

Environmental Toxicants and Maternal and Child Health: An Emerging Public Health Challenge

This brief provides an overview of environmental toxicants with regard to preconception and perinatal health, summarizes efforts to inform women and health care providers, outlines possible strategies for increasing awareness and surveillance efforts, and identifies resources for additional information for public health professionals.

A growing body of research suggests that maternal exposure to environmental toxicants poses a risk to women's health as well as to fetal and child health and development. While the evidence is not entirely conclusive, there is substantial evidence linking hazardous toxicants with increased risk of:

- Miscarriage
- Intrauterine growth restriction
- Low birth weight
- Preterm birth
- Birth defects
- Motor and cognitive delays in children¹⁻⁸

Of equal concern is the potential effect of toxins on a woman's health, regardless of her reproductive plans, choices, or history. Environmental toxicants have been implicated in asthma, breast cancer, and hormonal imbalances among women.

There has been recent notable action in addressing the impact of environmental toxicants on child health, including the creation of the Environmental Protection Agency's

(EPA) Office of Children's Health Protection in 1997. However, there has been much less focus on the effect of toxic substances on the health of women preconceptionally and during pregnancy. As public health programs face the intractable problems of low birth weight and preterm birth, even with advanced technology and enhanced prenatal care, the arena of environmental toxicants is ripe for investigation and action. To ensure population health, maternal and child health (MCH) professionals need to expand their focus to include the environmental factors that influence health in the earliest stage of life and the preconception period.⁹

This topic is important to MCH generally, since many exposures are ubiquitous, but also because the impact tends to cluster in disadvantaged populations—impoverished and low income families who often must live in less desirable areas, such as near highways and/or industrial sites. In addition, adults in such families are more likely to work in manufacturing, or other commercial sectors, where exposures are more common.

MCH professionals frequently focus efforts on reaching subpopulations who are at high risk for prenatal exposure to environmental toxicants. Individuals and groups with specific language and cultural concerns, those with local occupational or dietary exposures, and immigrants who may have sustained significant exposures in their home countries are among the most vulnerable. State and local public health professionals can leverage their knowledge of communities to address the issue of environmental toxicants and reproductive health at the local level.

Widespread awareness of environmental toxicants and their effects on reproductive and perinatal outcomes is essential in order to decrease preconception and prenatal exposure. As environmental toxicants are identified, the associated risks of exposure should be communicated to women so they can reduce their exposure or eliminate it completely. Reproductive health providers play a significant role in communicating environmental health risks, as they are a key, trusted source of health information for women during the preconception and

prenatal periods. Health care providers and women of child-bearing age need updated information and guidance in order to address and manage environmental exposures effectively. Currently, there is limited attention to concerns regarding access to information on preconception and prenatal exposure to environmental toxicants.

To effectively address maternal and child exposures to environmental toxicants, MCH professionals could benefit from working closely with environmental health professionals. Over the years, some MCH partnerships with environmental health have evolved (for example, efforts to address lead poisoning) but these have not necessarily been continuous or vigorous in many areas of the country. At this juncture, increasing knowledge about toxicants may have brought the field to a “tipping point” wherein renewed efforts are indicated. A collaborative effort between MCH and environmental health can increase women’s and provider’s knowledge on environmental toxicants so they can take steps to limit exposure before and during pregnancy.

Brief Review: Environmental Toxicants and Federal Public Policy Response

Environmental toxicants include organic and inorganic substances that are harmful to human health and development. Individuals are exposed to environmental toxicants at home, in the workplace, or in the community via contaminated soil, air, water, or food. While there is some debate as to the levels and types of exposure that precipitate health problems, there is mounting evidence that many toxicants may be linked to negative reproductive and child health outcomes. The developing fetus is particularly vulnerable to the adverse impact

of environmental toxicants due to the rapid growth and development of organ systems that occur during gestation, particularly during the first eight weeks.¹⁰ Exposures that damage organs or systems early on can have life-long implications for the individual, and potentially affect his or her reproductive capacity.

