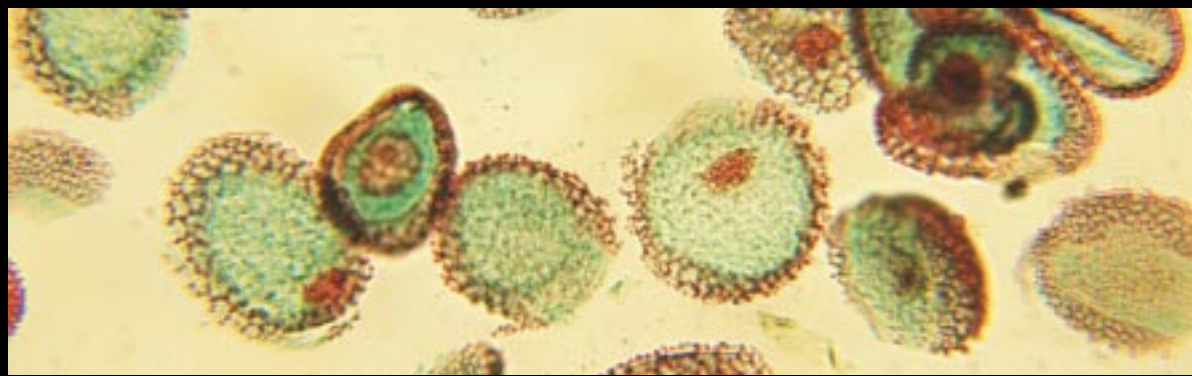
Bearing the Burden

Health Implications of Environmental Pollutants in Our Bodies



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Physicians for Social Responsibility

EXECUTIVE SUMMARY

The full report with chemical profiles is available at www.envirohealthaction.org/bearingtheburden.

Physicians for Social Responsibility (PSR) has a longstanding commitment to informing the public about environmental hazards to human health. Primary hazards of concern are chemicals that contaminate the food we eat, air we breathe, and water we drink. When new scientific data emerge about toxic substances in the environment, PSR is committed to help interpret the findings and make them available to the public.

This summary document includes background information to assist the American public in understanding the results of the 2003 National Report on Human Exposure to Environmental Chemicals (referred to here as the National Exposure Report) developed by the Centers for Disease Control and Prevention (CDC). PSR's full report also includes information about the chemical types in the 2003 National Exposure Report and, for many chemicals, detailed profiles describing potential sources of exposure, health effects, methods for detecting exposure, and federal regulations for protecting human health. The full report is available at www.envirohealthaction.org/bearingtheburden.

This report does not include chemical-specific biomonitoring data from the National Exposure Report. To obtain a copy of CDC's report, visit CDC's web site at http://www.cdc.gov/exposurereport or call CDC's National Center for Environmental Health at 1-866-670-6052.

WHAT IS THE CDC NATIONAL EXPOSURE REPORT?

In 2001, CDC presented the groundbreaking results of a new study describing the exposure of the American public to environmental pollutants. This CDC study was the first in a series of annual reports that is the most comprehensive assessment of its kind. It tries to identify exposures to specific toxic chemicals in the U.S. population. It estimates the degree of exposure by measuring amounts of those pollutants in the body. These data are gathered through biological monitoring, or *biomonitoring*, in which samples of urine or blood are collected from members of the population and analyzed for specific chemicals. *(Refer to the following section for more information about biomonitoring.)*

The National Exposure Report presents biomonitoring data for a representative cross-section of the American population, made up of several thousand people from across the country. These data are part of a larger study called the National

Health and Nutrition Examination Survey, or NHANES, in which volunteers are examined for a broad range of health measures. Among other tests, NHANES participants provide blood and urine that are tested for specific environmental chemicals. Study participants are selected from 15 different geographic regions of the U.S. and represent different segments of the population, including African Americans, Mexican Americans, adolescents, pregnant women, children, and the elderly.

