Methods

Indicator

B10. Bisphenol A in women ages 16 to 49 years: Median and 95th percentile concentrations in urine, 2003-2016.

B11. Bisphenol A in children ages 6 to 17 years: Median and 95th percentile concentrations in urine, 2003-2016.

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 non-institutionalized 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 bisphenol A (BPA) in women ages 16 to 49 years and children ages 6 to 17 years from 2003-2016.

Indicator B10 is the trend in the median and 95th percentile concentrations of BPA for women ages 16 to 49 for 2003-2016. The median is the estimated concentration such that 50% of all non-institutionalized civilian women ages 16 to 49 years have a BPA concentration below this level; the population distribution was adjusted by age-specific birth rates to reflect exposures to women who are pregnant or may become pregnant. The 95th percentile is the estimated concentration such that 95% of all non-institutionalized civilian women ages 16 to 49 years have a BPA concentration below this level. Indicator B11 is the trend in the median and 95th percentile concentrations of BPA for children ages 6 to 17 years for 2003-2016.

Supplementary Tables: Table B10a presents the median concentration of BPA for women ages 16 to 49 years for 2013-2016, stratified both by race/ethnicity and family income. Table B10b presents the 95th percentile concentration of BPA for women ages 16 to 49 years for 2013-2016, stratified both by race/ethnicity and family income. Table B11a presents the median concentration of BPA for children ages 6 to 17 years for2013-2016, stratified both by race/ethnicity and family income. Table B11b presents the 95th percentile concentration of BPA for children ages 6 to 17 years in 2013-2016, stratified both by race/ethnicity and family income. Table B11c presents the median and 95th percentile concentrations of BPA for children ages 6 to 17 in 2013-2016, stratified by age. The survey data were weighted to account for over-sampling, non-response, and non-coverage.

[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.

Data Summary

Indicator B10. Bisphenol A in women ages 16 to 49 years: Median and 95th percentile concentrations in urine, 2003-2016.

Data	Urine BPA						
Years	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016
Limits of Detection (µg/L)*	0.4	0.4	0.4	0.4	0.4	0.2	0.2
Number of Values	627	634	589	618	542	612	585
Number of Non-Missing Values**	611 (97%)	616 (97%)	571 (97%)	608 (98%)	536 (99%)	600 (98%)	564 (96%)
Number of Missing Values**	16 (3%)	18 (3%)	18 (3%)	10 (2%)	6 (1%)	12 (2%)	21 (4%)
Percentage Below Limit of Detection***	5	8	4	8	11	6	8

* 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 B11. Bisphenol A in children ages 6 to 17 years: Median and 95th percentile concentrations in urine, 2003-2016.

Data	Urine BPA						
Years	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016
Limits of Detection (µg/L)*	0.4	0.4	0.4	0.4	0.4	0.2	0.2
Number of Values	884	927	714	743	706	789	789
Number of Non-Missing Values**	852 (96%)	896 (97%)	690 (97%)	727 (98%)	689 (98%)	750 (95%)	742 (94%)
Number of Missing Values**	32 (4%)	31 (3%)	24 (3%)	16 (2%)	17 (2%)	39 (5%)	47 (6%)
Percentage Below Limit of Detection***	3	4	3	8	10	2	3

* 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.

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 non-institutionalized 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 BPA measurements from NHANES 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, and 2015-2016 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.[ii]

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 (WTC2YR for 2003-2004, WTSB2YR for 2005-2006, 2007-2008, 2009-2010, 2013-2014, 2015-2016, and WTA2YR for 2011-2012) to re-adjust the urine BPA data to represent the national population.

Age-Specific Birth Rates

In addition to the NHANES MEC survey weights, the data for women 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:[iii]

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)}.

[ii] See Hornung RW, Reed LD. 1990. Estimation of average concentration in the presence of nondetectable values. *Applied Occupational and Environmental Hygiene* 5:46–51.
[iii] Axelrad, D.A., Cohen, J. 2011. 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.