While a very large number of environmental toxicants are potentially harmful to health, the most commonly studied ones can be divided into three major categories: heavy metals, air pollutants, and pesticides. Prenatal exposures to heavy metals, including mercury, lead, and arsenic, are associated with increased risk for brain damage, neurodevelopmental problems, congenital malformations, miscarriage, and low birth weight. Air pollutants and pesticides also are linked to poor pregnancy outcomes. Exposure to air pollutants such as sulfur dioxide and particulate matter increases the risk for preterm birth and low birth weight. Exposure to certain pesticides, PCBs and DDT, increases the risk of preterm birth, low birth weight, and miscarriage. The sources and potential health impacts of the most commonly studied environmental toxicants are outlined in Table 1.

Some environmental exposures are more common among particular populations, while others are ubiquitous and difficult for anyone to avoid. For example, populations that consume large amounts of sport fish might have higher mercury exposure, while an agricultural community might have increased exposure to pesticides. Some exposures have no benefit and should be avoided by all. Others, such as fish, hold potential benefits (fatty acids that support healthy brain development) that must be weighed against potential risks (mercury, which is a neurotoxin).

Table 1. Prenatal Exposures to Major Environmental Toxicants

Toxicant	Sources	Potential impact on fetal/infant/child health
<i>Heavy Metals</i>		
Mercury	Eating contaminated fish or shellfish; breathing vapors from spills or incinerated materials; skin contact with mercury in the workplace.	Brain damage, mental retardation, poor coordination, blindness, seizures, nervous and digestive system problems, kidney damage.
Lead	Lead paint, contaminated soil, contaminated dust (breathed in or eaten), water.	Increased risk of miscarriage and still birth, low birth weight and preterm birth; neurodevelopmental effects.
Arsenic	Contaminated food, water, or air; occupational exposure, inhaling sawdust or smoke from arsenic-treated wood; exposure to high-levels of arsenic in soil.	Increased risk of miscarriage, congenital malformations.
<i>Air pollutants</i>		
Sulfur dioxide	Polluted air.	Increased risk of low birth weight and preterm birth.
Particulate matter	Polluted air.	Increased risk of low birth weight.
<i>Pesticides</i>		
Polychlorinated biphenyls (PCBs)	Drinking water, breathing air or eating foods, or exposure to soil that are contaminated; via older electrical equipment or transformers.	Lower birth weight; decreased motor skills; depressed immune system.
DDT	Exposure via agricultural work prior to coming to U.S. (banned in U.S.), accidental exposure (spills).	Increased risk of miscarriage, preterm birth, small for gestational age.

Table 2. Relevant Legislation and Regulations Regarding Exposure to Environmental Hazards

Legislation	Major components
Clean Air Act (1970)	<ul style="list-style-type: none"> Established federal regulation of air emissions from mobile and stationary sources. Created National Ambient Air Quality Standards (NAAQS) to be met by states. 1990 amendments created categories of industries that produce toxic air pollutants to monitor and reduce emissions.
The Occupational Safety and Health Act (OSHA) (1970)	<ul style="list-style-type: none"> Established employers' responsibility to provide employees with safe work environments, including those free from exposure to toxic chemicals. Hazard Communication Standard added in 1983 amendment: Mandated use of Material Safety Data Sheets (MSDS) to illustrate hazards and recommend protective measures.
Clean Water Act (1972)	<ul style="list-style-type: none"> Created standards for monitoring quality of surface water. Established regulatory structure for regulating the discharge of pollutants into waterways.
Consumer Product Safety Act (1972)	Created the U.S. Consumer Product Safety Commission, which creates safety standards and has the authority to ban and recall products that are hazardous.
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (1980)	Established a federal "Superfund" to clean up hazardous waste sites as well as spills and emergency releases of pollutants.
Emergency Planning and Community Right to Know Act (1986)	<ul style="list-style-type: none"> Established mechanisms to assist local communities in managing chemical hazards. Required the creation of State Emergency Response Commissions (SERC), Emergency Planning Districts within states, and Local Emergency Planning Committees for each district. Created the Toxics Release Inventory (Title III) - a publicly available database of toxic chemical releases and waste management activities reported annually by federal agencies and private industries.
Pollution Prevention Act (1990)	Established the prevention and/or reduction of source pollution as official federal policy.
Residential Lead-Based Paint Hazard Reduction Act (1992)	Required sellers and landlords to inform prospective buyers/renters of any known lead paint in structures built before 1978.

