Testimony before the Subcommittee on Superfund, Toxics and Environmental Health
Committee on
Environment and Public Works
United States Senate

Current Science on Public Exposures to Toxic Chemicals

Statement of

Henry Falk, MD, MPH
Acting Director,
National Center for Environmental Health,
Centers for Disease Control and Prevention; and
Agency for Toxic Substances and Disease Registry
U.S. Department of Health and Human Services

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Introduction

Good morning Mr. Chairman and Members of the Subcommittee.

My name is Dr. Henry Falk, and I am the Acting Director of the National Center for Environmental Health at the Centers for Disease Control and Prevention (CDC), and of the Agency for Toxic Substances and Disease Registry (ATSDR).

I am pleased to appear today before the Subcommittee to discuss CDC's work in assessing people's exposure to chemicals. My testimony will focus on the biomonitoring program at CDC, and public health uses of biomonitoring.

For approximately three decades, CDC has been using biomonitoring to assess human exposure to selected chemicals (both manmade and naturally occurring). Biomonitoring is the direct measurement of chemicals and naturally occurring compounds or their metabolites in people's blood, urine or tissue. It determines which chemicals—and how much of them—get into people after they have been exposed.

CDC's Biomonitoring Program

I will describe two aspects of CDC's biomonitoring program: assessment of the U.S. population's exposure to chemicals, and targeted studies to examine exposure in vulnerable populations.

How CDC assesses the U.S. population's exposure to chemicals: CDC's Environmental Health Laboratory measures chemicals or their metabolites in blood and urine samples from participants in the National Health and Nutrition

Examination Survey (NHANES). NHANES, which is conducted by CDC's National Center for Health Statistics, involves a complete physical exam, a detailed questionnaire that collects more than 1,000 pieces of information, and the collection of blood and urine samples. The survey, which is nationally representative of the U.S. population, has been conducted multiple times since the 1970s and became a continuous survey in 1999 with two-year survey cycles. With some exceptions, most urine measurements are done in participants ages 6 years and older, and most serum measurements are done in participants age 12 years and older. Thus, the exposure information it provides on young children is limited, mostly due to the difficulty in obtaining large enough blood and urine samples from them. Currently blood levels of lead, cadmium, and mercury are measured in children aged 1 year and older, and cotinine, which is a marker for environmental tobacco smoke exposure, is measured in children aged 3 years and older.

CDC scientists publish significant biomonitoring findings from NHANES in peer-reviewed publications, and then CDC periodically publishes a summary report, the National Report on Human Exposure to Environmental Chemicals. The Fourth Exposure Report was released in December 2009, and summarizes blood and urine levels for 212 chemicals, including levels for 75 chemicals which had never before been measured in a representative sample of the U.S. population. Findings show evidence of widespread exposure in the U.S. population to some commonly-used commercial chemicals such as bisphenol-A (BPA), the perfluorinated compound known as PFOA, and a type of fire retardant known as BDE-47. The Fourth Exposure Report also notes continued progress in reducing

children's exposure to lead.

The data in the Fourth Exposure Report provide unique exposure information that can be used by scientists, physicians, and health officials for a variety of public health purposes, such as to: determine which chemicals get into Americans' bodies and at what concentrations; determine what proportion of the population has levels above those associated with adverse health effects for chemicals with a known toxicity level; establish reference values that can be used by physicians and scientists to determine whether a person or group has an unusually high exposure; track over time trends in levels of exposure of the population; assess the effectiveness of public health efforts to reduce exposure of Americans to specific chemicals; determine whether exposure levels are higher among minorities, children, women of childbearing age, or other special groups; and direct priorities for research on human health effects from exposure.

Chemicals analyzed from the NHANES samples and reported in the Fourth Report were selected based on known or hypothesized exposure in the U.S. population; scientific data on the 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 with known health effects; the availability of an analytical method that is accurate, precise, sensitive, and specific; the availability of adequate blood or urine samples from the NHANES survey; and the analytical cost to perform the analysis. Also, CDC has solicited suggestions for candidate chemicals from the public and other government agencies.