Race/Ethnicity and Family Income

For these indicators, 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 2013-2016, 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 2007-2016 and Asian non-Hispanics in 2011-2016, 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 B10 is the median and 95th percentile for urine BPA in women 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 non-institutionalized civilian women ages 16 to 49 years during the survey period have urine BPA concentrations below this level. The 95th percentile for women ages 16 to 49 is the estimated concentration such that 95% of all non-institutionalized civilian women ages 16 to 49 years during the survey period have urine BPA 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 B11 is the median and 95th percentile for urine BPA in children ages 6 to 17 years, stratified by NHANES survey cycle. The birth rate adjustment was not applied to children ages 6 to 17.

Table B10a presents the median for urine BPA in women of ages 16 to 49 years in 2013-2016, stratified by race/ethnicity and family income. Table B10b presents the 95th percentile for urine BPA in women ages 16 to 49 years in 2013-2016, stratified by race/ethnicity and family income. Table B11a presents the median for urine BPA in children ages 6 to 17 years in 2013-2016, stratified by race/ethnicity and family income. Table B11b presents the 95th percentile for urine BPA in children ages 6 to 17 years in 2013-2016, stratified by race/ethnicity and family income. Table B11c presents the median concentration of BPA for children ages 6 to 17 in 2013-2016, stratified by age.

To simply demonstrate the calculations, we will use the NHANES 2009-2010 urine BPA 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 2009-2010 urine BPA values for women ages 16 to 49 years. Assume for the sake of simplicity that valid BPA 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 2009-2010, 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 BPA measurement for a woman between 16 and 49

years of age is 0.3 µg/L with an annual survey weight of 380,000, a birth rate of 0.0002, and thus an adjusted survey weight of 80, and so represents 80 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 0.3 µg/L with an adjusted survey weight of 22,000, and so represents another 22,000 U.S. births. The highest measurement is 965 µg/L with an adjusted survey weight of 500, and so represents another 500 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 80 values of 0.3 µg/L from the lowest measurement, 22,000 values of 0.3 µg/L from the second lowest measurement, and so on, up to 500 values of 965 µg/L from the highest measurement. Arranging these 4 million values in increasing order, the 2 millionth value is 2.1 µg/L. Since half of the values are below 2.1 and half of the values are above 2.1, the median equals 2.1 µg/L. To calculate the 95th percentile, note that 95% of 4 million equals 3.8 million. The 3.8 millionth value is 9.7 µg/L. Since 95% of the values are below 9.7, the 95th percentile equals 9.7 µg/L.

The calculations need to take into account that urine BPA measurements were not available for every respondent and need to use exact rather than rounded numbers. There were urine BPA measurements for only 608 of the 618 sampled women ages 16 to 49 years. The adjusted survey weights for all 618 sampled women add up to 4.29 million, the U.S. population of births to women ages 16 to 49. The adjusted survey weights for the 608 sampled women with urine BPA data add up to 4.26 million. Thus, the available data represent 4.26 million values and so represent 99% of the U.S. population of births. The median and 95th percentiles are given by the 2.13 millionth (50% of 4.26 million) and 4.05 millionth (95% of 4.26 million) U.S. birth's value. These calculations assume that the sampled women with valid urine BPA data are representative of women giving birth without valid urine BPA data. The calculations also assume that the sampled women are representative of women that actually gave birth in 2009-2010, since NHANES information on pregnancy and births was not incorporated into the analysis.

Equations

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 BPA values. Suppose there are n women of ages 16 to 49 years with valid urine BPA values. Arrange the urine BPA 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:

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

Relative Standard Error

The uncertainties of the median and 95th percentile values were calculated using a revised version of the CDC method given in CDC 2005,[iv] 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,[v] 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:

$$P_L(x,n_{df}) = v_1 F_{v1,v2}(0.025)/(v_2 + v_1 F_{v1,v2}(0.025))$$
$$P_U(x,n_{df}) = v_3 F_{v3,v4}(0.975)/(v_4 + v_3 F_{v3,v4}(0.975))$$

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}:

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

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}:

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

$$\text{Relative Standard Error (\%)} = [\text{Standard Error } (P_{CDC}) / P_{CDC}] \times 100\%$$

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 (in the cases of children), 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 BPA 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 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).[vi]

[vi] 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 BPA in women ages 16 to 49 years, between pairs of race/ethnicity groups, for 2013-2016.