Beginning in the mid 20th century, concerns about the health effects of environmental toxicants led to federal and state policies designed to regulate the production of toxicants, reduce exposures, and inform the public about environmental hazards. Table 2 presents some of the major federal legislation relating to the regulation of environmental toxicants. With the exception of the Consumer Product Safety Act, these laws are administered by the Environmental Protection Agency. (See www.epa.gov/lawsregs/laws for more details on these laws.)

The Hazard Communication Standard (HCS), an amendment to the Occupational Health and Safety Act, was designed to ensure that environmental health risks are communicated to workers so that protective measures can be taken to reduce or eliminate exposure. However, the extent to which the HCS has contributed to greater awareness is unclear. The published literature on this topic is sparse, and evaluations of the HCS noted concerns about technical complexity of the information¹¹⁻¹⁶ and inadequate and/or ineffective training,¹⁶⁻¹⁸ reliability,¹⁹ and sufficiency of information included, such as symptoms and updating.^{20,21} Of particular concern are the reported limited linkages and communication between workplace safety personnel and workplace health providers.¹⁹ It is encouraging to note, however, that states are increasingly taking legislative and regulatory action to reinforce and extend national efforts.²²

Challenges in Identifying and Addressing Women's Exposure to Environmental Toxicants

Limiting Exposure Before and During Pregnancy

The ubiquity and persistence of toxicants, both in the environment and within the body, pose unique challenges in addressing this public health issue. Without concerted public awareness efforts or media attention, individuals might not be aware of potential toxicants in their communities. Even though some substances, such as the pesticide DDT, have been banned in the U.S. for decades, these materials do not break down quickly and may persist in the environment. Thus, a pregnant woman may be unaware that she is being exposed to a potentially dangerous substance. Even if she tries to limit her exposure during her pregnancy, fat-soluble substances that have accumulated in her body over her lifetime may be released and passed on to her child during pregnancy or breastfeeding.²³ And while a woman may limit her exposure to harmful substances once she knows she's pregnant, this may be after the fetus has undergone the most critical period of organ development in the first eight weeks of pregnancy.

Many environmental toxicants also are prevalent in occupational settings. For example, despite improvements in protections for workers, there has been increasing concern that workers accumulate agricultural chemicals on their clothing and skin and carry these

chemicals home, thereby exposing their families. Women in certain jobs may be at increased risk: examples range from oncology nursing to women in the home/office cleaning business.

Limited Knowledge among Women and Health Care Providers

What Women Know. Very little is known about women's knowledge base regarding environmental toxicants and reproductive health. The Organization of Teratology Information Services (OTIS), a private non-profit organization that supports knowledge dissemination, education, and research in the field of clinical teratology, hosts a website that posts a set of fact sheets on prenatal exposures (63 in total) and tracks inquiries. In 2003-04, from among the 70,000 inquiries, the most frequent were medications (58%) and occupational-related (17%) exposures. Radiation, herbal products, and drugs of abuse each represented less than 10% of inquiries. A handful of studies have focused on fish consumption, both in general and during pregnancy.^{24,25} One of these studies indicates that awareness of risks associated with fish consumption and mercury is much less than for other hazardous prenatal exposures, such as drinking and cigarette smoking.²⁶ There is little or no peer-reviewed literature on women's knowledge of other environmental toxicants, such as pesticides or other heavy metals.

The heterogeneity of toxicants poses a challenge in educating women about risk and how to reduce exposures. For example, a substantial exploration of the Internet in 2007 did not reveal any national, state, or local organized efforts specifically targeting pregnant and/or childbearing age women about pesticides and how to reduce their exposures.⁹ In many of the materials found on professional and advocacy websites as well as in women's magazines, pesticides are generally flagged as important to avoid in pregnancy. However, the usual advice given is not likely to be feasible for low income women who may be more likely to be at risk: having someone else apply the chemical; avoidance of the area for 24 hours; removal of food, dishes, and towels from the area. Similarly, advising women to purchase organic produce to limit pesticide intake is not a strategy low income women likely can afford.

