Introduction to Biomonitoring Topics

What is biomonitoring?

Biomonitoring refers to the measurement of chemicals in human body fluids and tissues, such as blood, urine, breast milk, saliva, and hair. Measurements of the levels of pollutants in children's bodies provide direct information about their exposures to environmental contaminants. Measurements in women who may become pregnant, currently are pregnant, or currently are breastfeeding provide information about exposures that potentially can affect conception, the fetus, or the developing child.

Biomonitoring measurements provide an estimate of the amount of a chemical absorbed into the body from all pathways of exposure (e.g., ingestion of drinking water, inhalation of air), and thus give a cumulative estimate of the chemical burden that a person carries in their body, sometimes referred to as a body burden. Biomonitoring can identify differences in exposure among different groups within a population, and can identify changes in population exposure over time. Biomonitoring is frequently an important element of epidemiological research that seeks to determine whether chemical exposures are associated with adverse health effects in humans.

What environmental chemicals are included in the draft indicators for *America's Children and the Environment, Third Edition (ACE3)*?

Biomonitoring topics were selected for ACE3 based on: (1) research findings that indicate particular concerns for children's health; and (2) the nature of the biomonitoring data available (for example, range of ages for which data are available and frequency of detection). EPA obtained input from its Children's Health Protection Advisory Committee to assist in selecting topics from among the many chemicals with biomonitoring data available. The ACE3 biomonitoring indicators address the following topics:

- Lead
- Mercury
- Cotinine (a marker for environmental tobacco smoke exposure)
- Polychlorinated biphenyls (PCBs)
- Polybrominated diphenyl ethers (PBDEs)
- Perfluorochemicals (PFCs)
- Perchlorate
- Phthalates
- Bisphenol A

For many of these chemicals, scientific findings indicate concerns for children's health associated with the mother's exposure during pregnancy. For this reason, indicators for several of these topics present data for women of child-bearing age—defined here as ages 16 to 49 years.

What data sources were used to develop the biomonitoring indicators?

Biomonitoring data are generated by collecting samples of blood, urine or other biological specimens from a group of individuals, and by then measuring the concentrations of selected chemicals in those specimens. In the United States, the National Health and Nutrition Examination Survey (NHANES) conducted by the Centers for Disease Control and Prevention (CDC) measures chemicals in the blood and urine of a representative sample of the national population. NHANES is the source of all of the data for the biomonitoring indicators in ACE3. More than 200 environmental chemicals are currently measured in NHANES. For most of these chemicals, data are available starting in 1999 or more recently; measurement of lead and cotinine began earlier. Many other scientific research efforts collect biomonitoring data in the United States, but only NHANES provides measurements from a representative sample of the national population.

For environmental chemicals measured in urine, NHANES collects data from survey participants ages 6 years and older. For most environmental chemicals measured in blood, NHANES collects data from survey participants ages 12 years and older. Measurements of lead and mercury in blood are conducted for children and adults ages 1 year and older, and measurements of cotinine in blood are conducted for children and adults ages 3 years and older.

What can we learn from biomonitoring indicators?

Biomonitoring indicators in ACE3 provide summaries of biomonitoring measurements in blood or urine specimens obtained from a representative population group—either children within a specified age range, or women of child-bearing age. For chemicals that are persistent in the human body, biomonitoring measurements may be reflective of exposures that have occurred over several months or years. For chemicals that are cleared from the body more rapidly, a biomonitoring measurement may typically reflect exposures that have occurred within the previous 1–2 days.

The draft biomonitoring indicators prepared for ACE3 focus first on presenting biomonitoring data collected over multiple years, to see if the measured concentrations are increasing, decreasing, or not changing over time. An additional focus is to see if any particular groups (defined by race/ethnicity and income or by age) within the population have chemical concentrations that are higher or lower than other groups.

When combined with other information on hazards posed by chemicals, biomonitoring data may be able to provide a sense of the proportion of a population at risk for adverse health effects; however, in most cases information on health risks associated with levels of chemicals in blood or urine typical for the general population is limited. For some chemicals, such as lead and cotinine, there is an extensive body of literature demonstrating that adverse effects can occur in children with levels of exposure commonly experienced in the general population. However, biomonitoring by itself does not provide information about whether any adverse effects have occurred in an individual or in the population.

