Frequently Asked Questions: CDC's *Third National Report on Human Exposure to Environmental Chemicals*

What is the *Report*?

The *National Report on Human Exposure to Environmental Chemicals* provides an ongoing assessment of the U.S. population's exposure to environmental chemicals using biomonitoring. Biomonitoring is the direct assessment of people's exposure to chemicals by measuring the chemicals or their breakdown products (metabolites) in blood or urine.

The *First National Report on Human Exposure to Environmental Chemicals* was issued in March 2001 and presented exposure data for 27 chemicals from the 1999 National Health and Nutrition Examination Survey (NHANES 1999). The *Second Report*, released in January 2003, presented biomonitoring exposure data for 116 environmental chemicals (including the 27 in the *First Report*) for the noninstitutionalized, civilian U.S. population over the 2-year period 1999-2000.

The *Third Report* provides information on 148 chemicals and is the most extensive assessment ever of the exposure of the U.S. population to environmental chemicals. CDC's Environmental Health Laboratory at the National Center for Environmental Health conducted all measurements for the *Third Report*. The *Third Report* does not provide new health or toxicity information, state- or community-specific data, specific product or environmentally related information, or regulatory guidelines or recommendations.

What's in the *Report*?

The *Third Report* provides current exposure information about levels of environmental chemicals found in the blood or urine of people who took part in a national survey conducted by CDC's National Center for Health Statistics. This survey is called the National Health and Nutrition Examination Survey (NHANES). For more information about the survey, see the section titled "Questions about NHANES." The *Third Report* presents data for the years 1999-2002.

What chemicals are included in the *Third Report*?

CDC measured levels of 148 chemicals for this *Third Report*. These chemicals, grouped into categories, are as follows:

- Metals (such as lead, cadmium, and mercury)
- Cotinine (a metabolite of nicotine that tracks exposure to tobacco and tobacco smoke)
- Organochlorine pesticides
- Organophosphate pesticides
- Pyrethroid pesticides
- Carbamate insecticides
- Other pesticides and herbicides
- Phthalates
- Dioxins, furans, and polychlorinated biphenyls
- Polycyclic aromatic hydrocarbons (commonly known as PAHs)
- Phytoestrogens

What statistical information is given for each chemical?

For each chemical, the *Third Report* presents descriptive statistics about the distribution of blood or urine levels of the chemical in the population. Statistics include geometric means and percentiles with confidence intervals. Percentiles provide additional information about the shape of the distribution. For all chemicals, the 50th, 75th, 90th, and 95th percentiles are presented. Data are presented for the total population as well as by age, sex, and race or ethnicity.

How can people use the *Report*? Why are these measurements important?

The overall purpose of the *Report* is to provide unique exposure information to scientists, public health officials, and physicians to help prevent disease that results from exposure to environmental chemicals. Specific uses of the *Report* are:

- To determine which of the chemicals CDC measured are getting into the U.S. population. The results presented in this and future *Reports* will prove invaluable in helping set priorities for research on human health risks resulting from exposure to environmental chemicals.
- For chemicals that have a known toxicity level, to measure the number of people in the U.S. population with levels above that toxicity levels.

- To establish reference ranges that physicians can use to determine whether a person has an unusually high level of an environmental chemical in his or her blood or urine.
- To assess the effectiveness of public health efforts to reduce the exposure of the U.S. population to specific environmental chemicals (e.g., pesticides).
- To determine whether levels of environmental chemicals are higher among minorities, children, women of childbearing age, the elderly, the poor, or other population groups.
- To track, over time, trends in the levels of exposure of the U.S. population to environmental chemicals.

How did CDC decide which chemicals to include in the *Third Report*?

Chemicals in the *Third Report* were selected on the basis of scientific data that suggested exposure in the U.S. population; the seriousness of health effects known or thought to result from some levels of exposure; the need to assess the efficacy of public health actions to reduce exposure to a chemical; the availability of an analytical method that is accurate, precise, sensitive, specific, and rapid; the availability of adequate blood or urine samples; and the incremental analytical cost to perform the analyses.

In March 2002, CDC sought public comment on its proposed criteria for selecting environmental chemicals or categories of chemicals for inclusion in future releases of the *Report* by placing a notice in the Federal Register, Vol. 67, No. 34, March 20, 2002, pages 12996-7. In October 2002, CDC solicited nominations for chemicals or categories of chemicals for inclusion in future *Reports* by placing a notice in the *Federal Register*, Vol. 67, No. 194, October 7, 2002, pages 62477-8. In September 2003, CDC announced candidate chemicals for possible inclusion in future *Reports* by placing a notice in the Federal Register, Vol. 68, No. 189, September 30, 2003, pages 56296-8.

