Methods

Indicator

Indicator B9: Phthalate metabolites in women ages 16 to 49 years: Median concentrations in urine, 1999-2018

Indicator B10: Phthalate metabolites in children ages 6 to 17 years: Median concentrations in urine, 1999-2018

Summary

Since the 1970s, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has conducted the National Health and Nutrition Examination Surveys (NHANES), a series of U.S. national surveys of the health and nutrition status of the noninstitutionalized civilian population. The National Center for Environmental Health at CDC measures environmental chemicals in blood and urine samples collected from NHANES participants.[i] This indicator uses urine measurements of three phthalate metabolites in women ages 16 to 49 years and children ages 6 to 17 years. The three phthalate metabolites analyzed are: dibutyl phthalate (DBP) metabolites: the sum of the two metabolites mono-n-butyl phthalate (MBP) and mono-isobutyl phthalate (MIB); butyl benzyl phthalate (BBzP) metabolite: mono-benzyl phthalate (MBzP), and; di-2-ethylhexyl phthalate (DEHP) metabolites: the sum of the three metabolites mono-2-ethylhexyl phthalate (MEHP), mono-(2-ethyl-5-oxohexyl) phthalate (MEOHP), and mono-(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP). MBP and MIB were measured together as a total in the NHANES 1999-2000 survey but were measured separately in the NHANES 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018 surveys. The NHANES 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018 surveys included urine phthalate metabolite data for these three metabolites for adults and children ages 6 years and over, except that MEOHP and MEHHP were not measured in 1999-2000.

Indicator B9 is the trend in the median concentrations of the phthalate metabolites for women ages 16 to 49 years for 1999-2018. The median is the estimated concentration such that 50% of all noninstitutionalized civilian women ages 16 to 49 years during the survey period have a phthalate metabolite concentration below this level; the population distribution was adjusted by age-specific birth rates to estimate the median prenatal exposure to phthalate metabolites. Indicators B9a and B9b present the median concentration of phthalate metabolites for women ages 16 to 49 in 2015-2018, stratified both by race/ethnicity (B9a) and family income (B9b). Table B9c combines the information from Indicators B9a and B9b in one data table stratified by race/ethnicity and family income. Table B9d presents the 95th percentile concentrations of phthalate metabolites for women ages 16 to 49 years for 1999-2018. The 95th percentile for women is the estimated concentration such that 95% of all noninstitutionalized civilian women

[i] Centers for Disease Control and Prevention. 2009. Fourth National Report on Human Exposure to Environmental Chemicals. Atlanta, GA. Available at: www.cdc.gov/exposurereport.

ages 16 to 49 years during the survey period have a phthalate metabolite concentration below this level.

Indicator B10 is the trend in the median concentrations of the phthalate metabolites for children ages 6 to 17 years for 1999-2018. Indicators B10a and B10b present the median concentration of phthalate metabolites for children ages 6 to 17 years in 2015-2018, stratified both by race/ethnicity (B10a) and family income (B10b). Table B10c combines the information from Indicators B10a and B10b in one data table stratified by race/ethnicity and family income. Table B10d presents the trend in the 95th percentile concentration of phthalate metabolites for children ages 6 to 17 in 1999-2018. Table B10e presents the median concentration of phthalate metabolites for children ages 6 to 17 in 2015-2018, stratified by age group. The survey data were weighted to account for over-sampling, non-response, and non-coverage.

Data Summary

Indicator B9: Phthalate metabolites in women ages 16 to 49 years: Median concentrations in urine, 1999-2018

Data		Urine phthalate metabolites in women ages 16 to 49									
MBP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MBP	Limits of Detection (ng/mL)*	0.9	1.1	0.4	0.6	0.6	0.4	0.4	0.4	0.4	0.4
MBP	Number of Values	642	688	626	634	589	618	542	612	585	510
MBP	Number of Non-missing Values**	618 (96%)	659 (96%)	606 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	599 (98%)	564 (96%)	496 (97%)
MBP	Number of Missing Values**	24 (4%)	29 (4%)	20 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	13 (2%)	21 (4%)	14
MBP	Percentage Below Limit of Detection***	2	2	1	1	1	1	9	4	1	.4
MIB	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MIB	Limits of Detection (ng/mL)*	No data	1.0	0.26	0.3	0.3	0.2	0.2	0.8	0.8	0.8
MIB	Number of Values	0	688	626	634	589	618	542	612	585	510
MIB	Number of Non-missing Values**	0	659 (96%)	606 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	599 (98%)	564 (96%)	496 (97%)

Data		Urine phthalate metabolites in women ages 16 to 49									
	Number of Missing Values**	0	29 (4%)	20 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	13 (2%)	21 (4%)	14 (3%)
	Percentage Below Limit of Detection***	No data	23	2	4	2	0.4	1	4	2	4
MBzP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MBzP	Limits of Detection (ng/mL)*	0.58	0.22	0.07	0.22	0.22	0.22	0.3	0.3	0.3	0.3
MBzP	Number of Values	642	688	626	634	589	618	542	612	585	510
MBzP	Number of Non-missing Values**	618 (96%)	659 (96%)	606 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	599 (98%)	564 (96%)	496 (97%)
MBzP	Number of Missing Values**	24 (4%)	29 (4%)	20 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	13 (2%)	21 (4%)	14 (3%)
MBzP	Percentage Below Limit of Detection***	1	1	0	2	3	1	2	2	3	6
MEHP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MEHP	Limits of Detection (ng/mL)*	1.2	1.0	0.9	1.2	1.1	0.5	0.5	0.8	0.8	0.8
MEHP	Number of Values	642	688	626	634	589	618	542	612	585	510
MEHP	Number of Non-missing Values**	618 (96%)	659 (96%)	606 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	599 (98%)	564 (96%)	496 (97%)
MEHP	Number of Missing Values**	24 (4%)	29 (4%)	20 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	13 (2%)	21 (4%)	14 (3%)
MEHP	Percentage Below Limit of Detection***	21	19	23	27	25	22	25	38	35	3
MEOHP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MEOHP	Limits of Detection (ng/mL)*	No data	1.1	0.45	0.7	0.6	0.2	0.2	0.2	0.2	0.2

Data		Urine phthalate metabolites in women ages 16 to 49									
	Number of Values	0	688	626	634	589	618	542	612	585	510
	Number of Non-missing Values**	0	659 (96%)	606 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	599 (98%)	564 (96%)	496 (97%)
	Number of Missing Values	0	29 (4%)	20 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	13 (2%)	21 (4%)	14 (3%)
	Percentage Below Limit of Detection***	No data	6	0.4	1	1	0	1	1	0.4	0.5
MEHHP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MEHHP	Limits of Detection (ng/mL)*	No data	1.0	0.32	0.7	0.7	0.2	0.2	0.4	0.4	0.4
MEHHP	Number of Values	642	688	626	634	589	618	542	612	585	510
MEHHP	Number of Non-missing Values**	0	659 (96%)	606 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	599 (98%)	564 (96%)	496 (97%)
MEHHP	Number of Missing Values**	0	29 (4%)	20 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	13 (2%)	21 (4%)	14 (3%)
MEHHP	Percentage Below Limit of Detection***	No data	3	0.2	0.1	1	0	0.1	0.4	0	0.6

* The Limit of Detection (LOD) is defined as the level at which the measurement has a 95% probability of being greater than zero.
**Non-missing values include those below the analytical LOD, which are reported as LOD/√2. Missing values are the number of sampled women ages 16 to 49 years in the Mobile Examination Center (MEC) sub-sample that have no value reported for the particular variable used in calculating the indicator.
***This percentage is survey-weighted using the NHANES MEC survey weights for the given period and is weighted by age-specific birth rates.