The first National Exposure Report included biomonitoring data for 27 different environmental chemicals, including heavy metals, certain pesticides, and phthalates (chemicals used to make plastics, cosmetics, and other products). In 2001, CDC committed to adding new chemicals in subsequent reports. In the 2003 National Exposure Report, CDC presents findings for more than 100 different environmental chemicals. This latest report includes many new chemicals and chemical types not addressed in the first report, including persistent organochlorine pesticides, herbicides, fungicides, pest repellents, carbamate pesticides, polychlorinated biphenyls (PCBs), dioxins, and a class of chemicals called polycyclic aromatic hydrocarbons (PAHs). These chemicals are described in more detail in the full online report. Improvements in measuring chemicals should allow more to be monitored in coming years.

In the 2003 report, CDC has combined the data from the 1999 NHANES (presented in the 2001 National Exposure Report) with data from the current survey to develop a baseline of environmental chemical exposures. This baseline will be compared with results of future analyses and will be useful in identifying general trends in exposures across the population and within subgroups of the population. These baseline data will also help physicians interpret the results of biological sampling on patients and will help health scientists prioritize needs for research on exposure and health effects of chemicals of concern.

WHAT DOES THE NATIONAL EXPOSURE REPORT TELL US?

The overall purpose of the National Exposure Report is to provide a "snapshot" of the types and amounts of environmental chemical exposures in the U.S. population. Physicians, scientists, and public health officials can use the information to prevent diseases that might be caused by environmental contaminants. While the study tries to represent a large part of the U.S. population, a particular person's exposure to environmental chemicals may be very different from the sample in the report. Individual exposures may be higher or lower, depending on factors such as diet, age, occupation, chemical use, and many other variables.

In general, the amount of a chemical measured in blood or urine reflects the amount of a person's exposure to that chemical. However, some chemicals are rapidly broken down by the body and can be eliminated within hours or days following exposure. This makes them more difficult to detect through random testing. On the other hand, more persistent chemicals (e.g., certain pesticides, dioxins, and PCBs) are not readily broken down and can be stored in fatty tissues and organs for many years. In such cases, levels in blood or urine may reflect only a fraction of the total amount of stored chemical in the body (called *body burden*). It is therefore important that the chemical levels presented in the National Exposure Report be interpreted with care and that they be used as broad indicators of exposure rather than exact measurements.

The National Exposure Report does *not* measure the risk of disease from environmental chemical exposures, nor does it relate chemical levels in the body to disease. Information on body burden of pollutants provided by CDC's biomonitoring study is only one piece of the puzzle. There are more than 70,000 industrial chemicals registered for use in the U.S today. For the vast majority of these chemicals, scientists know little or nothing about releases to the environment, levels of human exposure, or long-term effects on health. For many environmental pollutants, scientists are only beginning to understand how levels of pollutants in the body relate to health effects and disease. We have an incomplete picture of the various chemical contaminants in our food, water, and air. We need to learn much more about how people are exposed and how chemicals are broken down or stored by the human body. These are critical missing links in our understanding, and they are the focus of intensive study by health researchers. This information is important for all Americans, but particularly for those individuals who may be especially vulnerable to the effects of certain chemicals. These include infants, young children, and pregnant women.

WHAT IS BIOMONITORING?

Biological monitoring, or biomonitoring, is defined as the measurement of toxic substances in the body. Scientists can analyze samples of urine, serum, saliva, blood, breast milk, and other tissues (such as body fat and teeth) to measure the levels of various chemicals in the body. Biomonitoring can show whether and how much an individual or population has been exposed to a chemical. When combined with efforts to track disease patterns, this information can be helpful in determining whether chemical exposures are causing illness and may aid in deciding what type of medical treatment is needed. Biomonitoring is also a valuable tool in disease prevention. Early detection of chemical exposure, followed by prompt and appropriate intervention to limit or stop the exposure, can help prevent illness from occurring.

While biomonitoring is not a new concept, the CDC's effort is the most intensive and comprehensive so far, aimed at measuring the types and amounts of environmental pollutants and other toxic chemicals Americans have in their bodies. Together with other environmental databases (reporting, for example, chemical releases to air or water), this effort is an important step in understanding our exposure to toxic chemicals in the environment and finding ways to reduce and ultimately eliminate our exposure to environmental pollutants.

WHAT CHEMICALS DID CDC MEASURE THIS YEAR?

In its 2001 report, CDC presented biomonitoring data that demonstrated exposure to 27 environmental chemicals—heavy metals, breakdown products (metabolites) of organophosphate pesticides, phthalates (chemicals used to make plastics, cosmetics, and other products), and one indoor air pollutant (cotinine, which represents exposure to tobacco smoke).