Some chemicals that were nominated appeared in the *Second Report.* In addition, other chemicals or groups of chemicals that were already scheduled for inclusion in either the third or fourth release of the *Report* were not reviewed by the external expert panel and thus do not appear on the list. Chemicals or chemical categories already slated for inclusion in future *Reports*, are listed in the link below.
Nominated Chemicals Already Planned for Inclusion in Future *Reports*

What methods did CDC use to analyze these chemicals? Where can I find more information about these chemicals?

To measure these chemicals or their metabolites in blood and urine, CDC's Environmental Health Laboratory (Division of Laboratory Sciences, National Center for Environmental Health) used these analytical methods: isotope dilution mass spectrometry, inductively coupled plasma

mass spectrometry, and graphite furnace atomic absorption spectrometry. You can find information on the methods used in the following journal articles:

Cotinine

Bernert JT, Turner WE, Pirkle JL, Sosnoff CS, Akins JR, Waldrep MK, et al. Development and validation of a sensitive measurement of serum cotinine in both smokers and nonsmokers by liquid chromatography/atmospheric pressure ionization tandem mass spectrometry. Clin Chem 1997;43:2281-91.

Bernert JT, McGuffey JE, Morrison MA, Pirkle JL. Comparison of serum and salivary cotinine measurements by a sensitive high-performance liquid chromatography/tandem mass spectrometry method as an indicator of exposure to tobacco smoke among smokers and nonsmokers. J Anal Toxicol 2000;24:333-9.

Dioxins, Furans, PCBs, Organochlorine Pesticides

Barr JB, Maggio VL, Barr DB, Turner WE, Sjodin A, Sandau CD, et al. New high-resolution mass spectrometric approach for the measurement of polychlorinated biphenyls and organochlorine pesticides in human serum. J Chromatog B 2003;794:137-48.

Patterson DG Jr., Alexander LR, Turner WE, Isaacs SG, Needham LL. The development and application of a high resolution mass spectrometry method for measuring polychlorinated dibenzo-p-dioxins and dibenzofurans in serum. In: Clement RE, Sui KM, Hill HH Jr., editors. Instrumentation for trace organic monitoring. Chelsea, MI: Lewis Publishers; 1990. p. 119-53.

Patterson DG Jr., Hampton L, Lapeza CR Jr., Belser WT, Green V, Alexander L, et al. High resolution gas chromatographic/high resolution mass spectrometric analysis of human serum on a whole weight and lipid basis for 2,3,7,8 TCDD. Anal Chem 1987;59:2000-5.

Turner WE, DiPietro E, Cash TP, McClure PC, Patterson DG Jr., Shirkhan H. An improved SPE extraction and automated sample cleanup method for serum PCDDs, PCDFs, and coplanar PCBs. Organohalogen Compounds 1994;19:31-5.

Turner WE, DiPietro E, Lapeza CR, Jr., Green V, Gill J, Patterson DG Jr., et al. Universal automated cleanup system for the isotope-dilution high-resolution mass spectrometric analysis of PCDDs, PCDFs, coplanar PCBs, PCB congeners, and persistent pesticides from the same serum sample. Organohalogen Compounds 1997;31:26-31.

Metals

Caldwell KL, Hartel J, Jarrett J, Jones RL. Inductively coupled plasma mass spectrometry to measure multiple toxic elements in urine in NHANES 1999-2000. Atomic Spectroscopy 2005;26(1):1-7.

Chen HP, Paschal DC, Miller DT, Morrow JC. Determination of total and inorganic mercury in whole blood by on-line digestion with flow injection. Atomic Spectroscopy 1998;19:176-9.

Miller, DT, Paschal DC, Gunter EW, Stroud PE, D'Angelo J. Determination of lead in blood using electrothermal atomization atomic absorption spectrometry with a L'vov platform and matrix modifier. Analyst 1987;112:1701-4.

Paschal DC, Ting BG, Morrow JC, Pirkle JL, Jackson RJ, Sampson EJ, et al. Trace metals in urine of United States residents: reference range concentrations. Environ Res 1998;76:53-9.

Stoeppler M, Brandt K. Determination of cadmium in whole blood and urine by electrothermal atomic-absorption spectrophotometry. Fresnius A Anal Chem 1980;300:372-80.