Indicator B10: Phthalate metabolites in children ages 6 to 17 years: Median concentrations in urine, 1999-2018

Data		Urine phthalate metabolites in children ages 6 to 17									
MBP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
	Limits of Detection (ng/mL)*	0.9	1.1	0.4	0.6	0.6	0.4	0.4	0.4	0.4	0.4
	Number of Values	940	1005	931	927	714	743	706	789	789	623
	Number of Non-missing Values**	900 (96%)	960 (96%)	895 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)	590 (95%)
	Number of Missing Values**	40 (4%)	45 (4%)	36 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)	33 (5%)
	Percentage Below Limit of Detection***	0.1	1	0	0.3	0.3	0.4	4	1	1	3
MIB	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
	Limits of Detection (ng/mL)*	No data	1.0	0.26	0.3	0.3	0.2	0.2	0.8	0.8	0.8
	Number of Values	0	1005	931	927	714	743	706	789	789	623
	Number of Non-missing Values**	0	960 (96%)	895 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)	590 (95%)
	Number of Missing Values**	0	45 (4%)	36 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)	33 (5%)
	Percentage Below Limit of Detection***	No data	17	1	1	1	0	1	2	1	2
MBzP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
	Limits of Detection (ng/mL)*	0.58	0.22	0.07	0.22	0.22	0.22	0.3	0.3	0.3	0.3

Data		Urine phthalate metabolites in children ages 6 to 17									
	Number of Values	940	1005	931	927	714	743	706	789	789	623
	Number of Non-missing Values**	900 (96%)	960 (96%)	895 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)	590 (95%)
	Number of Missing Values**	40 (4%)	45 (4%)	36 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)	33 (5%)
	Percentage Below Limit of Detection***	1	0	0	1	1	0.1	1	1	2	2
MEHP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
	Limits of Detection (ng/mL)*	1.2	1.0	0.9	1.2	1.1	0.5	0.5	0.8	0.8	0.8
	Number of Values	940	1005	931	927	714	743	706	789	789	623
	Number of Non-missing Values**	900 (96%)	960 (96%)	895 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)	590 (95%)
	Number of Missing Values**	40 (4%)	45 (4%)	36 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)	33 (5%)
	Percentage Below Limit of Detection***	15	16	26	26	31	19	21	36	35	37
MEOHP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
	Limits of Detection (ng/mL)*	No data	1.1	0.45	0.7	0.6	0.2	0.2	0.2	0.2	0.2
	Number of Values	0	1005	931	927	714	743	706	789	789	623
	Number of Non-missing Values**	0	960 (96%)	895 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)	590 (95%)

Data		Urine phthalate metabolites in children ages 6 to 17									
	Number of Missing Values**	0	45 (4%)	36 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)	33 (5%)
	Percentage Below Limit of Detection***	No data	1	0	0	1	0.2	1	0.1	1	0
MEHHP	Years	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018
MEHHP	Limits of Detection (ng/mL)*	No data	1.0	0.32	0.7	0.7	0.2	0.2	0.4	0.4	0.4
MEHHP	Number of Values	0	1005	931	927	714	743	706	789	789	623
MEHHP	Number of Non-missing Values**	0	960 (96%)	895 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)	590 (95%)
MEHHP	Number of Missing Values**	0	45 (4%)	36 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)	33 (5%)
MEHHP	Percentage Below Limit of Detection***	No data	1	0.2	0.1	0.2	0.1	0	1	1	0

* The Limit of Detection (LOD) is defined as the level at which the measurement has a 95% probability of being greater than zero.
**Non-missing values include those below the analytical LOD, which are reported as LOD/√2. Missing values are the number of sampled children ages 6 to 17 years in the Mobile Examination Center (MEC) sub-sample that have no value reported for the particular variable used in calculating the indicator.
***This percentage is survey-weighted using the NHANES MEC survey weights for the given period.

Overview of Data Files

The following files are needed to calculate this indicator.[ii] The files together with the survey documentation and SAS programs for reading in the data are available at the NHANES website: http://www.cdc.gov/nchs/nhanes.htm.

- NHANES 1999-2000: Demographic file demo.xpt. Urinary Phthalates, Urinary PAHs, and Urinary Phytoestrogens Laboratory file phpypa.xpt. The demographic file demo.xpt

[ii] On February 1, 2012, CDC announced that a correction factor needed to be applied to each value for certain phthalate metabolites, including mono-benzyl phthalate (MBzP). The correction factor for MBzP is 0.72, and is applicable to each MBzP measurement for NHANES survey periods 1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008. This correction was applied to the MBzP values presented in ACE3..

is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Urinary Phthalates, Urinary PAHs, and Urinary Phytoestrogens laboratory file phpypa.xpt contains SEQN, the three phthalate metabolite concentrations (URXMBP, URXMZP, URXMHP), and the two year Mobile Examination Center (MEC) sub-sample weight (WTSPH2YR). The two files are merged using the common variable SEQN.

- NHANES 2001-2002: Demographic file demo_b.xpt. Urinary Phthalates, Urinary PAHs, and Urinary Phytoestrogens Laboratory file phpypa_b.xpt. The demographic file demo_b.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Urinary Phthalates, Urinary PAHs, and Urinary Phytoestrogens laboratory file phpypa_b.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), and the two year MEC sub-sample weight (WTSPH2YR). The two files are merged using the common variable SEQN.

- NHANES 2003-2004: Demographic file demo_c.xpt. Urinary Phthalates Laboratory file l24ph_c.xpt. The demographic file demo_c.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Urinary Phthalates laboratory file l24ph_c.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.

- NHANES 2005-2006: Demographic file demo_d.xpt. Urinary Phthalates Laboratory file phthte_d.xpt. The demographic file demo_d.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Urinary Phthalates laboratory file phthte_d.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.