The 2003 National Exposure Report includes the same chemicals reported by CDC in 2001 and many new ones. The following table summarizes the environmental chemicals addressed in the current Report and the most common ways humans are exposed. An asterisk (*) indicates that the chemical class was also included in the first Report.

Chemical class	Examples	Primary Exposure Routes
HEAVY METALS *	Chromium, lead, mercury	Foods with pesticide or fertilizer residue; contaminated air/water/soil, especially in vicinity of hazardous waste or other industrial sites
PHTHALATES *	DEHP, DEP, DBP	Cosmetics; contaminated food; some PVC plastic products; contaminated air/water/soil, especially in vicinity of hazardous waste or other industrial sites
PESTICIDES		
Non-persistent Pesticides		
• Organophosphate pesticides *	Diazinon, malathion	Foods (especially fruits and vegetables) contaminated with pesticide residues; lawns and gardens; contaminated indoor dust
• Carbamate pesticides	Aldicarb (Temik), carbaryl (Sevin), propoxur (Baygon)	Residues on crop foods; lawns and gardens; flea/tick repellents
Persistent Pesticides		
• Organochlorine pesticides	DDT, aldrin, dieldrin, chlordane	Fatty foods (primarily fish, meat, dairy, eggs)
PEST REPELLENTS	DEET	Repellent products applied directly to skin
FUNGICIDES	Ortho-phenylphenol	Residential insecticides and disinfectants
HERBICIDES	2,4-D, alachlor, atrazine	Foods; contaminated water; residential plant growth regulators
DIOXINS	2,3,7,8-TCDD, many other forms	Fatty foods (primarily fish, meat, dairy, eggs); contaminated soil/sediment, especially in vicinity of incinerators, hazardous waste, or other industrial sites
POLYCHLORINATED BIPHENYLS (PCBs)	Many different forms	Fatty foods (primarily fish, meat, eggs, dairy, processed food); contaminated soil/sediment, especially in vicinity of hazardous waste or other industrial sites
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)	Benzo[a]pyrene, 1-benzo[a]anthracene	Tobacco or wood smoke; fossil fuel combustion products; grilled foods; contaminated ambient air; dairy foods
COTININE *	—	Tobacco products or second-hand tobacco smoke

WHAT HAPPENS TO POLLUTANTS IN THE BODY?

The effect of chemicals on the body depends on a number of different factors. Chemical-specific properties, the amount, duration, and timing of exposure, the route of exposure (e.g., eating/drinking, breathing, skin contact), and an individual's genetic makeup affect how a chemical behaves in the body and its toxic effects. A discussion of these complex factors and their interactions is beyond the scope of this document. Rather, this section focuses on some key concepts to help understand biomonitoring data.

Biomonitoring studies are designed to recognize the unique behavior of each chemical in the body. This knowledge is used to determine which body tissues and fluids should be sampled and which specific chemical markers should be measured. Some chemicals, such as heavy metals and certain pesticides, are toxic without breaking down in the body and are excreted practically unchanged. These chemicals can be measured directly in the blood or urine. Other chemicals, such as organophosphate and carbamate pesticides, are partially or totally broken down in the body, forming new chemicals called *metabolites*. These metabolites can then be measured in blood or urine. Some metabolites are unique, in that they are formed from one specific parent compound. Measurements of such metabolites are highly useful in confirming exposure to specific chemical pollutants. Other metabolites, however, can have multiple sources and are less specific indicators of exposure. For example, dimethylphosphate is a metabolite of more than a dozen different organophosphate pesticides. Without more specific chemical markers, biomonitoring studies can only broadly show possible exposure to a chemical or class of chemicals.

Finally, certain chemicals or metabolites may be stored in various tissues of the body, such as fat, organs, blood, hair, bones, or teeth. The amount of stored chemical in the body is referred to as the *body burden*. It is important to know which chemicals are stored in the body because they are a source for continued exposure with potentially serious health consequences. Some chemicals, when stored in the body for prolonged periods, can increase the potential for disease to occur.