Targeted studies: Each year CDC's Environmental Health Laboratory works with states, other federal agencies, academic institutions and international organizations on 50-70 studies that examine vulnerable populations, particularly newborns, children, pregnant women and population groups or communities known or likely to have higher exposures. For example, one important current partnership is with the Eunice Kennedy Shriver National Institute of Child Health and Human Development at the National Institutes of Health. This partnership involves a pilot study of 525 pregnant women in which CDC is lending analytical and biomonitoring expertise. Scientists at CDC's Environmental Health Lab will measure chemicals in pregnant women's blood and urine and, after delivery, in the newborn's cord blood and mother's breast milk. Cord blood is a promising way to assess prenatal exposure to certain chemicals. However, cord blood is not the best way to measure exposures to chemicals that pass through the body more quickly; these generally are best measured in urine.

Public Health Uses

As distinguished from measurements in environmental samples, such as air, soil, water, food, and consumer products, biomonitoring measurements have the advantage of indicating the amount of a chemical that actually gets into people, rather than extrapolating from measurements of environmental media. Although biomonitoring is far ahead of the science of interpreting what exposures mean for health, biomonitoring data is valuable, and CDC uses it for a range of public health purposes, including to establish reference ranges in the population and to identify groups of people with higher levels of exposure than those typical for the

U.S. population. In addition, by tracking exposures in the U.S. population, we can detect trends in people over time, and assess whether a chemical is present in large numbers of people, or is disproportionately present in vulnerable subgroups, such as children. This information can be used by scientists and policy makers as one of the considerations in setting priorities for evaluating health impacts of chemicals. Biomonitoring thereby serves as one important tool in identifying and reducing or preventing exposures and potential health problems.

A National Research Council review of biomonitoring noted that it has been a key tool in some landmark public health actions (NRC, 2006). One example is lead. Our laboratory has been measuring lead in the NHANES blood samples since 1976. Many of the effects of lead can be benchmarked to blood lead concentrations. Lead is highly toxic, especially to young children, and can harm a child's brain, kidneys, bone marrow, and other body systems. It can cause decrements in cognitive ability and IQ and at very high levels can cause coma, convulsions, and death.[1] Our laboratory analysis of the NHANES samples, which showed that the American population's blood lead levels were declining in parallel with declining levels of lead in gasoline, provided critical support for the Environmental Protection Agency (EPA) regulations that reduced lead in gasoline (GAO, 2000). CDC and EPA have used this decline in blood lead levels over time to demonstrate that the removal of lead from gasoline had a dramatic impact on the levels of lead in the U.S. population. Today, the most common source of children's exposure to lead is from dust and soil derived from lead-based paints in older homes.[2] In the late 1970s, CDC used the NHANES data to document

that 88 percent of children had blood lead levels above 10 µg/dL, the current level of concern. Data from the Fourth Exposure Report demonstrate that collaborative public health efforts by CDC, EPA, NIEHS, the Department of Housing and Urban Development, and others reduced children's exposure to lead. For the period 1999–2004, only 1.4% of children aged 1 to 5 years had elevated blood lead levels.

Biomonitoring also can be used to monitor the effectiveness of interventions designed to reduce exposures. In the early 1990s, our laboratory analysis of cotinine data from NHANES showed that 88 percent of the nonsmoking population was exposed to secondhand tobacco smoke. This finding was used by state and local areas as a justification for restricting smoking in public places. Over the past 15 years, NHANES data have shown that exposure to secondhand smoke in nonsmokers has decreased about 70 percent, indicating that public health interventions to reduce exposure have been successful.

Conclusion

In conclusion, biomonitoring provides solid human data that can assist in making important health decisions. Better exposure information means that we can make better decisions to protect the health of the public.

CDC is fully committed to working with other federal agencies and partners to improve the uses and benefits of biomonitoring. Thank you Mr. Chairman and members of the Subcommittee. I look forward to answering any questions you may have.

References

National Research Council (2006). Human Biomonitoring for Environmental Chemicals. The National Academies Press, Washington, D.C.

United States General Accounting Office (2000). Toxic Chemicals: Long-Term Coordinated Strategy Needed to Measure Exposures in Humans. Washington, D.C.

Fourth National Report on Human Exposure to Environmental Chemicals: http://www.cdc.gov/exposurereport/

NHANES Web Site: http://www.cdc.gov/nchs/nhanes.htm

[1] *Eliminating Childhood Lead Poisoning: A Federal Strategy Targeting Lead Paint Hazards*. Washington, DC: President's Task Force on Environmental Health Risks and Safety Risks to Children; 2000.