Women's Health Care Providers. Clinicians could play a critical role in educating women and identifying those who might be at increased risk for exposure to environmental toxicants. However, reproductive health providers may lack knowledge about specific exposure risks in the community, how to advise women about avoiding exposures, or how to elicit exposure histories. There are no studies that directly address the existing knowledge base of reproductive health providers with regard to the risks and management of exposure to environmental toxicants. However, it is generally understood that environmental health competency could be strengthened among primary care providers. In 1988, an IOM panel recommended integrating information on environmental health into medical education curricula.²⁷ A decade later, however, only 76 percent of accredited medical schools indicated inclusion of environmental content, with an average of seven hours total of instruction on this topic.²⁸

In a supplement of the *Maternal and Child Health Journal* devoted to preconception health, McDiarmid and Gehle²⁰ discuss exposure histories in the context of reproductive and perinatal health. At present, the standard environmental history form endorsed by the American College of Obstetricians and Gynecologists is limited to an assessment of smoking, alcohol, and drug use. Other preconception

and prenatal history forms include a few additional items, such as queries about fish consumption or residential proximity to a known pollution source, but none comprehensively assesses exposure to environmental toxicants. McDiarmid and Gehle recommend that the environmental history be expanded to include assessment of environmental exposures that occur in a woman's home, community, and workplace. McDiarmid and Gehle present an occupational/environmental history checklist, adapted from work by Grajewski,²⁹ for use by providers at the preconception visit. The comprehensive environmental exposure history recommended by McDiarmid and Gehle is beginning to gain recognition and the Environmental Protection Agency has funded several projects on environmental histories and prenatal health.

Dispersed Public Information

A critical challenge for both consumers and clinicians is the inaccessible and dispersed nature of information about environmental toxicants and pregnancy available online. Federal agencies, professional organization, and other groups have created websites and briefs on environmental toxicants. However, these sites are often highly technical and detailed, difficult to navigate, and include a very broad array of substances. Most importantly, the information is not organized with reproductive health concerns in mind. A lack of print materials to use in educating patients is another major challenge for clinicians. Fact sheets, such as those made available at the Centers for Disease Control Agency for Toxic Substances and Diseases Registry website, often focus on individual substances and are not targeted to pregnant or preconceptional women. Also, these materials are not tailored to specific groups who may be at greatest risk for exposure.

A number of websites, particularly those hosted by federal agencies, however, do have specific components for professionals, providers, and consumers. Yet, there appear to be significant limitations in the usability of information available on the Internet. Selected resources are listed in Table 3, and are categorized by the target audience—clinician or provider, public health worker, and general population. The technical complexity of each resource also is scored. Information on resources on environmental toxicants also is available in the Maternal and Child Health Library Environmental Health Resource Brief at www.mchlibrary.info/guides/environmentalhealth.html.

Multiple websites offer information to women and providers on local environmental hazards. These sites allow users to find details on toxic releases, hazardous waste, spills and accidents, lead levels, and air quality in their community:

- The Right-to-Know Network (www.rtknet.org) provides information about local environmental hazards and conditions, publications on environmental health issues, and tool boxes for community organizing.
- SCORECARD (www.scorecard.org) allows a zip-code-based search of local environmental conditions, air and water quality, and location of pollution sites. The site includes factsheets on a wide variety of chemicals and exposures, indexed by type of health risk posed (including developmental and reproductive toxicants).

Beyond these, the federal government offers online resources with detailed technical information about environmental toxicants. These resources are not specific to prenatal and preconception health, but can provide valuable information on environmental exposures:

Figure 1. Online Sources of Continuing Education Specific to Pregnancy and Environmental Hazards³⁰

“Environmental Medicine: Integrating a Missing Element into Medical Education” (1995) (69); a text that can be used to integrate material into medical school curriculum; it has 4 appendices with 55 case studies, and also educational resources and teaching aids. The topic of Case Study # 53 is “Reproductive and Developmental Hazards.”

Primary Care: Clinics in Office Practice (Vol 27, Issue 4, December 2000) “Workplace Reproductive Problems” Written for practicing primary care physicians, the paper includes an overview of hazards and specific advice about screening, assessment, counseling, and possible actions that the physician can take to assist his/her patient. www.primarycare.theclinics.com

Obstetrics and Gynecology primary care update, “Environmental and Occupational Hazards to Pregnancy” (2003)—a brief synthesis of new science.