For more information, refer to the National Institutes of Health, National Library of Medicine (NLM) web site on Toxicology and Environmental Health, found at http://sis.nlm.nih.gov/Tox/ToxMain.html.

WHAT IS THE DIFFERENCE BETWEEN "ACUTE" AND "CHRONIC" EXPOSURES AND EFFECTS?

The terms *acute* and *chronic* are often used to describe types of chemical exposure or the health effects resulting from such exposure. These are terms that you will see used frequently in the online chemical summaries. They apply to the timing and not the severity of the exposure. An *acute exposure* refers to an exposure that occurs over a short period or in a single dose. An *acute effect* is one that occurs within a short time (often hours or days) following a brief exposure. Acute exposures (and effects) are more typical in the workplace or from accidental poisonings. The term *chronic exposure* refers to a chemical exposure that occurs repeatedly over a long period (months or years) and often at low concentrations. Chronic, low-level exposures are much more common in everyday life than acute, high-level exposures. Most people encounter low levels of many different chemicals

through their everyday activities. This exposure can continue undetected for days, months, or years. Exposures to pollutants are most often chronic exposures with long-term health effects. A *chronic effect* is one that shows up a long time after exposure or that results from a long-term exposure. It is important to recognize that *acute exposures* can have both *acute* and *chronic* health effects.

When a chemical is first studied, research tends to focus on acute health effects. Chronic health effects (cancer, for instance) studies are expensive and time-consuming and are therefore available for only a fraction of the toxic chemicals in use. For these reasons, our understanding of the chronic health effects of many chemicals is limited. In recent years, however, research has focused more on long-term, chronic effects of chemical exposures. As a result of this research, scientists are discovering effects on the developing fetus, effects on brain and nervous system development, and disruption of the human hormonal and reproductive systems. For example, animal studies have shown that certain pesticides can damage the brain, producing a syndrome similar to Parkinson's disease. These findings support growing evidence that pesticide exposure, including in-home exposure, might contribute to the development of Parkinson's disease in humans.

Because most people in the U.S. are mostly exposed to low levels of chemicals over long periods of time, the data in the National Exposure Report reflect such exposures, rather than acute or high-level exposures. Similarly, the summaries presented in this report online focus on chronic health effects and effects of low-level exposure, where we know or have good reason to suspect them. While the health effects information presented here is drawn from the most authoritative sources available, including Environmental Protection Agency (EPA) and CDC, new information on chemical health effects is becoming available almost daily. Consequently, the profiles may not include all that is currently known about these chemicals and may, in fact, understate potential health consequences of long-term exposures.

REGULATORY PROGRAMS FOR PROTECTION OF PUBLIC HEALTH FROM CHEMICAL EXPOSURES

The federal government has a variety of regulatory programs intended to reduce exposure to toxic substances to workers and the general public. For some chemicals, there are enforceable maximum levels of pollutants in air, industrial emissions, drinking water, food products, and workplace settings. However, as CDC's National Exposure Report shows, the public is exposed to a variety of pollutants in spite of these regulations. Biomonitoring data from this and future years may ultimately prove helpful in identifying critical gaps and shortcomings in the laws and regulations designed to prevent or minimize such exposures.

The chemical profiles at www.envirohealthaction.org/bearingtheburden identify specific federal standards, where they exist. It is important to note that allowable levels of chemicals in the environment and the workplace are not comparable to the levels that CDC has measured in human blood and urine samples. So-called "legally" safe levels of human exposure have not been determined for many chemicals. But for some chemicals, there may be no safe level of exposure, especially for vulnerable people like pregnant women and young children. The regulations and standards presented here are listed for the purpose of showing where efforts to limit human exposures exist.

Drinking Water Standards

The Safe Drinking Water Act (SDWA) authorizes EPA to establish allowable levels of contaminants in public drinking water supplies. The National Primary Drinking Water Standards are intended to protect consumers from adverse health effects of contaminants in public water systems. Enforceable standards, called Maximum Contaminant Levels (MCLs), have been established for a number of contaminants, including many of the chemicals addressed in CDC's National Exposure Report. Public water systems are required to meet these standards through drinking water treatment or other techniques. In spite of EPA's regulations, testing has shown that allowable levels of many contaminants are frequently exceeded in some public drinking water supplies. Furthermore, private wells are not tested for contaminants, and EPA does not regulate the quality of water from such wells. MCLs, expressed as milligrams of contaminant per liter of water, or mg/L, are cited in the chemical profiles, if applicable.