- NHANES 2007-2008: Demographic file demo_e.xpt. Urinary Phthalates Laboratory file phthte_e.xpt. The demographic file demo_e.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Urinary Phthalates laboratory file phthte_e.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR).

- NHANES 2009-2010: Demographic file demo_f.xpt. Phthalates – Urine Laboratory file phthte_f.xpt. The demographic file demo_f.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Phthalates – Urine laboratory file phthte_f.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.

- NHANES 2011-2012: Demographic file demo_g.xpt. Phthalates & Plasticizers Metabolites – Urine Laboratory file phthte_g.xpt. The demographic file demo_g.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Phthalates & Plasticizers Metabolites – Urine laboratory file phthte_g.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample A weight (WTSA2YR). The two files are merged using the common variable SEQN.

- NHANES 2013-2014: Demographic file demo_h.xpt. Phthalates & Plasticizers Metabolites – Urine Laboratory file phthte_h.xpt. The demographic file demo_h.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Phthalates & Plasticizers Metabolites – Urine laboratory file phthte_h.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.

- NHANES 2015-2016: Demographic file demo_i.xpt. Phthalates & Plasticizers Metabolites – Urine Laboratory file phthte_i.xpt. The demographic file demo_i.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Phthalates & Plasticizers Metabolites – Urine laboratory file phthte_i.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.

- NHANES 2017-2018: Demographic file demo_j.xpt. Phthalates & Plasticizers Metabolites – Urine Laboratory file phthte_j.xpt. The demographic file demo_j.xpt is a SAS transport file that contains the subject identifier (SEQN), age (RIDAGEYR), sex (RIAGENDR), race/ethnicity (RIDRETH1), poverty income ratio (INDFMPIR), pseudo-stratum (SDMVSTRA) and the pseudo-PSU (SDMVPSU). The Phthalates & Plasticizers Metabolites – Urine laboratory file phthte_j.xpt contains SEQN, the six phthalate metabolite concentrations (URXMBP, URXMIB, URXMZP, URXMHP, URXMOH, URXMHH), the six phthalate metabolite non-detect comment codes (URDMBPLC, URDMIBLC, URDMZPLC, URDMHPLC, URDMOHLC, URDMHHLC), and the two year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.

National Health and Nutrition Examination Surveys (NHANES)

Since the 1970s, the National Center for Health Statistics, a division of the Centers for Disease Control and Prevention, has conducted the National Health and Nutrition Examination Surveys (NHANES), a series of U.S. national surveys of the health and nutrition status of the noninstitutionalized civilian population. The National Center for Environmental Health at CDC measures environmental chemicals in blood and urine samples collected from NHANES participants. This indicator uses urine phthalate metabolite concentration measurements for the six metabolites listed in the following table from NHANES 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018 in women ages 16 to 49 and children ages 6 to 17. The NHANES data were obtained from the NHANES website: http://www.cdc.gov/nchs/nhanes.htm. Following the CDC recommended approach, values below the analytical limit of detection (LOD) were replaced by LOD/√2.[iii]

Phthalate metabolite	Full name	SAS name	SAS name for non-detect comment code*
MBP	mono-n-butyl phthalate	URXMBP	URDMBPLC
MIB	mono-isobutyl phthalate	URXMIB	URDMIBLC
MBzP	mono-benzyl phthalate	URXMZP	URDMZPLC

[iii] See Hornung RW, Reed LD. 1990. Estimation of average concentration in the presence of nondetectable values. *Applied Occupational and Environmental Hygiene* 5:46–51.

MEHP	mono-2-ethylhexyl phthalate	URXMHP	URDMHPLC
MEOHP	mono-(2-ethyl-5-oxohexyl) phthalate	URXMOH	URDMOHLC
MEHHP	mono-(2-ethyl-5-hydroxyhexyl) phthalate	URXMHH	URDMHHLC

*The non-detect comment code equals 1 if the measurement is below the analytical limit of detection, and equals 0 if the measurement is at or above the analytical limit of detection. The non-detect comment code variables were not included in NHANES 1999-2000 and 2001-2002.

The analytes studied are the sum of MBP and MIB, MBzP, and the sum of MEHP, MEOHP, and MEHHP. In NHANES 1999-2000, MBP and MIB were measured together as a total and reported as MBP. In NHANES 1999-2000, MEOHP and MEHHP were not measured and the sum of MEHP, MEOHP, and MEHHP is missing. In NHANES 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018 every sample measurement either had both of MBP and MIB, or neither of these phthalate metabolites. In NHANES 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, and 2017-2018 every sample measurement either had all three of MEHP, MEOHP, and MEHHP, or none of these phthalate metabolites. For the sum of MBP and MIB, and the sum of MEHP, MEOHP, and MEHHP, the sums are treated as being non-detects if one or more of the constituent phthalate metabolites is a non-detect. For calculating the sums, any constituent phthalate metabolite that is below its analytical limit of detection (LOD) is replaced by $LOD/\sqrt{2}$ before adding the concentrations.

The NHANES use a complex multi-stage, stratified, clustered sampling design. Certain demographic groups were deliberately over-sampled, including Mexican-Americans, Blacks, and, from 2007 onwards, All Hispanics, to increase the reliability and precision of estimates of health status indicators for these population subgroups. The publicly released data includes survey weights to adjust for the over-sampling, non-response, and non-coverage. The statistical analyses used the applicable MEC sub-sample survey weights (WTSPH2YR for 1999-2000 and 2001-2002, WTSB2YR for 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2013-2014, 2015-2016, and 2017-2018, and WTSA2YR for 2011-2012) to re-adjust the urine phthalate metabolite data to represent the national population.

Age-Specific Birth Rates

In addition to the NHANES MEC survey weights, the data for women of child-bearing age (ages 16 to 49) were also weighted by the birth rate for women of the given age and race/ethnicity to estimate prenatal exposures. Thus the overall weight in each two year period is the product of the NHANES survey weight and the total number of births in the two calendar years for the given age and race/ethnicity, divided by twice the corresponding population of women at the midpoint of the two year period:[iv]

[iv]Axelrad, D.A., Cohen, J. 2010. Calculating summary statistics for population chemical biomonitoring in women of child-bearing age with adjustment for age-specific natality. *Environmental Research* 111 (1): 149-155.

Adjusted Survey Weight =
MEC survey weight × U.S. Births (NHANES cycle, age, race/ethnicity) /
{Number of years in NHANES cycle × U.S. Women (NHANES cycle midpoint, age, race/ethnicity)}.

Race/Ethnicity and Family Income

For this indicator, the percentiles were calculated for demographic strata defined by the combination of race/ethnicity and family income.