Agency for Toxic Substances and Disease Registry Division of Toxicology and Environmental Medicine Internet series of self-instructional publications—Case Studies in Environmental Medicine designed to increase primary care provider’s knowledge of hazardous substances in the environment “Taking an Exposure History” updated in 2000 the most relevant of the set (to perinatal health). www.atsdr.cdc.gov

Association of Occupational and Environmental Clinics website, which posts “Peer-Reviewed Modules” as educational resources. www.aoec.org

- Agency for Toxic Substances and Disease Registry (www.atsdr.cdc.gov)
- National Institute of Environmental Health Sciences (www.niehs.nih.gov)
- National Institute of Occupational Safety and Health (www.cdc.gov/niosh)
- Occupational Safety and Health Administration (www.osha.gov)
- National Library of Medicine: Household Product Database (<http://householdproducts.nlm.nih.gov>)
- National Library of Medicine: MedlinePlus (www.nlm.nih.gov/medlineplus/poisoningtoxicologyenvironmentalhealth.html)
- National Library of Medicine: TOXNET (www.toxnet.nlm.nih.gov)
- National Library of Medicine: ToxTown (<http://toxtown.nlm.nih.gov>)

Strategies for Public Health Professionals

Maternal and child health professionals have a critical role to play in educating providers and the public about managing exposure to environmental toxicants, as well as in supporting surveillance efforts to monitor exposure to toxicants and maternal and child health outcomes.

Collaboration with Environmental Health Professionals

In forming partnerships, MCH professionals can bring their expertise to bear on joint efforts to identify, measure, and limit the impact of environmental toxicants on women and children. Addressing the risks posed by environmental toxicants will require collaboration with local, state, and federal environmental health agencies. These agencies regulate and monitor environmental toxicants, but are not focused primarily on reproductive or maternal and child health. MCH programs need to identify the key players in the environmental

health field in their state and local areas. These also may include major employers in the area, with whom public health professionals might collaborate to raise awareness and ensure compliance with regulatory guidelines for the workplace.

Educating Pregnant and Reproductive-Age Women

State and local maternal and child health programs may play a direct role in educating both pregnant women and the general population about the risks of environmental exposures. Working in concert with local environmental health specialists, MCH professionals can develop print materials that are culturally appropriate and that address local environmental health concerns and likely exposures. Collaboration with local media outlets might also provide a venue for increasing awareness and crafting targeted messages for specific high-risk groups. Several states have taken steps in this direction. For example:

- **Utah:** Pregnancy Risk Line, telephone information service to answer women’s questions about medicines, drugs, chemicals, and other environmental exposures during pregnancy.
- **Washington State:** Information on the health risks associated with mercury, healthy fish consumption, and household/business products containing mercury.
- **Minnesota:** Information on lead exposure during pregnancy and breastfeeding.

Providing Education for Reproductive Health Care Providers

Targeting and offering educational opportunities for providers may be even more effective than broad public awareness campaigns; clinicians are both a trusted source of information and a bridge to additional services for pregnant women. Reproductive and primary care clinicians can educate patients, identify and assess those who are at greater risk, and make referrals to specialty care and resources. Increasing clinicians’ awareness of existing resources to address these needs is an important role for MCH professionals. Relevant resources include the specialized teratology information centers that exist in 17 locations and serve 24 states, in addition to

Table 3. Selected Resources on Prenatal Exposure to Environmental Toxicants for Reproductive Age Women and their Healthcare Providers³⁰