				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)**
BPA	50	White non-Hispanic	Black non-Hispanic	< 0.001	< 0.001	0.094	0.002	< 0.001	0.001
BPA	50	White non-Hispanic	Mexican-American	0.159	< 0.001	0.342	< 0.001	0.479	0.232
BPA	50	White non-Hispanic	Other	0.101	0.041	0.114	0.884	0.411	0.108
BPA	50	Black non-Hispanic	Mexican-American	0.011	< 0.001	0.449	0.388	0.032	0.037
BPA	50	Black non-Hispanic	Other	< 0.001	< 0.001	< 0.001	0.025	< 0.001	< 0.001
BPA	50	Mexican-American	Other	0.014	< 0.001	0.001	0.004	0.275	0.020
BPA	95	White non-Hispanic	Black non-Hispanic	0.236	0.022	0.787	0.139	0.015	< 0.001
BPA	95	White non-Hispanic	Mexican-American	0.193	0.632	1.000	0.007	0.243	0.760
BPA	95	White non-Hispanic	Other	0.812	0.256	0.046	0.001	0.686	< 0.001
BPA	95	Black non-Hispanic	Mexican-American	0.029	< 0.001	0.862	0.106	0.002	< 0.001
BPA	95	Black non-Hispanic	Other	0.198	< 0.001	0.126	0.012	0.015	0.115
BPA	95	Mexican-American	Other	0.327	0.328	0.396	0.340	0.542	< 0.001

* "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 BPA in women ages 16 to 49 years, between those below poverty level and those at or above poverty level, for 2013-2016.

			P-Values for difference between income levels	
Variable	**Percentile**	**Population***	**Unadjusted**	**Adjusted (for age)****
BPA	50	All	0.002	0.532
BPA	50	White non-Hispanic	0.350	0.054
BPA	50	Black non-Hispanic	0.317	0.749
BPA	50	Mexican-American	0.093	0.019
BPA	50	Other	0.235	0.723
BPA	95	All	0.482	0.918
BPA	95	White non-Hispanic	0.473	< 0.001
BPA	95	Black non-Hispanic	0.412	0.001
BPA	95	Mexican-American	0.426	0.013
BPA	95	Other	0.434	< 0.001

* "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 BPA in women ages 16 to 49 years, for 2013-2016 (trends for 2003-2016).

					P-VALUES	
Variable	**Percentile**	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
BPA	50	2013	2016	income	0.002	0.532
BPA	50	2003	2016	year	< 0.001	< 0.001
BPA	95	2013	2016	income	0.482	0.918
BPA	95	2003	2016	year	0.003	< 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.

Table 4. Statistical significance tests comparing the percentiles of BPA in children ages 6 to 17 years, between pairs of race/ethnicity groups, for 2013-2016.