The family income was characterized based on the INDFMPIR variable, which is the ratio of the family income to the poverty level. The National Center for Health Statistics used the U.S. Census Bureau Current Population Survey definition of a "family" as "a group of two people or more (one of whom is the householder) related by birth, marriage, or adoption and residing together" to group household members into family units, and the corresponding family income for the respondent was obtained during the interview. The U.S. Census Bureau defines annual poverty level money thresholds varying by family size and composition. The poverty income ratio (PIR) is the family income divided by the poverty level for that family. Family income was stratified into the following groups:

- Below Poverty Level: PIR < 1
- Above Poverty Level: PIR ≥ 1
- Unknown Income: PIR is missing

For the four year period 2015-2018, the weighted percentage of women ages 16 to 49 years with unknown income was 7% and the weighted percentage of children ages 6 to 17 years with unknown income was 6%.

Race/ethnicity was characterized using the RIDRETH1 variable. The possible values of this variable are:

- 1. Mexican American
- 2. Other Hispanic
- 3. Non-Hispanic White
- 4. Non-Hispanic Black
- 5. Other Race – Including Multi-racial
- "." Missing

Category 5 includes: all Non-Hispanic single race responses other than White or Black; and multi-racial responses.

For this indicator, the RIDRETH1 categories 2, 5, and missing were combined into a single "All Other Races/Ethnicities" category. This produced the following categories:

- White non-Hispanic: RIDRETH1 = 3
- Black non-Hispanic: RIDRETH1 = 4

- Mexican-American: RIDRETH1 = 1
- All Other Races/Ethnicities: RIDRETH1 = 2 or 5 or missing

The "All Other Races/Ethnicities" category includes multiracial persons and individuals whose racial or ethnic identity is not White non-Hispanic, Black non-Hispanic, or Mexican-American. Except for non-Mexican-American Hispanics in 2007-2018 and Asian non-Hispanics in 2011-2018, persons of "All Other Races/Ethnicities" are selected into the survey with a probability that is very much lower than White non-Hispanic, Black non-Hispanic and Mexican-American individuals, and as a group they are not representative of all other race and ethnicities in the United States.

Calculation of Indicator

Indicator B9 is the median for urine phthalate metabolites in women of ages 16 to 49 years, stratified by NHANES survey cycle. The median for women ages 16 to 49 is the estimated concentration such that 50% of all noninstitutionalized civilian women ages 16 to 49 years during the survey period have urine phthalate metabolites concentrations below this level. To adjust the NHANES data to represent prenatal exposures, the data for each woman surveyed was multiplied by the estimated number of births per woman of the given age and race/ethnicity. Indicator B10 is the median for urine phthalate metabolites in children of ages 6 to 17 years, stratified by NHANES survey cycle. The birth rate adjustment was not applied to children ages 6 to 17. Indicators B9a and B9b present the median concentration of phthalate metabolites for women ages 16 to 49 in 2015-2018, stratified both by race/ethnicity (B9a) and family income (B9b). Table B9c combines the information from Indicators B9a and B9b in one data table stratified by race/ethnicity and family income. Table B9d presents the 95th percentile for urine phthalate metabolites in women of ages 16 to 49 years, stratified by NHANES survey cycle. The 95th percentile for women ages 16 to 49 is the estimated concentration such that 95% of all noninstitutionalized civilian women ages 16 to 49 years during the survey period have urine phthalate metabolites concentrations below this level.

Indicators B10a and B10b present the median concentration of phthalate metabolites for children ages 6 to 17 years in 2015-2018, stratified both by race/ethnicity (B10a) and family income (B10b). Table B10c combines the information from Indicators B10a and B10b in one data table stratified by race/ethnicity and family income. Table B10d presents the trend in the 95th percentile concentration of phthalate metabolites for children ages 6 to 17 in 1999-2018. Table B10e presents the median concentration of phthalate metabolites for children ages 6 to 17 in 2015-2018, stratified by age group.

To simply demonstrate the calculations, we will use the NHANES 2007-2008 urine sum of MBP and MIB (DBP = DBP metabolites) values for women ages 16 to 49 years of all race/ethnicities and all incomes as an example. We have rounded all the numbers to make the calculations easier:

We begin with all the non-missing NHANES 2007-2008 urine DBP values for women ages 16 to 49 years. Assume for the sake of simplicity that valid DBP data were available for every sampled woman. Each sampled woman has an associated annual survey weight that estimates the annual number of U.S. women represented by that sampled woman. For 2007-2008, the associated annual survey weight for each woman is defined as WTSB2YR. Each sampled woman also has an associated birth rate giving the numbers of annual births per woman of the given age, race, and ethnicity. The product of the annual survey weight and the birth rate estimates the annual number of U.S. births represented by that sampled woman, which we will refer to as the adjusted survey weight. For example, the lowest urine DBP measurement for a woman between 16 and 49 years of age is 0.6 µg/L with an annual survey weight of 350,000, a birth rate of 0.0013, and thus an adjusted survey weight of 450, and so represents 450 births. The total of the adjusted survey weights for the sampled women equals 4 million, the total number of annual U.S. births to women ages 16 to 49 years. The second lowest measurement is also 0.6 µg/L with an adjusted survey weight of 12,000, and so represents another 12,000 U.S. births. The highest measurement is 788.9 µg/L with an adjusted survey weight of 1,200, and so represents another 1,200 U.S. births.

To calculate the median, we can use the adjusted survey weights to expand the data to the entire U.S. population of births to women ages 16 to 49. We have 450 values of 0.6 µg/L from the lowest measurement, 12,000 values of 0.6 µg/L from the second lowest measurement, and so on, up to 1,200 values of 788.9 µg/L from the highest measurement. Arranging these 4 million values in increasing order, the 2 millionth value is 36.3 µg/L. Since half of the values are below 36.3 and half of the values are above 36.3, the median equals 36.3 µg/L. To calculate the 95th percentile, note that 95% of 4 million equals 3.8 million. The 3.8 millionth value is 160.2 µg/L. Since 95% of the values are below 160.2, the 95th percentile equals 160.2µg/L.

In reality, the calculations need to take into account that urine DBP measurements were not available for every respondent, and to use exact rather than rounded numbers. There were urine DBP measurements for only 571 of the 589 sampled women ages 16 to 49 years. The adjusted survey weights for all 589 sampled women add up to 4.2 million, the U.S. population of births to women ages 16 to 49. The adjusted survey weights for the 571 sampled women with urine DBP data add up to 4.1 million. Thus the available data represent 4.1 million values and so represent only 98% of the U.S. population of births. The median and 95th percentiles are given by the 2.05 millionth (50% of 4.1 million) and 3.90 millionth (95% of 4.1 million) U.S. birth's value. These calculations assume that the sampled women with valid urine DBP data are representative of women giving birth without valid urine DBP data. The calculations also assume that the sampled women are representative of women that actually gave birth in 2007-2008, since NHANES information on pregnancy and births was not incorporated into the analysis.