Source	Target Audiences	Technical Complexity	Available information
Organization of Teratology Information Specialists (OTIS)	Pregnant and reproductive-age women; health professionals	++	www.otispregnancy.org Factsheets on a variety of common exposures in English and Spanish Links to OTIS information centers for both health professionals and individuals
March of Dimes (MOD)	Pregnant women; health professionals	++	www.marchofdimes.com/pnhec/159.asp Fact sheets, brochures, and a screening checklist
Motherisk	Pregnant women; health professionals	+++	www.motherisk.org Telephone helplines to answer women’s questions about pregnancy, including exposures Links to peer-reviewed articles about environmental exposures and child health E-Learning Centre for healthcare professionals with video tutorials on teratology
American College of Obstetricians & Gynecologists (ACOG)	Pregnant and reproductive-age women	++	www.acog.org/publications/patient_education Brochure on good health before pregnancy, including environmental exposures
What to Expect	Pregnant and reproductive-age women	++	www.whattoexpect.com/pregnancy/work-issues/health-and-safety.aspx Basic information about common exposures, particularly in the workplace Includes message boards and blogs for women to post and respond to questions
Association of Occupational and Environmental Clinics	Health professionals	++++	www.aoc.org Provides a directory for Pediatric Environmental Health Specialty Units (PESHUs) Provides a list of environmental health education resources, including a peer-reviewed module “Environmental Aspects of Reproductive Health”; most are not immediately downloadable but available upon email request
American College of Nurse Midwives	Pregnant women; health professionals	+++	www.acnm.org “Share with Women” briefs on specific topics, including “Eating Safely During Pregnancy” and “Environmental Hazards During Pregnancy” Continuing education and practice resources for midwives, including a module on “Environmental Hazards in Women’s Health”
Women’s Voices for the Earth	Pregnant and reproductive-age women	+++	www.womenandenvironment.org Grassroots environmental health and justice organization Reports and fact sheets with specific information on risks of household cleaning products and exposures such as mercury during pregnancy Awareness campaigns and community events
Office of Women’s Health, U.S. Department of Health and Human Services	Pregnant and reproductive-age women; health professionals	+++	www.womenshealth.gov Fact sheets on mercury and medications, “Fish Facts Print and Go Guide” and “Food Don’ts Print and Go Guide” General information on the environment and women’s health General information about preconception, pregnancy and overall health

+ = video, cartoons, or pictograms

++ = simple brochures with pictures, etc.

+++ = short reports, fact sheets, etc. understandable at high school reading/comprehension level

++++ = moderately technical scientific reports and resources; understandable at advanced reading level

+++++ = published scientific journal material, technical scientific databases

providing regional telephone consulting services via a toll-free number (866-626-OTIS) for states not covered by the centers. Additional resources include the 10 EPA-sponsored Pediatric Environmental Health Specialty Units, which provide education and consultation for clinicians and public health professionals about children's environmental health (Figure 2). Public health agencies moving in this direction include:

- **New York City:** Information for providers on lead poisoning prevention, identification, and management (for both obstetric patients and pediatric patients).
- **New York State:** Preconception care checklist for providers that includes questions about environmental toxins (occupational exposures, household chemicals, and radiation exposure).
- **Berkshire County, MA:** Healthy Beginnings program. Nurses, midwives, obstetricians, and Lamaze instructors are trained on environmental risks during pregnancy, specifically lead, mercury, PCBs, pesticides, and solvents.