				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)**
BPA	50	White non-Hispanic	Black non-Hispanic	0.013	< 0.001	0.492	0.002	0.081	0.010
BPA	50	White non-Hispanic	Mexican-American	0.327	0.082	0.196	0.946	0.137	0.013
BPA	50	White non-Hispanic	Other	0.332	< 0.001	0.582	0.015	0.028	< 0.001
BPA	50	Black non-Hispanic	Mexican-American	0.001	< 0.001	0.133	0.003	0.003	< 0.001
BPA	50	Black non-Hispanic	Other	0.001	< 0.001	0.288	< 0.001	0.001	< 0.001
BPA	50	Mexican-American	Other	1.000	0.074	0.469	0.043	0.459	0.052
BPA	95	White non-Hispanic	Black non-Hispanic	0.101	0.050	0.297	< 0.001	0.930	0.178
BPA	95	White non-Hispanic	Mexican-American	0.937	0.009	0.496	< 0.001	0.821	0.004
BPA	95	White non-Hispanic	Other	0.458	< 0.001	0.243	< 0.001	0.005	0.847
BPA	95	Black non-Hispanic	Mexican-American	0.126	< 0.001	0.547	< 0.001	0.831	< 0.001
BPA	95	Black non-Hispanic	Other	0.010	< 0.001	0.799	< 0.001	0.157	< 0.001
BPA	95	Mexican-American	Other	0.418	0.026	0.428	< 0.001	0.024	< 0.001

* "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 BPA in children ages 6 to 17 years, between those below poverty level and those at or above poverty level, for 2013-2016.

			P-Values for difference between income levels	
Variable	**Percentile**	**Population***	**Unadjusted**	**Adjusted (for age, sex)****
BPA	50	All	1.000	0.069
BPA	50	White non-Hispanic	0.552	0.034
BPA	50	Black non-Hispanic	1.000	0.754
BPA	50	Mexican-American	0.395	0.920
BPA	50	Other	0.050	0.251
BPA	95	All	0.675	0.003
BPA	95	White non-Hispanic	0.213	0.019
BPA	95	Black non-Hispanic	0.877	0.663
BPA	95	Mexican-American	0.500	< 0.001
BPA	95	Other	0.087	< 0.001

* "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 BPA in children ages 6 to 17 years, for 2013-2016 (trends for 2003-2016).

					P-VALUES	
Variable	**Percentile**	**From**	**To**	**Against**	**Unadjusted**	**Adjusted***
BPA	50	2013	2016	age	0.586	0.009
BPA	50	2013	2016	income	1.000	0.069
BPA	50	2003	2016	year	< 0.001	< 0.001
BPA	95	2013	2016	age	0.694	< 0.001
BPA	95	2013	2016	income	0.675	0.003
BPA	95	2003	2016	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.

Data Files

The following files are needed to calculate this indicator. 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/nhanes_questionnaires.htm.

- NHANES 2003-2004: Demographic file demo_c.xpt. Environmental Phenols laboratory file l24eph_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 Environmental Phenols laboratory file l24eph_c.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code (URDBPHLC), and the two-year Mobile Examination Center (MEC) sub-sample C weight (WTSC2YR). The two files are merged using the common variable SEQN.

- NHANES 2005-2006: Demographic file demo_d.xpt. Environmental Phenols and Parabens laboratory file eph_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 Environmental Phenols and Parabens laboratory file eph_d.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code (URDBPHLC), urine creatinine (URXUCR) 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. Environmental Phenols laboratory file eph_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 Environmental Phenols laboratory file eph_e.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code (URDBPHLC), and the two-year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN. Note that these files were downloaded in October 2011 and so include the corrected subsample weights released in September 2011.

- NHANES 2009-2010: Demographic file demo_f.xpt. Environmental Phenols laboratory file eph_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 Environmental Phenols laboratory file eph_f.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code

(URDBPHLC), 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. Environmental Phenols & Parabens laboratory file eph_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 Environmental Phenols & Parabens laboratory file eph_g.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code (URDBPHLC), 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. Personal Care and Consumer Product Chemicals and Metabolites laboratory file ephpp_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 Personal Care and Consumer Product Chemicals and Metabolites laboratory file ephpp_h.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code (URDBPHLC), 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. Personal Care and Consumer Product Chemicals and Metabolites laboratory file ephpp_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 Personal Care and Consumer Product Chemicals and Metabolites laboratory file ephpp_i.xpt contains SEQN, urine BPA (URXBPH), the BPA non-detect comment code (URDBPHLC), and the two-year MEC sub-sample B weight (WTSB2YR). The two files are merged using the common variable SEQN.