<u>Equations</u>

These percentile calculations can also be given as the following mathematical equations, which are based on the default percentile calculation formulas from Statistical Analysis System (SAS) software. Exclude all missing urine DBP values. Suppose there are n women of ages 16 to 49 years with valid urine DBP values. Arrange the urine DBP concentrations in increasing order (including tied values) so that the lowest concentration is x(1) with an adjusted survey weight of w(1), the second lowest concentration is x(2) with an adjusted survey weight of w(2), …, and the highest concentration is x(n) with an adjusted survey weight of w(n).

1. Sum all the adjusted survey weights to get the total weight W:

$W = \Sigma[1 \leq i \leq n]\ w(i)$

2. Find the largest number i so that the total of the weights for the i lowest values is less than or equal to W/2.

$\Sigma[j \leq i]\ w(j) \leq W/2 < \Sigma[j \leq i + 1]\ w(j)$

3. Calculate the median using the results of the second step. We either have

$\Sigma[j \leq i]\ w(j) = W/2 < \Sigma[j \leq i + 1]\ w(j)$

or

$\Sigma[j \leq i]\ w(j) < W/2 < \Sigma[j \leq i + 1]\ w(j)$

In the first case we define the median as the average of the i'th and i + 1'th values:

$\text{Median} = [x(i) + x(i + 1)]/2 \text{ if } \Sigma[j \leq i]\ w(j) = W/2$

In the second case we define the median as the i + 1'th value:

$\text{Median} = x(i + 1) \text{ if } \Sigma[j \leq i]\ w(j) < W/2$

(The estimated median does not depend upon how the tied values of x(j) are ordered).

A similar calculation applies to the 95th percentile. The first step to calculate the sum of the weights, W, is the same. In the second step, find the largest number i so that the total of the weights for the i lowest values is less than or equal to 0.95W.

$\Sigma[j \leq i]\ w(j) \leq 0.95W < \Sigma[j \leq i + 1]\ w(j)$

In the third step we calculate the 95th percentile using the results of the second step. We either have

$\Sigma[j \leq i]\ w(j) = 0.95W < \Sigma[j \leq i + 1]\ w(j)$

or

$\Sigma[j \leq i]\ w(j) < 0.95W < \Sigma[j \leq i + 1]\ w(j)$

In the first case we define the 95th percentile as the average of the i'th and i + 1'th values:

$95^{th} \text{ Percentile} = [x(i) + x(i + 1)]/2 \text{ if } \Sigma[j \leq i]\ w(j) = 0.95W$

In the second case we define the 95th percentile as the i + 1'th value:

95^{th} Percentile = x(i + 1) if $\Sigma[j \leq i]\ w(j) < 0.95W$

Relative Standard Error

The uncertainties of the median and 95^{th} percentile values were calculated using a revised version of the CDC method given in CDC 2005,[v] Appendix C, and the SAS® program provided by CDC. The method uses the Clopper-Pearson binomial confidence intervals adapted for complex surveys by Korn and Graubard (see Korn and Graubard, 1999,[vi] p. 65). The following text is a revised version of the Appendix C. For the birth rate adjusted calculations for women ages 16 to 49, the sample weight is adjusted by multiplying by the age-specific birth rate.

Step 1: Use SAS® Proc Univariate to obtain a point estimate P_{SAS} of the percentile value. Use the Weight option to assign the exact correct sample weight for each chemical result.

Step 2: Use SUDAAN® Proc Descript with Taylor Linearization DESIGN = WR (i.e., sampling with replacement) and the proper sampling weight to estimate the proportion (p) of subjects with results less than and not equal to the percentile estimate P_{SAS} obtained in Step 1 and to obtain the standard error (se_p) associated with this proportion estimate. Compute the degrees-of-freedom adjusted effective sample size

$$n_{df} = (t_{num}/t_{denom})^2\ p(1 - p)/(se_p{}^2)$$

where t_{num} and t_{denom} are 0.975 critical values of the Student's t distribution with degrees of freedom equal to the sample size minus 1 and the number of PSUs minus the number of strata, respectively. Note: the degrees of freedom for t_{denom} can vary with the demographic sub-group of interest.

Step 3: After obtaining an estimate of p (i.e., the proportion obtained in Step 2), compute the Clopper-Pearson 95% confidence interval ($P_L(x,n_{df})$, $P_U(x,n_{df})$) as follows:

$$P_L(x,n_{df}) = v_1F_{v1,v2}\,(0.025)/(v_2 + v_1F_{v1,v2}(0.025))$$
$$P_U(x,n_{df}) = v_3F_{v3,v4}\,(0.975)/(v_4 + v_3F_{v3,v4}(0.975))$$

where x is equal to p times n_{df}, $v_1 = 2x$, $v_2 = 2(n_{df} - x + 1)$, $v_3 = 2(x + 1)$, $v_4 = 2(n_{df} - x)$, and $F_{d1,d2}(\beta)$ is the β quantile of an F distribution with d1 and d2 degrees of freedom. (Note: If n_{df} is greater than the actual sample size or if p is equal to zero, then the actual sample size should be used.) This step will produce a lower and an upper limit for the estimated proportion obtained in Step 2.

Step 4: Use SAS Proc Univariate (again using the Weight option to assign weights) to determine the chemical percentile values P_{CDC}, L_{CDC} and U_{CDC} that correspond to the proportion p obtained in Step 2 and its lower and upper limits obtained in Step 3. Do not round the values of p and the lower and upper limits. For example, if p = 0.4832, then P_{CDC} is the 48.32'th percentile value of the chemical. The alternative percentile estimates P_{CDC} and P_{SAS} are not necessarily equal.

Step 5: Use the confidence interval from Step 4 to estimate the standard error of the estimated percentile P_{CDC}:

[v] CDC Third National Report on Human Exposure to Environmental Chemicals. 2005
[vi] Korn E. L., Graubard B. I. 1999. *Analysis of Health Surveys.* Wiley.

Standard Error (P_{CDC}) = (U_{CDC} − L_{CDC}) / ($2t_{denom}$)

Step 6: Use the estimated percentile P_{CDC} and the standard error from Step 4 to estimate the relative standard error of the estimated percentile P_{CDC}:

Relative Standard Error (%) = [Standard Error (P_{CDC}) / P_{CDC}] × 100%

The tabulated estimated percentile is the value of P_{SAS} given in Step 1. The relative standard error is given in Step 6, using P_{CDC} and its standard error.