Pesticide Metabolites

Bravo R, Caltabiano LM, Fernandez C, Smith KD, Gallegos M, Whitehead RD, et al. Quantification of phenolic metabolites of environmental chemicals in human urine using gas chromatography-tandem mass spectrometry and isotope dilution quantification. J Chromatog B. In press 2005. Available online: 26 April 2005, doi:10.1016/j.jchromb.2005.03.012.

Bravo R, Caltabiano LM, Weerasekera G, Whitehead RD, Fernandez C, Needham LL, et al. Measurement of dialkyl phosphate metabolites of organophosphorus pesticides in human urine using lyophilization with gas chromatography-tandem mass spectrometry and isotope dilution quantification. J Expo Anal Environ Epidemiol 2004;14:249-59.

Bravo R, Driskell WJ, Whitehead RD Jr, Needham LL, Barr DB. Quantitation of dialkyl phosphate metabolites of organophosphate pesticides in human urine using GC-MS-MS with isotopic internal standards. J Anal Toxicol 2002;26:245-52.

Hill RH Jr, Shealy DB, Head SL, Williams CC, Bailey SL, Gregg M, et al. Determination of pesticide metabolites in human urine using isotope dilution technique and tandem mass spectrometry. J Anal Toxicol 1995;19(5):323-9.

Olsson AO, Baker SE, Nguyen JV, Romanoff LC, Udunka SO, Walker RD, et al. A liquid chromatography-tandem mass spectrometry multiresidue method for quantification of specific metabolites of organophosphorus pesticides, synthetic pyrethroids, selected herbicides, and DEET in human urine. Anal Chem 2004;76(9):2453-61.

Polycyclic Aromatic Hydrocarbons

Smith CJ, Huang WL, Walcott CJ, Turner WE, Grainger J, Patterson DG Jr. Quantification of monohydroxy-PAH metabolites in urine by solid-phase extraction with isotope dilution GC-HRMS. Analytical and Bioanalytical Chemistry 2002;372:216-20.

Li Z, Romanoff LC, Young KJ, Blakely NC III, Wei RW, Needham LL, et al. Biomonitoring of human exposure to polycyclic aromatic hydrocarbons (PAH) and diesel exhaust by measurement of urinary biomarkers. Epidemiology 2004;15(4):S75.

Phthalate Metabolites

Blount BC, Milgram KE, Silva M, Malek N, Reidy J, Needham LL, et al. Quantitative detection of eight phthalate metabolites in human urine using HPLC-APCI-MS/MS. Anal Chem 2000;72:4127-34.

Silva MJ, Malek NA, Hodge CC, Reidy JA, Kato K, Barr DB, et al. Improved quantitative detection of 11 urinary phthalate metabolites in humans using liquid chromatography-atmospheric pressure chemical ionization tandem mass spectrometry. J Chromatog B 2003;789:393-404.

Silva MJ, Slakman AR, Reidy JA, Preau JLJ, Herbert AR, Samandar E, et al. Analysis of human urine for 15 phthalate metabolites using automated solid-phase extraction. J Chromatog B 2004;805:161-7.

Phytoestrogens

Valentin-Blasini L, Blount BC, Rogers HS, Needham LL. HPLC-MS/MS method for the measurement of seven phytoestrogens in human serum and urine. J Expo Anal Environ Epidemiol 2000;10:799-807.

Kuklenyik Z, Ye X, Reich JA, Needham LL, Calafat AM. Automated on-line and off-line solid phase extraction methods for measuring isoflavones and lignans in urine. J Chromatogr Sci 2004; 42:495-500.

What does finding these levels in people's bodies mean? Are the levels dangerous?

Just because we can detect levels of an environmental chemical in a person's blood or urine does not necessarily mean that the chemical will cause disease. Advances in analytical chemistry enable us to measure low levels of environmental chemicals in people, but we need to conduct more studies of varying levels of exposure to determine which levels cause health effects.

Scientists have already conducted extensive research on the human health effects of exposure to lead. CDC has published guidelines on preventing lead poisoning among children (see www.cdc.gov/nceh/lead/lead.htm) that are based on lead levels in blood. CDC's National Tobacco Control Program (www.cdc.gov/tobacco) is working to reduce the exposure of nonsmokers to environmental tobacco smoke. However, for many environmental chemicals, few studies are available; more research must be done to assess health risks associated with the varying blood or urine levels of these chemicals that are documented in the *Report*.