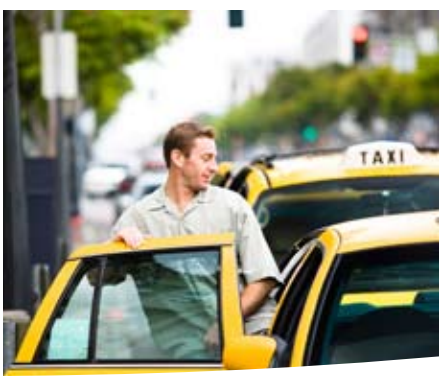
[2] Lanphear BP, Roghmann KJ. Pathways of lead exposure in urban children. Environ Res. 1997;74(1):67-73




2009

Fourth National Report on Human Exposure to Environmental Chemicals





Executive Summary

Department of Health and Human Services
Centers for Disease Control and Prevention
National Center for Environmental Health




Background

The *National Report on Human Exposure to Environmental Chemicals (National Exposure Report)* is a series of ongoing assessments of the U.S. population's exposure to environmental chemicals by measuring chemicals in people's blood and urine, also called biomonitoring. The *Fourth National Report* on *Human Exposure to Environmental Chemicals* (*Fourth Report*) presents exposure data for 212 environmental chemicals for the civilian, noninstitutionalized U.S. population. This *Fourth Report* includes results from 2003–2004, as well as data from1999–2000 and 2001–2002 as reported in the *Second* and *Third National Report on Human Exposure to Environmental Chemicals*.

To obtain data for this *Fourth Report*, the Centers for Disease Control and Prevention (CDC)'s Environmental Health Laboratory at the National Center for Environmental Health measured chemicals or their metabolites in blood and urine from a random sample of participants from the National Health and Nutrition Examination Survey (NHANES). CDC's National Center for Health Statistics conducts NHANES, which is a series of surveys on the health status, health-related behaviors, and nutrition of the U.S. population. Since 1999, NHANES has been conducted in continuous two-year survey cycles.

For the *National Exposure Report*, an environmental chemical refers to a chemical compound or chemical element present in air, water, food, soil, dust, or other environmental media, such as consumer products. Blood and urine levels reflect the amount of the chemical that actually gets into the body from the environment. Either the chemical or its metabolite is measured. A metabolite is a substance produced when body tissues chemically alter the original compound.

The *Fourth Report* includes results for 75 chemicals measured for the first time in the U.S. population. These chemicals are in the following groups:

- acrylamide and glycidamide adducts;
- arsenic species and metabolites;
- environmental phenols, including bisphenol A and triclosan;
- perchlorate;
- perfluorinated chemicals;
- polybrominated diphenyl ethers;
- volatile organic compounds; and
- some additions to chemical groups previously measured.

A complete listing of the 75 new chemicals is given on page 10. A full listing of the chemicals included in the *Fourth Report* is available at http://www.cdc.gov/exposurereport/pdf/NER_Chemical_List.pdf.

Interpreting the Data

The presence of an environmental chemical in people's blood or urine does not mean that it will cause effects or disease. The toxicity of a chemical is related to its dose or concentration, in addition to a person's individual susceptibility. Small amounts may be of no health consequence, whereas larger amounts may cause adverse health effects. Research studies, separate from the *National Exposure Report*, are required to determine the levels of a chemical that may cause health effects and the levels that are not a significant health concern. For some chemicals, such as lead, research studies provide a good understanding of health risks associated with various blood levels. For most of the environmental chemicals included in the *Fourth Report*, more research is needed to determine whether exposure at the levels reported is a cause for health concern. CDC conducts and provides biomonitoring measurements for this type of research in collaboration with other agencies and institutions.

The *Fourth Report* presents data that provides estimates of exposure for the civilian, noninstitutionalized U.S. population. The current survey design does not permit CDC to estimate exposure on a state-by-state or city-by-city basis. For example, CDC cannot extract a subset of data and examine levels of blood lead that represent a state population.

Public Health Uses of *the Fourth Report*

The *Fourth Report* provides unique exposure information to scientists, physicians, and health officials to help prevent effects that may result from exposure to environmental chemicals. Specific public health uses of the exposure information in the *Fourth Report* are to:

- determine which chemicals get into Americans' bodies and at what concentrations;
- determine what proportion of the population has levels above those associated with adverse health effects for chemicals with a known toxicity level;
- establish reference values that can be used by physicians and scientists to determine whether a person or group has an unusually high exposure;
- assess the effectiveness of public health efforts to reduce exposure of Americans to track levels over time;
- determine whether exposure levels are higher among minorities, children, women of childbearing age, or other special groups; and
- direct priorities for research on human health effects from exposure.