The relative standard error depends upon the survey design. For this purpose, the public release version of NHANES includes the variables SDMVSTRA and SDMVPSU, which are the Masked Variance Unit pseudo-stratum and pseudo-primary sampling unit (pseudo-PSU). For approximate variance estimation, the survey design can be approximated as being a stratified random sample with replacement of the pseudo-PSUs from each pseudo-stratum; the true stratum and PSU variables are not provided in the public release version to protect confidentiality. If the relative standard error is too high, then the estimated percentile will not be accurately estimated. Furthermore, if the degrees of freedom (from Step 2) is too low, then the relative standard error will be less accurately estimated and thus may be underestimated. For these reasons, percentiles with high relative standard errors or with low degrees of freedom are unstable or unreliable.

Percentiles with a relative standard error less than 30% and with 12 or more degrees of freedom were treated as being reliable and were tabulated. Percentiles with a relative standard error that is 30% or greater but less than 40% and with 12 or more degrees of freedom were treated as being unstable; these values were tabulated but were flagged to be interpreted with caution. Percentiles with a relative standard error less than 40% and with between 7 and 11 degrees of freedom were also treated as being unstable; these values were tabulated but were flagged to be interpreted with caution. Percentiles with a relative standard error that is 40% or greater, or without an estimated relative standard error, or with 6 or less degrees of freedom, were treated as being unreliable; these values were not tabulated and were flagged as having a large uncertainty.

Questions and Comments

Questions regarding these methods, and suggestions to improve the description of the methods, are welcome. Please use the “Contact Us” link at the bottom of any page in the America’s Children and the Environment website.

Statistical Comparisons

Statistical analyses of the percentiles were used to determine whether the differences between percentiles for different demographic groups were statistically significant. For these analyses, the percentiles and their standard errors were calculated for each combination of age group, sex, income group (below poverty, at or above poverty, unknown income), and race/ethnicity group using the method described in the "Relative Standard Error" section. In the notation of that section, the percentile and standard error are the values of P_{CDC} and Standard Error (P_{CDC}), respectively. These calculated standard errors account for the survey weighting and design and, for women, for the age-specific birth rate.

Using a weighted linear regression model, the percentile was assumed to be the sum of explanatory terms for age, sex, income and/or race/ethnicity and a random error term; the error terms were assumed to be approximately independent and normally distributed with a mean of zero and a variance equal to the square of the standard error. In this model, the weight is the inverse of the variance, so that percentiles with larger standard errors are given less of a statistical weight in the fitted regression model. Using this model, the difference in the value of a percentile between different demographic groups is statistically significant if the difference between the corresponding sums of explanatory terms is statistically significantly different from zero. A p-value at or below 0.05 implies that the difference is statistically significant at the 5% significance level. No adjustment is made for multiple comparisons.

For each type of comparison, we present unadjusted and adjusted analyses. The unadjusted analyses directly compare a percentile between different demographic groups. The adjusted analyses add other demographic explanatory variables to the statistical model and use the statistical model to account for the possible confounding effects of these other demographic variables. For example, the unadjusted race/ethnicity comparisons use and compare the percentiles between different race/ethnicity pairs. The adjusted race/ethnicity comparisons use the percentiles for each age/sex/income/race/ethnicity combination. The adjusted analyses add age, sex, and income terms to the statistical model and compare the percentiles between different race/ethnicity pairs after accounting for the effects of the other demographic variables. For example, if White non-Hispanics tend to have higher family incomes than Black non-Hispanics, and if the urine phthalate level strongly depends on family income only, then the unadjusted differences between these two race/ethnicity groups would be significant but the adjusted difference (taking into account income) would not be significant.

Comparisons between pairs of race/ethnicity groups are shown in Table 1 for women ages 16 to 49 years and in Table 4 for children ages 6 to 17 years. Comparisons between income groups are shown in Table 2 for women ages 16 to 49 years and in Table 5 for children ages 6 to 17 years. In Tables 1 and 4, for the unadjusted "All incomes" comparisons, the only explanatory variables are terms for each race/ethnicity group. For these unadjusted comparisons, the statistical tests compare the percentiles for each pair of race/ethnicity groups. For the adjusted "All incomes (adjusted for age, sex, income)" comparisons, the explanatory variables are terms for each race/ethnicity group together with terms for each age, sex (for children), and income group. For these adjusted comparisons, the statistical test compares the pair of race/ethnicity groups after accounting for any differences in the age, sex (for children) and income distributions between the race/ethnicity groups. The adjustment for sex is applicable only to the analyses for children, and thus appears only in Tables 4, 5, and 6.

In Tables 1 and 4, for the unadjusted "Below Poverty Level" and "At or Above Poverty Level" comparisons, the only explanatory variables are terms for each of the twelve race/ethnicity/income combinations (combinations of four race/ethnicity groups and three income groups). For example, in row 1, the p-value for "Below Poverty Level" compares White non-Hispanics below the poverty level with Black non-Hispanics below the poverty level. The same set of explanatory variables are used in Tables 2 and 5 for the unadjusted comparisons between one race/ethnicity group below the poverty level and the same race/ethnicity group at or above the poverty level. The corresponding adjusted analyses include extra explanatory variables for age and sex (for children), so that race/ethnicity/income groups are compared after accounting for any differences due to age or sex. Although these comparisons only involve the two income groups with known incomes, these statistical models were fitted to all three income groups (including those with unknown income) to make a more general, better fitting model; this approach has no impact on the unadjusted p-values but has a small impact on the adjusted p-values. Also in Tables 2 and 5, the unadjusted p-value for the population "All" compares the percentiles for women ages 16 to 49 years or children ages 6 to 17 years below poverty level with those at or above poverty level, using the explanatory variables for the two income groups (below poverty, at or above poverty), excluding those with unknown income. The adjusted p-value includes adjustment terms for age, sex (for children), and race/ethnicity in the model.

Additional comparisons are shown in Table 3 for women ages 16 to 49 years and in Table 6 for children ages 6 to 17 years. Comparisons are shown for differences between children's age groups, between those below poverty and those at or above poverty, and for changes over time (trends). The Against = "age" unadjusted p-value compares the percentiles between children in different age groups, using the explanatory variables for the age groups. The adjusted p-value includes adjustment terms for sex (for children), race/ethnicity, and income in the model. The Against = "income" unadjusted p-value compares the percentiles for those below poverty level with those at or above poverty level, using the explanatory variables for the two income groups (below poverty, at or above poverty). The adjusted p-value includes adjustment terms for age, sex (for children), and race/ethnicity in the model. The Against = "year" p-value examines whether the linear trend in the percentiles is statistically significant (using the percentiles for each NHANES period regressed against the midpoint of that period); the adjusted model for trend adjusts for demographic changes in the populations from year to year by including terms for age, sex (for children), income, and race/ethnicity. The adjustment for sex is applicable only for children, and thus appears only in Table 6.