For more information about EPA drinking water programs, refer to http://www.epa.gov/safewater/. A list of current federal drinking water standards and health advisories is available online at http://www.epa.gov/ost/drinking/standards/dwstandards.pdf.

Air Quality Standards

The Clean Air Act is the main law for protecting Americans from air pollutants. Under this law, EPA requires the reduction of emissions of various types of air pollutants. For example, EPA is required to establish National Ambient Air Quality Standards for six of the most common air pollutants in the U.S. (so-called "criteria air pollutants"), one of which is lead, a chemical included in CDC's National Exposure Report.[1] In addition, EPA has taken steps to protect the public from other air pollutants that are known or suspected to cause cancer and other serious health effects, including many of the pollutants addressed by CDC. Ways these pollutants are reduced include controls on industrial sources and vehicle emissions and reductions of levels in indoor air. Despite these programs, however, air pollution continues to pose a serious health threat in many communities, with pollutants frequently exceeding the national standards.

More information on criteria air pollutants is available at http://www.epa.gov/air/urbanair/6poll.html. Additional details on EPA's air toxics program can be found in the publication "Taking Toxics Out of the Air," which is available online at http://www.epa.gov/oar/oaqps/takingtoxics/. A list of EPA-designated hazardous air pollutants is available online at http://www.epa.gov/ttn/atw/188polls.html.

Chemical Residues in Food

The EPA, Food and Drug Administration (FDA), and U.S. Department of Agriculture (USDA) share responsibility for protecting consumers from exposure to pesticides and other contaminants in the food supply. EPA sets limits on the amount of pesticides that can be applied to food crops and the levels of pesticide residues that can remain on food when it is sold. The Food Quality Protection Act of 1996 requires the EPA to review pesticide food residue limits (known as "tolerances") and consider combined exposures

1. The six pollutants are ozone, sulphur dioxide, oxides of nitrogen, lead, particulate matter, and carbon monoxide.

for those pesticides that have a common mechanism of toxicity, a process that has been extremely slow. EPA is currently reviewing organophosphate pesticides, such as those addressed by CDC's National Exposure Report. FDA is responsible for enforcing pesticide tolerances on all foods except meat, poultry, and certain egg products, which are regulated by the USDA. FDA also sets enforcement guidelines called "action levels" for pesticides that are no longer allowed (such as DDT) as well as non-pesticide contaminants (e.g., cadmium, lead, mercury, and PCBs) found in food. FDA conducts annual surveys to determine residue levels of pesticides, metals, radionuclides, PCBs, and volatile organic compounds in the food supply. If it finds a chemical residue higher than allowed during these surveys, the FDA has the authority to remove contaminated foods from the market; however, severe limitations of the surveys leave most foods in the U.S. untested and restrict the FDA's actions.

Overall, despite three federal agencies overseeing food safety, harmful chemical contaminants in food are not well monitored or regulated. Indeed, a recent FDA study found residues of 12 persistent organic pollutants (POPs) in the average American diet. These results highlighted two regulatory flaws. First, health limits are established for a single chemical and not for the total amount of similar chemicals found in the entire diet. Second, FDA's action levels for chemicals are significantly higher than the health-based levels regulated by the EPA.

For more information on FDA's Total Diet Study, refer to http://www.cfsan.fda.gov/~comm/tds-toc.html. EPA publications provide more information on regulation of pesticides in food: "Pesticides and Food: How the Government Regulates Pesticides" is available online at www.epa.gov/pesticides/food/govt.htm, and residue tolerances for specific foods and pesticides can be found by searching EPA's database at http://www.epa.gov/pesticides/food/viewtols.htm.

Worker Protection Standards

Health-based standards to protect workers from chemical, physical, and biological agents in the workplace are developed by the federal Occupational Health and Safety Administration (OSHA). OSHA has established maximum acceptable levels (called Permissible Exposure Levels, or PELs) for a large number of airborne chemicals found in the workplace. The intention of PELs is to show how much workers can be exposed to a substance without harmful effects averaged over a normal 8-hour workday or a 40-hour week (called a time-weighted average, or TWA). However, there is no consensus among the occupational health community that PELs protect workers. The OSHA standards (known as PEL-TWAs) for workplace exposures are identified in the "Regulations" section of each chemical profile.