First-Time Exposure Information for the U.S. Population Provided for 75 Chemicals

The *Fourth Report*, for the first time, provides population reference values in blood and urine, including 95th percentile levels, for 75 chemicals. The 95th percentile level means that 95% of the population has concentrations below that level. Public health officials use such reference values to determine whether groups of people are experiencing an exposure that is unusual compared with an exposure experienced by the rest of the population.

To provide scientists and public health officials these new data quickly, CDC published much of this exposure information on new chemicals in separate scientific peer-reviewed publications before the *Fourth Report* was released. Abstracts and links to full-text articles are available at http://www.cdc.gov/exposurereport/.

Widespread Exposure to Some Industrial Chemicals

Findings in the *Fourth Report* indicate widespread exposure to some commonly used industrial chemicals.

- Polybrominated diphenyl ethers are fire retardants used in certain manufactured products. These accumulate in the environment and in human fat tissue. One type of polybrominated diphenyl ether, BDE-47, was found in the serum of nearly all of the NHANES participants.
- Bisphenol A (BPA), a component of epoxy resins and polycarbonates, may have potential reproductive toxicity. General population exposure to BPA may occur through ingestion of foods in contact with BPA-containing materials. CDC scientists found bisphenol A in more than 90% of the urine samples representative of the U.S. population.
- Another example of widespread human exposure included several of the perfluorinated chemicals. One of these chemicals, perfluorooctanoic acid (PFOA), was a byproduct of the synthesis of other perfluorinated chemicals and was a synthesis aid in the manufacture of a commonly used polymer, polytetrafluoroethylene, which is used to create heat-resistant non-stick coatings in cookware. Most participants had measurable levels of this environmental contaminant.

Ongoing Progress in Reducing Blood Lead Levels in Children

Progress is being made in reducing children's blood lead levels. New data on blood lead levels in children aged 1 to 5 years enable estimates of the number of children with elevated levels (that is, levels greater than or equal to 10 micrograms per deciliter [µg/dL]). Figure 1 shows how the percentage of blood lead levels in children has declined since the late 1970s. For example, for the period 1999–2004, 1.4% of children aged 1 to 5 years had elevated blood lead levels, the smallest percentage of any of the prior survey periods.

These data document that public health efforts to reduce the number of children with elevated blood lead levels in the general population continue to be successful. However, the *Fourth Report* also notes that other data sources show that special populations of children at high risk for lead exposure (for example, children living in homes containing lead-based paint or lead-contaminated dust) have higher rates of elevated blood lead levels and remain a major public health concern.

First-Time Assessment of Acrylamide Exposure in the U.S. Population

Acrylamide is formed when foods containing carbohydrates are cooked at high temperatures (e.g., French fries) and as a byproduct of tobacco smoke. Most people are exposed to acrylamide through the diet and from smoking. Because acrylamide is a reactive chemical, it can bind to proteins. These reaction products are called adducts. CDC's Environmental Health Laboratory developed a new method to measure acrylamide and its metabolite, glycidamide, as adducts of hemoglobin, a major blood protein. This measure reflects the dose of acrylamide and glycidamide over the previous several months of intake. The data in the *Fourth Report* show that acrylamide exposure is extremely common in the U.S. population.