Surveillance

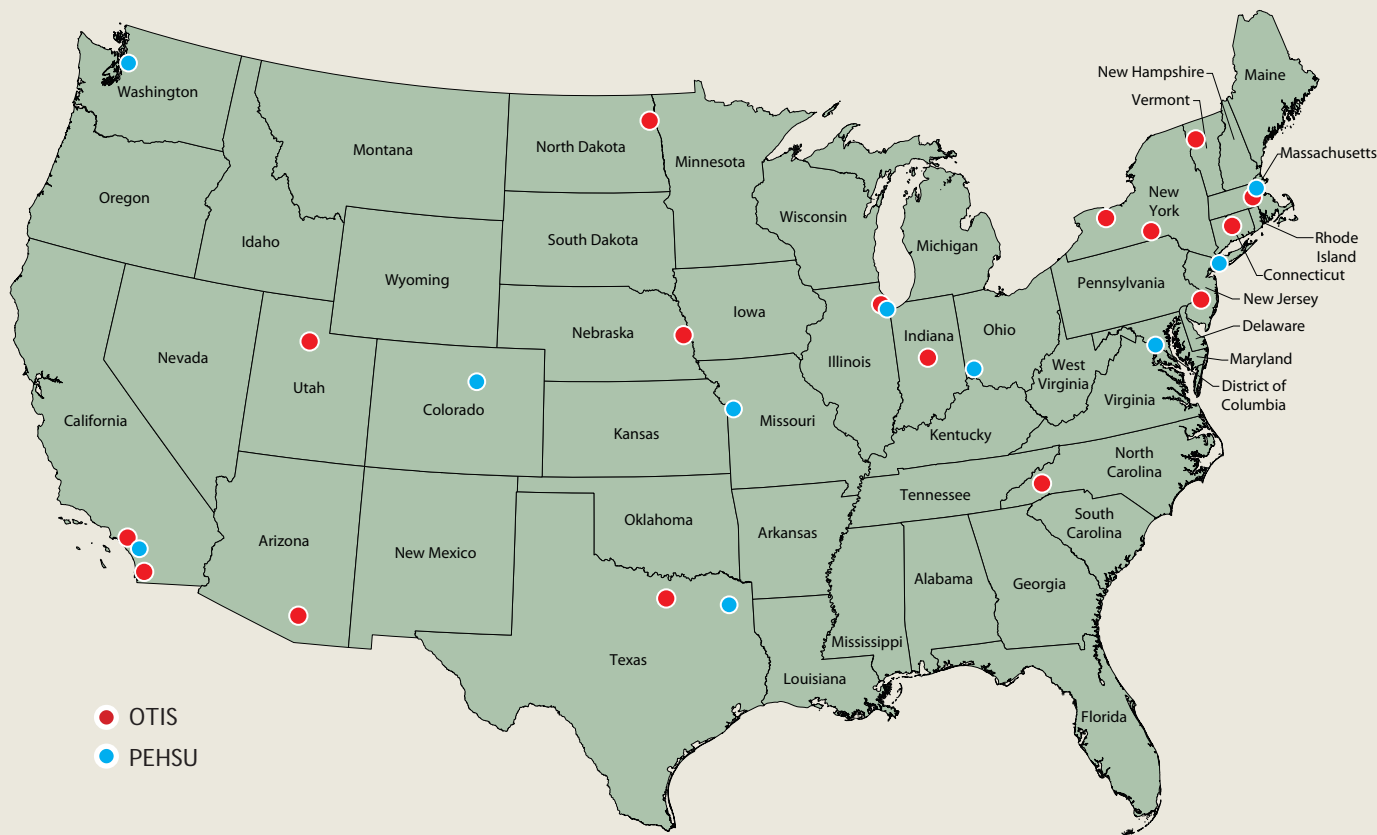
Public health professionals have long-standing expertise in surveillance and should consider expanding efforts to monitor environmental toxicants and their potential impacts on maternal and child health. These efforts may include evaluating the EPA's data from the

America's Children and the Environment (available at www.epa.gov/envirohealth/children/index.htm). In New York City, the public health department is measuring blood mercury levels in adult women as part of its HANES surveillance (analogous to NHANES at the national level). In lieu of this, states may want to consider adding questions about exposure to environmental toxicants to the Pregnancy and Risk Assessment Monitoring Systems (PRAMS) instrument.

Some states are moving forward in this arena. Florida and New York State conduct environmental public health tracking, covering air quality and drinking water quality as well as health effects including birth defects. California has long been a leader in this arena through both its Birth Defects Monitoring Program and the Occupation Health Branch/Hazard Evaluation System and Information Service (www.dhs.ca.gov/ohb/HESIS), which monitors workplace hazards and makes recommendations for workplace standards.

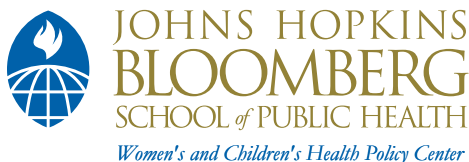
While unanswered questions remain regarding the risks of environmental toxicants to reproductive health, there is a need for action at the state and local levels to produce data, raise awareness generally, and to educate and support clinicians. Building systems of surveillance and education will enable public and environmental health agencies to act upon additional findings as they emerge.

Figure 2. Locations of Organization of Teratology Information Services (OTIS) and Pediatric Environmental Health Specialty Units (PEHSU) in the US



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Authors: Elizabeth Harrison, Jenelle Partelow, MPH, and Holly Grason, MA. *Johns Hopkins Bloomberg School of Public Health*

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