The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental and Industrial Hygienists (ACGIH), a non-government organization, have also recommended exposure limits for many chemicals to help protect worker health. However, these limits are not enforceable standards and are not cited in the chemical profiles.

The full list of OSHA standards is available online at http://www.osha.gov/SLTC/respiratory_advisor/advisor_genius_nrdl/z_tables.html (29CFR 1910.1000, Table Z-1 and Z-2). For more information, on NIOSH recommendations refer to the

NIOSH Pocket Guide to Chemical Hazards http://www.cdc.gov/niosh/npg/npg.html and ACGIH 2002 Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices at http://www.acgih.org/home.htm.

THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

Many of the chemicals addressed in CDC's National Exposure Report belong to a group of substances called *persistent organic pollutants,* or POPs. These chemicals are of particular public health concern because of their high toxicity, extreme persistence in the environment, ability to travel long distances through air and water, and strong tendency to accumulate in fatty tissues of animals and humans. They bioconcenrate up the food chain and can reach very high levels in the body tissues of fish, predatory birds, and mammals, including humans. Biomonitoring studies have confirmed that almost everyone carries traces of these persistent chemicals in their bodies.

In the U.S., the manufacture and use of some POPs are already restricted or prohibited. However, this is not the case in many other countries. Because POPs can move readily through the environment, their continued use anywhere becomes a concern for the global community. The Stockholm Convention is an international treaty targeting the elimination of these toxic chemicals, beginning with 12 of the worst POPs. These are: nine pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, and toxaphene); the industrial chemicals hexachlorobenzene and PCBs; and the toxic chemical byproducts, polychlorinated dioxins and furans. The Convention will also allow countries to act together to restrict additional POPs in the future.

The Stockholm Convention was formally adopted in May 2001 and has been signed by the U.S. and more than 150 countries. Governments must now ratify the agreement, and when 50 countries have done so, the treaty will enter into force.

For more information about the Stockholm Convention, refer to the web sites for the International POPs Elimination Network (IPEN) at http://ipen.ecn.cz/, the United Nations Environment Programme (UNEP) POPs web site at http://www.chem.unep.ch/pops/, and PSR's EnviroHealthAction web site at http://www.envirohealthaction.org.

THE PUBLIC HEALTH IMPLICATIONS OF THE CDC REPORT: HEALTH TRACKING

The data in CDC's National Exposure Report show that Americans are exposed to a broad spectrum of potentially hazardous chemicals. These exposures have occurred because of both current and past contacts with chemical contaminants in the food we eat, the air we breathe, and the water we drink. CDC's exposure data are significant to our health, since they represent actual pollutants in human body tissues and fluids. While these data are a concern, what they mean regarding human disease is uncertain. We do not have enough scientific knowledge.

PSR believes the CDC biomonitoring data present a significant public health opportunity. Biomonitoring is an important part of understanding the connection between specific chemical exposure and chronic disease. EPA currently tracks environmental hazards through its Toxic Release Inventory, which monitors chemical releases to the environment. But no comprehensive system exists to collect chronic disease infor-

mation. PSR recommends the creation of a nationwide environmental health tracking network to monitor and analyze data on chronic conditions and their relationship to the external environment. An effective tracking network should include local, state, and federal public health agencies that work together to follow the incidence and prevalence of certain chronic diseases. When combined with data from biomonitoring and hazard tracking, the disease data will give health practitioners and environmental regulators the ability to identify disease clusters and make informed decisions when formulating policy that affects health.

More research is needed to understand the health effects of the chemicals tested by the CDC. Enough is known, though, that we should reduce exposure through pollution prevention efforts, vigorous enforcement of workplace and environmental standards, and people's personal efforts to avoid contact with hazardous substances. The chemical information in the online report can be used by individuals and groups as a resource for pollution prevention programs and lifestyle choices.

THE FULL REPORT WITH CHEMICAL PROFILES IS AVAILABLE AT:

www.envirohealthaction.org/bearingtheburden.

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