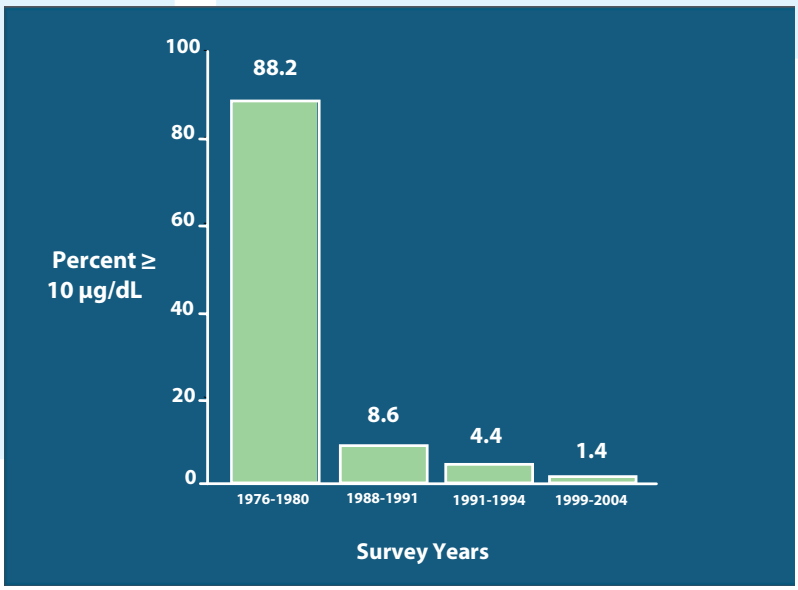


Figure 1. Percentage of children 1-5 years old in the U.S. population with elevated blood lead levels (≥ 10 µg/dL).[1]

[1] *Jones RL, Homa DM, Meyer PA, Brody DJ, Caldwell KL, Pirkle JL, Brown MJ. Trends in blood lead levels and blood lead testing among U.S. children aged 1 to 5 years, 1988–2004. Pediatrics 2009;123(3):e376-e385.*

First Available Exposure Data on Mercury in the U.S. Population

For the first time, the *Fourth Report* characterizes mercury exposure of the U.S. population aged 1 year and older. Previous *National Exposure Reports* presented mercury levels for children 1–5 years old and women 16–49 years old. Total blood mercury levels are primarily composed of one type of mercury, methyl mercury, which enters the body mainly from dietary seafood sources. Findings in the *Fourth Report* show that total blood mercury levels increase with age for all groups and begin to decline after the fifth decade of life. Compared to older women of childbearing age, younger women have higher birth rates and lower mercury levels (see Figure 2).

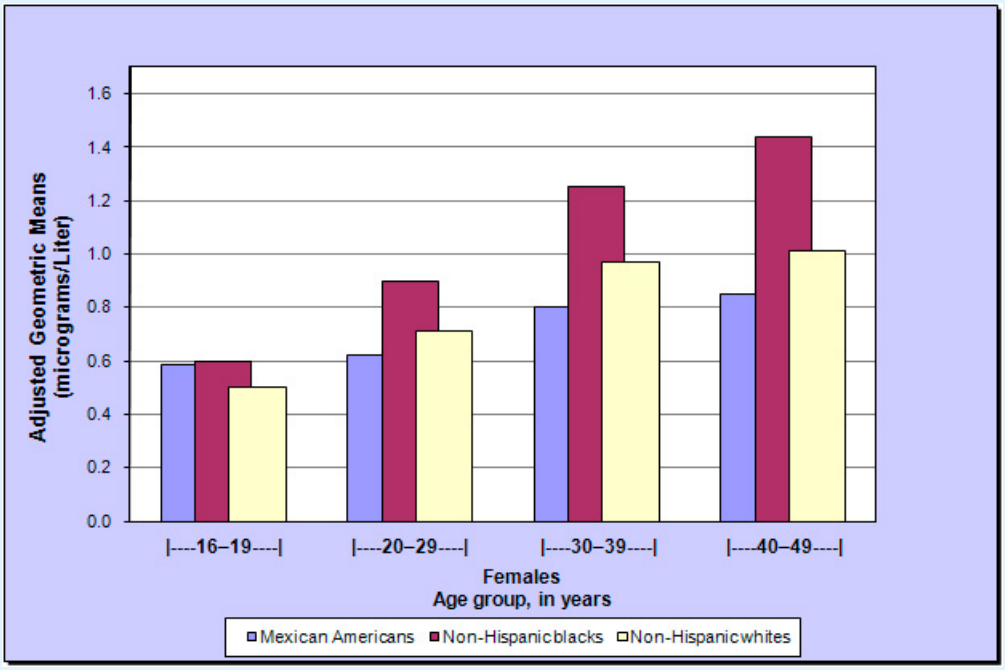


Figure 2. Age-related changes in total blood mercury levels for females aged16-49 by race/ethnicity, 1999-2006.[2]

Eight Different Species and Metabolites of Arsenic Measured

By using special laboratory methods, CDC researchers measured total arsenic and seven other forms of arsenic in the urine of NHANES participants for the first time. Some of the forms of arsenic measured are metabolites of inorganic arsenic and others are less toxic species that are formed in the environment. By differentiating these types of arsenic exposure, the *Fourth Report* helps scientists understand which forms of arsenic are important to human health.