Is CDC involved in other studies to determine the sources of and the health effects caused by these exposures?

CDC's Environmental Health Laboratory at the National Center for Environmental Health collaborates with other federal agencies, academic institutions, governments, and other organizations on about 50 to 70 studies of exposure to environmental chemicals each year. These studies address (1) health effects resulting from exposure, (2) sources of exposure, and (3) how chemicals are processed in the body. Here are some examples of topics the collaborative studies address:

Cotinine

- The impact that exposure to environmental tobacco smoke has on children's asthma
- Evaluation of interventions to reduce nonsmokers' exposure to tobacco smoke in the home, workplace, and public places

Organochlorine Pesticides

- The relation between exposure to pesticides and adverse birth outcomes

Dioxin

- Association between levels of dioxin and breast cancer among women
- Dioxin concentrations in Vietnam veterans who used Agent Orange (a defoliant that contains dioxin)

Multiple Chemicals

- The relation between fertility and exposure to environmental chemicals (cotinine, phytoestrogens, organochlorine pesticides, PCBs)
- The health impact of environmental exposures (organophosphate pesticides, organochlorine pesticides, polycyclic aromatic hydrocarbons, phthalates, lead, cotinine, PCBs and other chemicals) in prepubescent girls

What are other organizations doing to study these exposures?

The Agency for Toxic Substances and Disease Registry (ATSDR), the National Institutes of Health (particularly the National Institute of Environmental Health Sciences [NIEHS]), and the Environmental Protection Agency (U.S. EPA) sponsor research that addresses sources and effects of chemical exposures. People can get information online at these sites:

ATSDR Programs: www.atsdr.cdc.gov/atsdrhome.html

NIEHS Research Efforts: www.niehs.nih.gov/external/scirsrch.htm
U.S. EPA Research Efforts: www.epa.gov/ord

Why did CDC measure exposure levels for chemicals that require more research before we can interpret the health significance of these levels in people?

Armed with the knowledge of the levels of chemicals in the *Report*, researchers can study whether health effects occur at these levels. Also, chemicals that are getting into or that are increasing in concentration in the U.S. population merit high priority.

Why did CDC develop the *Report*? Did a particular law mandate it?

The *Report* was not mandated by law. CDC developed the *Report* to address critical information gaps in environmental health. This *Third Report* builds on information contained in the *First* and *Second Reports*, thus increasing knowledge about which environmental chemicals that CDC measures actually get into people and at the concentration of those chemicals in people. This information will improve public health efforts to identify and prevent diseases that may be caused by people's exposure to environmental chemicals.

Although no law required CDC to do the *Report*, a report issued by the General Accounting Office discussed the importance of the availability of information on human exposure to environmental chemicals. In addition, a report titled *The Bush Administration's Record of Environmental Progress* published by the President's Council on Environmental Quality cites the value of the *Report* in providing exposure information to evaluate efforts to improve the nation's health.

What actions should be taken on the basis of findings in this *Third Report*?

People can use the information to become better informed about the chemicals that are in the environment. They can then take action to reduce their exposure to those chemicals. Better exposure information will help us identify and prevent exposure problems.

Here is an example of an action that people can take to reduce their exposure to environmental tobacco smoke (which is tracked by cotinine levels presented in the *Report*). Parents who smoke can go outdoors to smoke to protect their children from exposure to tobacco smoke in the home.

See answers to the question "How can people use the *Report*?" for additional information. The uses listed in those answers may lead to actions taken on the basis of the findings shown in the *Report*.

What are the common sources of exposure to the chemicals listed in the *Report*? How are people exposed? What are the sources of these chemicals in the environment?

Sources of exposure vary by chemical. You can access the *Third Report* and information about specific sources of exposure for each chemical online at www.cdc.gov/exposurereport. A section of the *Report* titled "Toxicology and Health-Risk Information" contains links to both federal and nonfederal sites that provide additional information about these chemicals.

How can people find out what their levels are? Can their doctors perform these tests? If not, can people send samples to CDC or some other laboratory to be tested?

For most of the chemicals listed in the *Third Report*, analyses are not widely available in commercial laboratories. A physician may be able to test people's blood or urine for a few chemicals, such as lead or mercury, that have known health consequences. If necessary, physicians can refer people for further evaluation to a medical specialist, such as a medical toxicologist or a physician who specializes in occupational and environmental medicine. CDC does not perform laboratory tests at the request of individuals.

How often will the information in the *Report* be updated?