For women, the age groups used were 16-19, 20-24, 25-29, 30-39, and 40-49. For children, the age groups used were 6-10, 11-15, and 16-17.

For more details on these statistical analyses, see the memorandum by Cohen (2010).[vii]

[vii] Cohen, J. 2010. *Selected statistical methods for testing for trends and comparing years or demographic groups in ACE NHIS and NHANES indicators.* Memorandum submitted to Dan Axelrad, EPA, 21 March, 2010.

Table 1. Statistical significance tests comparing the percentiles of phthalate metabolites in women ages 16 to 49 years, between pairs of race/ethnicity groups, for 2015-2018.

				P-VALUES					
Variable	**Percentile**	**First race/ethnicity group**	**Second race/ethnicity group***	**All incomes**	**All incomes (adjusted for age, income)**	**Below Poverty Level**	**Below Poverty Level (adjusted for age)**	**At or Above Poverty Level**	**At or Above Poverty Level (adjusted for age)**
DEHP metabolites	50	White non-Hispanic	Black non-Hispanic	< 0.001	< 0.001	0.019	< 0.001	0.051	0.049
DEHP metabolites	50	White non-Hispanic	Mexican-American	0.850	0.130	0.127	< 0.001	0.835	0.097
DEHP metabolites	50	White non-Hispanic	Other	0.581	0.414	0.201	0.234	0.174	0.474
DEHP metabolites	50	Black non-Hispanic	Mexican-American	0.013	0.075	0.797	< 0.001	0.057	< 0.001
DEHP metabolites	50	Black non-Hispanic	Other	< 0.001	< 0.001	0.468	0.002	0.007	0.004
DEHP metabolites	50	Mexican-American	Other	0.590	0.308	0.724	< 0.001	0.330	0.230
DBP metabolites	50	White non-Hispanic	Black non-Hispanic	0.001	< 0.001	0.001	< 0.001	0.221	0.017
DBP metabolites	50	White non-Hispanic	Mexican-American	0.663	0.676	0.189	0.705	0.486	0.001
DBP metabolites	50	White non-Hispanic	Other	0.692	0.001	0.627	< 0.001	0.599	0.618
DBP metabolites	50	Black non-Hispanic	Mexican-American	0.002	< 0.001	0.018	< 0.001	0.129	< 0.001
DBP metabolites	50	Black non-Hispanic	Other	0.006	< 0.001	0.022	0.001	0.481	0.046
DBP metabolites	50	Mexican-American	Other	0.955	0.011	0.631	0.010	0.343	< 0.001
BBzP metabolite	50	White non-Hispanic	Black non-Hispanic	< 0.001	< 0.001	0.333	< 0.001	0.122	0.064
BBzP metabolite	50	White non-Hispanic	Mexican-American	0.641	0.687	0.340	< 0.001	0.823	0.021
BBzP metabolite	50	White non-Hispanic	Other	0.523	0.033	0.751	0.171	1.000	0.966
BBzP metabolite	50	Black non-Hispanic	Mexican-American	0.002	< 0.001	0.155	0.189	0.232	< 0.001
BBzP metabolite	50	Black non-Hispanic	Other	0.001	< 0.001	0.290	0.004	0.106	0.041
BBzP metabolite	50	Mexican-American	Other	0.916	0.001	0.773	0.020	0.815	0.004

* "Other" represents the "All Other Races/Ethnicities" category, which includes all other races and ethnicities not specified, together with those individuals who report more than one race.

Table 2. Statistical significance tests comparing the percentiles of phthalate metabolites in women ages 16 to 49 years, between those below poverty level and those at or above poverty level, for 2015-18.

			P-Values for difference between income levels	
Variable	**Percentile**	**Population***	**Unadjusted**	**Adjusted (for age)****
DEHP metabolites	50	All	0.571	< 0.001
DEHP metabolites	50	White non-Hispanic	0.305	0.112
DEHP metabolites	50	Black non-Hispanic	0.455	0.868
DEHP metabolites	50	Mexican-American	0.247	< 0.001
DEHP metabolites	50	Other	0.203	0.880

			P-Values for difference between income levels	
Variable	**Percentile**	**Population***	**Unadjusted**	**Adjusted (for age)****
DBP metabolites	50	All	0.583	< 0.001
DBP metabolites	50	White non-Hispanic	0.429	0.003
DBP metabolites	50	Black non-Hispanic	0.110	0.012
DBP metabolites	50	Mexican-American	0.198	0.522
DBP metabolites	50	Other	0.782	0.247
BBzP metabolite	50	All	0.198	< 0.001
BBzP metabolite	50	White non-Hispanic	0.150	0.419
BBzP metabolite	50	Black non-Hispanic	0.327	0.004
BBzP metabolite	50	Mexican-American	0.837	< 0.001
BBzP metabolite	50	Other	0.576	0.385

* "Other" represents the "All Other Races/Ethnicities" category, which includes all other races and ethnicities not specified, together with those individuals who report more than one race.
** Comparison for "All" is adjusted for age and race/ethnicity; comparisons for race/ethnicity categories are adjusted for age.

Table 3. Other statistical significance tests comparing the percentiles of phthalate metabolites in women ages 16 to 49 years, for 2015-2018 (trends for 1999-2018, 1999-2008, and 2007-2018).

					P-VALUES	
Variable	**Percentile**	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
DEHP metabolites	50	2015	2018	income	0.123	0.177
DEHP metabolites	50	2001	2018	year	< 0.001	0.847
DEHP metabolites	50	2007	2018	year	< 0.001	< 0.001
DBP metabolites	50	2015	2018	income	0.051	0.641
DBP metabolites	50	1999	2018	year	< 0.001	< 0.001
DBP metabolites	50	2007	2018	year	< 0.001	< 0.001
BBzP metabolite	50	2015	2018	income	0.177	< 0.001
BBzP metabolite	50	1999	2018	year	< 0.001	< 0.001
BBzP metabolite	50	2007	2018	year	0.158	< 0.001
DEHP metabolites	95	2001	2018	year	< 0.001	< 0.001
DEHP metabolites	95	2007	2018	year	< 0.001	< 0.001
DBP metabolites	95	1999	2018	year	0.051	0.641
DBP metabolites	95	1999	2008	year	0.092	< 0.001
DBP metabolites	95	2007	2018	year	< 0.001	< 0.001
BBzP metabolite	95	1999	2018	year	< 0.001	< 0.001
BBzP metabolite	95	2007	2018	year	0.158	< 0.001

*For Against = "income," the comparison is between those below the poverty level and those at or above the poverty level, and the p-values are adjusted for age and race/ethnicity.
For Against = "year" the comparison is the trend over different years, and the p-values are adjusted for age, race/ethnicity, and income.
**P-value is not available. Model convergence is questionable.