[2] Caldwell KL, Mortensen ME, Jones RL, Caudill SP, Osterloh JD. Total blood mercury concentrations in the U.S. population: 1999-2006. Int J Hyg Environ Health 2009;212:588-598.

Perchlorate and Thyroid Function

The chemical perchlorate is both naturally occurring and manmade and is used to manufacture fireworks, explosives, flares, and rocket propellant. For decades, scientists have known that large medical doses of perchlorate affect thyroid function. Low-level exposure to perchlorate from the environment has been under investigation by many scientists in recent years. The *Fourth Report* shows that all NHANES participants have detectable perchlorate in their urine and provides reference values for urinary perchlorate levels (see Table 1). This knowledge helps scientists target the levels of human exposure for future study.

Urinary Perchlorate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population from the National Health and Nutrition Examination Survey.

	Survey years	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval) 50th	75th	90th	95th	Sample size
Total	01-02	**3.54** (3.29-3.81)	**3.70** (3.50-4.00)	**6.30** (5.80-6.90)	**10.0** (9.10-11.0)	**14.0** (11.0-17.0)	2820
	03-04	**3.22** (2.93-3.55)	**3.30** (2.90-3.80)	**5.50** (5.00-6.40)	**9.50** (8.40-11.0)	**13.0** (12.0-15.0)	2522
Age group							
6-11 years	01-02	**4.93** (4.22-5.76)	**5.20** (4.40-6.40)	**8.10** (6.90-9.80)	**12.0** (9.30-19.0)	**19.0** (12.0-23.0)	374
	03-04	**4.32** (3.67-5.09)	**4.60** (4.00-5.20)	**7.90** (5.70-9.50)	**13.0** (8.81-16.0)	**16.0** (11.0-29.0)	314
12-19 years	01-02	**3.80** (3.44-4.20)	**4.40** (3.80-4.80)	**6.80** (6.30-7.30)	**10.0** (8.90-11.0)	**13.0** (11.0-17.0)	828
	03-04	**3.62** (3.19-4.12)	**3.80** (3.20-4.40)	**6.40** (5.50-7.10)	**9.80** (7.90-12.0)	**13.0** (10.0-18.0)	721
20 years and older	01-02	**3.35** (3.08-3.65)	**3.50** (3.20-3.70)	**5.90** (5.30-6.60)	**10.0** (8.70-11.0)	**13.0** (11.0-17.0)	1618
	03-04	**3.05** (2.75-3.38)	**3.20** (2.70-3.60)	**5.20** (4.70-6.10)	**9.10** (7.90-10.0)	**12.0** (11.0-14.0)	1487
Gender							
Males	01-02	**4.19** (3.93-4.46)	**4.40** (4.20-4.60)	**7.10** (6.40-7.90)	**11.0** (9.70-12.0)	**14.0** (11.0-19.0)	1335
	03-04	**3.75** (3.39-4.16)	**3.90** (3.40-4.40)	**6.40** (5.60-7.50)	**11.0** (9.20-12.0)	**14.0** (13.0-17.0)	1229
Females	01-02	**3.01** (2.74-3.31)	**3.10** (2.70-3.40)	**5.40** (5.00-6.00)	**9.20** (8.20-11.0)	**13.0** (11.0-17.0)	1485
	03-04	**2.79** (2.49-3.11)	**2.90** (2.50-3.20)	**4.90** (4.40-5.50)	**8.20** (6.90-9.84)	**11.0** (8.80-15.0)	1293
Race/ethnicity							
Mexican Americans	01-02	**4.02** (3.47-4.66)	**4.40** (3.70-5.00)	**7.10** (5.80-8.40)	**12.0** (9.40-13.0)	**14.0** (12.0-18.0)	708
	03-04	**3.76** (3.45-4.11)	**3.96** (3.50-4.40)	**6.20** (5.30-7.50)	**11.0** (9.10-12.0)	**15.0** (12.0-17.0)	617
Non-Hispanic blacks	01-02	**3.51** (3.07-4.03)	**3.70** (3.10-4.10)	**5.90** (5.10-7.00)	**9.20** (7.80-12.0)	**15.0** (11.0-20.0)	681
	03-04	**3.21** (2.90-3.56)	**3.20** (2.87-3.50)	**5.40** (4.60-6.30)	**8.60** (7.50-11.0)	**13.0** (9.30-17.0)	652
Non-Hispanic whites	01-02	**3.51** (3.18-3.88)	**3.70** (3.40-4.10)	**6.30** (5.70-7.10)	**10.0** (8.90-11.0)	**14.0** (11.0-18.0)	1228
	03-04	**3.26** (2.89-3.68)	**3.30** (2.80-4.00)	**5.60** (4.90-6.80)	**9.40** (8.10-11.0)	**13.0** (11.0-15.0)	1092