Future *Reports* will be released every 2 years. Two years of data provide more stable estimates for the total population as well as adequate sample sizes. Larger population sample sizes enable CDC to analyze levels in some subgroups of the population.

How can people get copies of the *Report*?

People can download the *Report* at this Web site: www.cdc.gov/exposurereport. People can also call toll-free at 1-800-CDC-INFO (1-800-232-4636) and ask for a copy of the entire *Report* or a *Report* summary. People can also ask for fact sheets about some of the chemicals listed in the *Report*. Finally, people can request this information by sending an E-mail to CDCINFO@cdc.gov or writing to:

Public Inquiries
National Center for Environmental Health
Division of Laboratory Sciences
Mail Stop F-20
4770 Buford Highway, NE
Atlanta, Georgia 30341-3724

Questions about NHANES

What is NHANES?

NHANES is a unique program conducted by CDC's National Center for Health Statistics that collects data on the health of people living in the United States through interviews, direct physical examinations, and laboratory tests.

How are people chosen for the survey?

NHANES examines about 5,000 people each year. These people are chosen in a random, scientific sample that is representative of the U.S. population. They are not chosen by name, but rather on the basis of living in a household and neighborhood chosen for the survey.

Why doesn't the *Report* include data on the states or local communities that are included in the survey?

NHANES is a national survey, not a regional or state-based survey, and thus is designed to reflect the health of the nation rather than of individual counties or states that are selected into the survey. To produce accurate estimates at the state or local level would have required a much bigger and much different sample and would have hindered CDC's ability to collect national data.

How much does it cost to conduct NHANES?

The annual cost of conducting the survey is approximately $25 million. This amount includes traveling to 15 survey locations, moving and setting up mobile examination centers, paying staff costs and travel, and maintaining and managing all specialized equipment. It also covers the extensive costs associated with the survey's computerized information systems and the cost of processing of all specimens, from blood and urine to hair and dust. Research and development costs are factored into this equation as well.

How does CDC ensure the confidentiality of NHANES data?

Confidentiality is mandated by law. Section 308(d) of the Public Health Service Act protects the confidentiality of this information. Information that would permit identification of any individual has been collected with a guarantee that it will be held in strict confidence. Identifying information about an individual who participates in the survey is released only to the person's physician or other sources of medical care and only with the written consent of the examinee. All survey staff are legally bound to follow confidentiality procedures. CDC's National Center for Health Statistics has operated under these principles for at least 25 years and has never violated

them.

The *Report* includes data for Mexican Americans, non-Hispanic blacks, and non-Hispanic whites but not for other races or ethnic groups. Why?

No population group is excluded from participation in NHANES. However, the sample sizes for some of these groups are too small to calculate estimates. To produce reliable statistics for Mexican Americans and non-Hispanic blacks, the survey selects larger numbers of these two groups. Currently, it is not economically feasible in this general survey to select larger numbers for all groups for which data are needed.

The number of respondents selected who are Mexican American and non-Hispanic blacks reflects the numbers necessary to ensure that data for each group are reliable and useful. Statistical weighting for final analyses puts all information from individuals back into their proportions for the population. This process, known as "oversampling," is also used for teens and the elderly -- two important populations for which researchers need more data.

Why doesn't the *Third Report* include data on all age groups?

NHANES examines people of all ages; however, the age groups may be limited for some tests on the basis of public health information needs, the availability of biological specimens, or cost.

Where can people find data from NHANES 1999-2000 and 2001-2002?

The information is online at http://www.cdc.gov/nchs/about/major/nhanes/NHANES99_00.htm

http://www.cdc.gov/nchs/about/major/nhanes/nhanes01-02.htm

When will the biomonitoring data be available to the public?

The biomonitoring data presented in the *Third Report* were released May 8, 2005 and are available at the NHANES Web site listed above.

Will other data from NHANES 2000-2002 be available?

Certain data will not be released through public-release files but will be available through the NCHS Research Data Center. For example, because of confidentiality concerns, geographic data will not be released. General information about the release of data from NHANES 2001-2002 is available at the NHANES Web site.

How can people get more information about the NCHS Research Data Center?

More information is available online at www.cdc.gov/nchs/r&d/rdc.htm.

How can people get more information about NHANES and analysis of NHANES data?

Refer to the Web site at http://www.cdc.gov/nchs/about/major/nhanes/nhanes01-02.htm for general information. For analytical guidelines, the URL is www.cdc.gov/nchs/data/nhanes/guidelines1.pdf.

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