Table 4. Statistical significance tests comparing the percentiles of phthalate metabolites in children ages 6 to 17 years, between pairs of race/ethnicity groups, for 2015-2018.

				P-VALUES					
Variable	**Percentile**	**First race/ethnicity group**	**Second race/ethnicity group***	**All incomes**	**All incomes (adjusted for age, income)**	**Below Poverty Level**	**Below Poverty Level (adjusted for age)**	**At or Above Poverty Level**	**At or Above Poverty Level (adjusted for age)**
DEHP metabolites	50	White non-Hispanic	Black non-Hispanic	< 0.001	0.007	< 0.001	0.004	0.061	0.031
DEHP metabolites	50	White non-Hispanic	Mexican-American	0.936	0.444	0.849	0.696	0.509	0.277
DEHP metabolites	50	White non-Hispanic	Other	0.620	< 0.001	0.284	< 0.001	0.750	0.727
DEHP metabolites	50	Black non-Hispanic	Mexican-American	< 0.001	0.004	0.076	0.010	0.024	0.345
DEHP metabolites	50	Black non-Hispanic	Other	< 0.001	< 0.001	0.151	< 0.001	0.044	0.017
DEHP metabolites	50	Mexican-American	Other	0.754	< 0.001	0.564	< 0.001	0.770	0.169
DBP metabolites	50	White non-Hispanic	Black non-Hispanic	0.028	0.983	0.072	0.028	0.345	0.725
DBP metabolites	50	White non-Hispanic	Mexican-American	0.153	< 0.001	0.606	< 0.001	0.123	0.299
DBP metabolites	50	White non-Hispanic	Other	0.609	< 0.001	0.721	< 0.001	0.906	0.424
DBP metabolites	50	Black non-Hispanic	Mexican-American	< 0.001	0.002	0.025	< 0.001	0.022	0.460
DBP metabolites	50	Black non-Hispanic	Other	0.060	< 0.001	0.252	< 0.001	0.408	0.649
DBP metabolites	50	Mexican-American	Other	0.037	0.423	0.464	0.505	0.243	0.734
BBzP metabolite	50	White non-Hispanic	Black non-Hispanic	0.115	0.954	0.146	0.966	0.777	0.979
BBzP metabolite	50	White non-Hispanic	Mexican-American	0.053	< 0.001	0.477	< 0.001	0.004	0.004
BBzP metabolite	50	White non-Hispanic	Other	0.104	< 0.001	0.846	< 0.001	0.022	0.017
BBzP metabolite	50	Black non-Hispanic	Mexican-American	< 0.001	< 0.001	0.030	0.167	0.002	0.002
BBzP metabolite	50	Black non-Hispanic	Other	< 0.001	< 0.001	0.073	0.224	0.019	0.008
BBzP metabolite	50	Mexican-American	Other	0.621	0.920	0.412	0.613	0.510	0.439

* "Other" represents the "All Other Races/Ethnicities" category, which includes all other races and ethnicities not specified, together with those individuals who report more than one race.

Table 5. Statistical significance tests comparing the percentiles of phthalate metabolites in children ages 6 to 17 years, between those below poverty level and those at or above poverty level, for 2015-2018.

			P-Values for difference between income levels	
Variable	**Percentile**	**Population***	**Unadjusted**	**Adjusted (for age, sex)****
DEHP metabolites	50	All	0.055	0.006
DEHP metabolites	50	White non-Hispanic	0.784	0.010
DEHP metabolites	50	Black non-Hispanic	0.045	0.442
DEHP metabolites	50	Mexican-American	0.041	0.209
DEHP metabolites	50	Other	0.018	0.283
DBP metabolites	50	All	0.146	< 0.001
DBP metabolites	50	White non-Hispanic	0.889	< 0.001
DBP metabolites	50	Black non-Hispanic	0.077	< 0.001
DBP metabolites	50	Mexican-American	0.511	0.868
DBP metabolites	50	Other	0.603	0.171
BBzP metabolite	50	All	0.055	0.006
BBzP metabolite	50	White non-Hispanic	0.784	0.010
BBzP metabolite	50	Black non-Hispanic	0.045	0.442
BBzP metabolite	50	Mexican-American	0.041	0.209
BBzP metabolite	50	Other	0.018	0.283

* "Other" represents the "All Other Races/Ethnicities" category, which includes all other races and ethnicities not specified, together with those individuals who report more than one race.
** Comparison for "All" is adjusted for age, sex, and race/ethnicity; comparisons for race/ethnicity categories are adjusted for age and sex.

Table 6. Other statistical significance tests comparing the percentiles of phthalate metabolites in children ages 6 to 17 years, for 2015-2018 (trends for 1999-2018, 2001-2008, and 2007-2018).

					P-VALUES	
Variable	**Percentile**	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
DEHP metabolites	50	2015	2018	age	< 0.001	< 0.001
DEHP metabolites	50	2015	2018	income	0.175	0.257
DEHP metabolites	50	2001	2018	year	< 0.001	< 0.001
DEHP metabolites	50	2007	2018	year	< 0.001	< 0.001
DBP metabolites	50	2015	2018	age	0.045	0.926
DBP metabolites	50	2015	2018	income	0.095	0.002
DBP metabolites	50	1999	2018	year	< 0.001	< 0.001
DBP metabolites	50	2007	2018	year	< 0.001	< 0.001
BBzP metabolite	50	2015	2018	age	0.041	0.001
BBzP metabolite	50	2015	2018	income	0.095	0.003
BBzP metabolite	50	1999	2018	year	< 0.001	< 0.001
BBzP metabolite	50	2007	2018	year	< 0.001	< 0.001
DEHP metabolites	95	2001	2018	year	< 0.001	< 0.001
DEHP metabolites	95	2001	2008	year	0.043	< 0.001
DEHP metabolites	95	2007	2018	year	< 0.001	< 0.001
DBP metabolites	95	1999	2018	year	< 0.001	< 0.001
DBP metabolites	95	2007	2018	year	< 0.001	< 0.001
BBzP metabolite	95	1999	2018	year	< 0.001	< 0.001

					P-VALUES	
Variable	**Percentile**	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
BBzP metabolite	95	2007	2018	year	< 0.001	< 0.001

*For Against = "age," the comparison is between the age groups 6-10, 11-15, and 16-17 years, and the p-values are adjusted for sex, race/ethnicity and income.
For Against = "income," the comparison is between those below the poverty level and those at or above the poverty level, and the p-values are adjusted for age, sex, and race/ethnicity.
For Against = "year" the comparison is the trend over different years, and the p-values are adjusted for age, sex, race/ethnicity, and income.