Limit of detection (LOD, see Data Analysis section in full *Report*) for Survey years 01-02 and 03-04 are 0.05 and 0.05. For the 2001-2002 Survey period, surplus samples were used, and data are unavailable at NHANES website.

***Table 1. Urinary Perchlorate as provided in the* Fourth Report.**

Reduced Exposure to Environmental Tobacco Smoke

Environmental tobacco smoke (ETS) has significant health effects on cardiovascular and respiratory disease. Cotinine is a metabolite of nicotine, and for nonsmokers, levels of cotinine in people's blood tracks exposure to ETS. In the past 15 years, data show that blood cotinine levels for nonsmokers in the U.S. population have decreased about 70%, indicating that public health interventions to reduce ETS exposure have been successful.

U.S. Population's Exposure to Volatile Organic Compounds

People are exposed every day to volatile chemicals in the air we breathe. The *Fourth Report* provides measurements on 33 of these hydrocarbon and halohydrocarbon-type chemicals. One example is the gasoline additive methyl *tert*-butyl ether (MTBE). Exposure to this chemical can occur through the air we breathe or from contaminated water sources. A high percentage of the NHANES participants representing the U.S. population showed detectable levels of MTBE.

Exposure to Cadmium

Recent research studies show that urine cadmium levels as low as 1 microgram per gram of creatinine in people may be associated with subtle markers of effects on the kidney and with an increased risk for low bone-mineral density. The *Fourth Report* shows that about 5% of the U.S. population aged 20 years and older has urinary cadmium levels at or near these levels. Cigarette smoking is the most likely source for these higher cadmium levels. These findings should promote further research on the public health consequences of cadmium in people.

Selection of Chemicals for the *Fourth Report*

Chemicals presented in the *Fourth Report* were selected on the basis of scientific data that suggested exposure in the U.S. population; the seriousness of health effects known or suspected to result from exposure; the need to assess the efficacy of public health actions to reduce exposure to a chemical; the availability of a biomonitoring analytical method with adequate accuracy, precision, sensitivity, specificity, and speed; the availability of sufficient quantity of blood or urine samples; and the incremental analytical cost to perform the analyses. More information is available at http://www.cdc.gov/exposurereport/chemical_selection.htm.

Plans for Future *National Exposure Reports*

CDC's goal is to make new biomonitoring exposure information available as soon as possible to the public and scientific community. To meet this goal, CDC periodically releases the *National Exposure Report* and also publishes biomonitoring exposure information in peer-reviewed publications. The *National Exposure Report* is cumulative, providing biomonitoring exposure data starting in 1999 through the latest available data at the time of the report release. Future plans include releasing data on additional chemicals and providing more information on exposure in population groups defined by age, sex, and race or ethnicity. Peer-reviewed journal articles published since the latest release of the *National Exposure Report* provide more recent and supplementary biomonitoring data for the U.S. population. These peer-reviewed publications typically also contain more extensive data analysis than that provided in the *National Exposure Report*.

About CDC's Environmental Health Laboratory

By using advanced laboratory science and innovative techniques, CDC's Environmental Health Laboratory at the National Center for Environmental Health has been at the forefront of efforts to assess people's exposure to environmental chemicals. CDC's laboratory scientists have built on more than three decades of experience in measuring chemicals directly in people's blood or urine, a process known as biomonitoring. Biomonitoring measurements are the most health-relevant assessments of exposure because they measure the total amount of the chemical that actually gets into people from all environmental sources (e.g., air, soil, water, dust, or food). With a few exceptions, the concentration of the chemical in people provides the best exposure information for public health officials to evaluate the potential for adverse health effects.