An important limitation of biomonitoring is that it provides few clues to the source(s) of exposure. For example, lead in children's blood may come from exposure to airborne sources, contaminated water or food, or contaminated soil or dust.

What information is provided in the draft biomonitoring indicator documents?

THIS INFORMATION IS DISTRIBUTED SOLELY FOR THE PURPOSE OF PRE-DISSEMINATION PEER REVIEW UNDER APPLICABLE INFORMATION QUALITY GUIDELINES. IT HAS NOT BEEN FORMALLY DISSEMINATED BY EPA. IT DOES NOT REPRESENT AND SHOULD NOT BE CONSTRUED TO REPRESENT ANY AGENCY DETERMINATION OR POLICY.

There is a separate document for each of the nine biomonitoring topics. An introduction section explains the importance of the chemical for children's health, including a discussion of typical exposure pathways and scientific findings concerning possible adverse health effects.

The introduction section is followed by a description of the indicators, including a summary of the data available from NHANES for the specific chemical or chemical group and information on how each indicator was calculated. One or two indicators, each a graphical presentation of the available data, are included for each topic. Where data are available for a sufficient number of years (at least three NHANES two-year cycles), the indicator presents a time series. When time series data are not available, the indicator shows a comparison of the most current biomonitoring data by race/ethnicity and income level. All indicator figures present median (50^{th} percentile) values; some time series figures also provide 95^{th} percentile values. These values are meant to represent typical and high end exposures, respectively. Beneath each figure are explanatory bullet points highlighting key findings from the data presented in the figure, along with key data from any supplemental data tables.

Following the indicator figures and bullet points, each document provides data tables, references, metadata, and details of how the indicators were calculated. When ACE3 is completed, this documentation will be available in appendices and in online files. The detailed information on the calculation of the indicators and statistical testing will not be included in the published report, but will be available through the ACE website.

How were the indicators calculated and presented?

Data files: All indicators were calculated by downloading NHANES data files from the CDC website. Files include values for the biomonitoring measurement, and information on the sampled individual's age, sex, race/ethnicity, and income level (i.e., family income above or below poverty level). Each individual observation also has a survey weight that is used in calculating population statistics; the weight equals the number of people in the U.S. population represented by the particular observation.

Population age groups: Indicators of biomonitoring data in children used all data available for children ages 17 years and younger, except for lead where the indicator focuses on children ages 5 years and younger. Indicators of biomonitoring data in women of child-bearing age used all

available data for women ages 16 to 49 years. Adjustments were applied to the population distribution for women ages 16 to 49 years to incorporate birth rates specific to age and race/ethnicity. These adjustments give greater weight to women of ages more likely to give birth, and are detailed in the draft indicator documents.

Calculation of 50^{th} and 95^{th} percentiles over specified time periods: For all ACE3 biomonitoring indicators, the 50^{th} and 95^{th} percentile values were selected as the indicator statistics to represent the central tendency and upper end of the exposure distribution. Where data are available for at least three 2-year NHANES survey periods, the indicator presentation focuses on how the measured values have changed over time. If data are available for only one or two NHANES survey periods, the indicator presentation focuses on demographic comparisons. For comparisons of biomonitoring data between different population groups (defined by race/ethnicity or income), four-year data sets were used to ensure that there were a sufficient number of observations for each population group. These were calculated for all chemicals considered in the indicators. All calculations incorporated the NHANES survey weights.

Statistical considerations in presenting and characterizing the indicators: In some cases, calculated indicator values have substantial uncertainty. Uncertainty in these estimates is assessed by looking at the relative standard error (RSE), a measure of how large the variability of the estimate is in relation to the estimate (RSE = standard error divided by the estimate). The estimate should be interpreted with caution if the RSE is at least 30%; a notation is provided for such estimates in the indicator figures and tables. If the RSE is greater than 40%, the estimate is considered to have very large uncertainty and is not reported. In addition, statistical analysis has been applied to the indicators to determine whether any changes in concentration levels over time, or any differences in concentration levels between demographic groups, are statistically significant.