable limit	28	760	
2	detectable result and exceeds the calibrated range of assay	3	763	
.	Missing	686	1449	

LBXVCM	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Dibromochloromethane (pg/mL)			
English Text: Blood Dibromochloromethane Result (pg/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.1407 to 81.1	Range of Values	817	817	
.	Missing	632	1449	

LBDVCMLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Dibromochloromethane Comment Code			
English Text: Blood Dibromochloromethane Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	659	659	
1	below detectable limit	158	817	
2	detectable result and exceeds the calibrated range of assay	0	817	
.	Missing	632	1449	

LBXVCT	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Carbon Tetrachloride (ng/mL)			
English Text: Blood Carbon Tetrachloride Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0035 to 0.747	Range of Values	941	941	
.	Missing	508	1449	

LBDVCTLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Carbon Tetrachloride Comment Code			
English Text: Blood Carbon Tetrachloride Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	80	80	
1	below detectable limit	861	941	
2	detectable result and exceeds the calibrated range of assay	0	941	
.	Missing	508	1449	

LBXVDB	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood 1,4-Dichlorobenzene (ng/mL)			
English Text: Blood 1,4-Dichlorobenzene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0351 to 86	Range of Values	863	863	
.	Missing	586	1449	

LBDVDBLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood 1,4-Dichlorobenzene Comment Code			
English Text: Blood 1,4-Dichlorobenzene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	449	449	
1	below detectable limit	408	857	
2	detectable result and exceeds the calibrated range of assay	6	863	
.	Missing	586	1449	

LBXVEB	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Ethylbenzene (ng/mL)			
English Text: Blood Ethylbenzene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0117 to 5.46	Range of Values	975	975	
.	Missing	474	1449	

LBDVEBLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Ethylbenzene Comment Code			
English Text: Blood Ethylbenzene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	631	631	
1	below detectable limit	343	974	
2	detectable result and exceeds the calibrated range of assay	1	975	
.	Missing	474	1449	

LBXVME	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood MTBE (pg/mL)			
English Text: Blood Methyl t-Butyl Ether (MTBE) Result (pg/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.1344 to 2290	Range of Values	698	698	
.	Missing	751	1449	

LBDVMELC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood MTBE Comment Code			
English Text: Blood MTBE Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	641	641	
1	below detectable limit	42	683	
2	detectable result and exceeds the calibrated range of assay	15	698	
.	Missing	751	1449	

LBXVOX	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood o-Xylene (ng/mL)			
English Text: Blood o-Xylene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0233 to 3.22	Range of Values	1116	1116	
.	Missing	333	1449	

LBDVOXLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood o-Xylene Comment Code			
English Text: Blood o-Xylene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	502	502	
1	below detectable limit	614	1116	
2	detectable result and exceeds the calibrated range of assay	0	1116	
.	Missing	333	1449	

LBXVST	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Styrene (ng/mL)			
English Text: Blood Styrene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0106 to 100	Range of Values	1070	1070	
.	Missing	379	1449	

LBDVSTLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Styrene Comment Code			
English Text: Blood Styrene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	630	630	
1	below detectable limit	438	1068	
2	detectable result and exceeds the calibrated range of assay	2	1070	
.	Missing	379	1449	

LBXVTC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Trichloroethene (ng/mL)			
English Text: Blood Trichloroethene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0064 to 3.86	Range of Values	1065	1065	
.	Missing	384	1449	

LBDVTCLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Trichloroethene Comment Code			
English Text: Blood Trichloroethene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	39	39	
1	below detectable limit	1026	1065	
2	detectable result and exceeds the calibrated range of assay	0	1065	
.	Missing	384	1449	

LBXVTO	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood Toluene (ng/mL)			
English Text: Blood Toluene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.0177 to 96.8	Range of Values	1106	1106	
.	Missing	343	1449	

LBDVTOLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood Toluene Comment Code			
English Text: Blood Toluene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	1020	1020	
1	below detectable limit	83	1103	
2	detectable result and exceeds the calibrated range of assay	3	1106	
.	Missing	343	1449	

LBXVXY	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
0 to 99999.9999	Blood m-/p-Xylene (ng/mL)			
English Text: Blood m-/p-Xylene Result (ng/mL)				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0.024 to 19.4	Range of Values	1083	1083	
.	Missing	366	1449	

LBDVXYLC	Target			
	B(20 Yrs. to 59 Yrs.)			
Hard Edits	SAS Label			
	Blood m-/p-Xylene Comment Code			
English Text: Blood m-/p-Xylene Comment Code				
English Instructions:				
Code or Value	Description	Count	Cumulative	Skip to Item
0	detectable result	1049	1049	
1	below detectable limit	34	1083	
2	detectable result and exceeds the calibrated range of assay	0	1083	
.	Missing	366	1449	