New Chemicals in the *Fourth Report*

Acrylamide
Acrylamide hemoglobin adducts
Glycidamide hemoglobin adducts

Perchlorate

Total and Speciated Arsenic
Arsenic, Total
Arsenic (V) acid
Arsenobetaine
Arsenocholine
Arsenous (III) acid
Dimethylarsinic acid
Monomethylarsonic acid
Trimethylarsine oxide

Environmental Phenols
Benzophenone-3 (2-Hydroxy-4-methoxybenzophenone)
Bisphenol A (2,2-*bis* [4-Hydroxyphenyl] propane)
4-*tert* -Octylphenol (4-[1,1,3,3-Tetramethylbutyl] phenol)
Triclosan (2,4,4′-Trichloro-2′-hydroxyphenyl ether)

Phthalate Metabolite
Mono-(2-ethyl-5-carboxypentyl) phthalate (MECPP)

Perfluorochemicals
Perfluorobutane sulfonic acid (PFBuS)
Perfluorodecanoic acid (PFDeA)
Perfluorododecanoic acid (PFDoA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexane sulfonic acid (PFHxS)
Perfluorononanoic acid (PFNA)
Perfluorooctane sulfonamide (PFOSA)
Perfluorooctane sulfonic acid (PFOS)
2-(N-Ethyl-perfluorooctane sulfonamido) acetic acid (Et-PFOSA-AcOH)
2-(N-Methyl-perfluorooctane sulfonamido) acetic acid (Me-PFOSA-AcOH)
Perfluorooctanoic acid (PFOA)
Perfluoroundecanoic acid (PFUA)

Non-Dioxin-Like Polychlorinated Biphenyls
2,2′,3,5′-Tetrachlorobiphenyl (PCB 44)
2,2′,4,5′-Tetrachlorobiphenyl (PCB 49)
2,2′,3,3′,4,4′,5,5′,6,6′-Decachlorobiphenyl (PCB 209)

Brominated Fire Retardants
2,2′,4-Tribromodiphenyl ether (BDE 17)
2,4,4′-Tribromodiphenyl ether (BDE 28)
2,2′,4,4′-Tetrabromodiphenyl ether (BDE 47)
2,3′,4,4′-Tetrabromodiphenyl ether (BDE 66)
2,2′,3,4,4′-Pentabromodiphenyl ether (BDE 85)
2,2′,4,4′,5-Pentabromodiphenyl ether (BDE 99)
2,2′,4,4′,6-Pentabromodiphenyl ether (BDE 100)
2,2′,4,4′,5,5′-Hexabromodiphenyl ether (BDE 153)
2,2′,4,4′,5,6′-Hexabromodiphenyl ether (BDE 154)
2,2′,3,4,4′,5′,6-Heptabromodiphenyl ether (BDE 183)
2,2′,4,4′,5,5′-Hexabromobiphenyl (BB 153)

Disinfection By-Products (Trihalomethanes)
Bromodichloromethane
Dibromochloromethane (Chlorodibromomethane)
Tribromomethane (Bromoform)
Trichloromethane (Chloroform)

Volatile Organic Compounds
Benzene
Chlorobenzene (Monochlorobenzene)
1,2-Dibromo-3-chloropropane (DBCP)
Dibromomethane
1,2-Dichlorobenzene (*ortho*-Dichlorobenzene)
1,3-Dichlorobenzene (*meta*-Dichlorobenzene)
1,4-Dichlorobenzene (*para*-Dichlorobenzene)
1,1-Dichloroethane
1,2-Dichloroethane (Ethylene dichloride)
1,1-Dichloroethene (Vinylidene chloride)
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
Dichloromethane (Methylene chloride)
1,2-Dichloropropane
2,5-Dimethylfuran (DMF)
Ethylbenzene
Hexachloroethane
Methyl *tert*-butyl ether (MTBE)
Nitrobenzene
Styrene
1,1,2,2-Tetrachloroethane
Tetrachloroethene (Perchloroethylene)
Tetrachloromethane (Carbon tetrachloride)
Toluene
1,1,1-Trichloroethane (Methyl chloroform)
1,1,2-Trichloroethane
Trichloroethene (Trichloroethylene, TCE)
meta- and *para*-Xylene
ortho-Xylene






Centers for Disease Control and Prevention
National Center for Environmental Health
Division of Laboratory Sciences
Mail Stop F-20
4770 Buford Highway, NE
Atlanta, GA 30341-3724

Telephone: (toll free) 1-800-CDC-INFO (1-800-232-4636)
Email: CDCINFO@cdc.gov
Website: http://www.cdc.gov/exposurereport