Research Memo Addendum: Toxics and Health Effects

Highlights of key trends in health effects and diseases linked to toxic chemical exposure

While it is difficult to establish causality between environmental exposures to toxic chemicals and specific health impacts, much more is known about trends in health effects and trends in environmental exposures. Studies have shown increases in incidence of many diseases that are linked to toxic exposure, including asthma, cancer, reproductive disorders, and others. This section highlights information that is known about trends in health problems and potential links to exposure to toxic chemicals. Much research on this topic focuses specifically on health effects and trends in children. Young children have higher levels of exposure to environmental chemicals in homes due to their higher breathing rate and natural tendency to mouth or suck on household objects and surfaces. Children are especially prone to experience ill effects from chemical exposure because even small exposures during critical periods of early childhood development can result in permanent negative effects that can cause lifelong damage.¹

Trends in Health Effects
This section describes key trends in health effects that may be associated with exposure to toxic chemicals, including child reproductive health, child learning and behavior, obesity, asthma, and cancer.

Child Reproductive Health
Many environmental factors may interfere with normal development of reproductive systems in fetuses and children. These abnormalities can have harmful consequences; however, finding causal links between reproductive health problems and exposures to specific chemicals is difficult.

- The American Medical Association (AMA) has recommended reducing prenatal and childhood exposure to endocrine disruptors as a reasonable preventive step to improve health.
- Studies suggest that exposure to bisphenol-A (BPA) may be linked to early puberty in girls, which is associated with an increased risk of breast cancer, infertility, menstrual problems, and reduced adult height, as well as psychological difficulties that can lead to behavioral problems such as alcohol and drug use.
- Hypospadia (a birth defect in which the opening of the urethra in boys is on the underside of the penis instead of the tip) has been linked to exposure to phthalates and other chemicals in laboratory studies.
- Cryptorchidism, a birth defect that causes male infants’ testicles to fail to descend fully into the scrotum, is linked to prenatal exposure to chemicals including diethylstilbestrol (DES).

Child Learning and Behavior

Learning disabilities, attention deficit [hyperactivity] disorder (ADD/ADHD), autism spectrum disorders, and intellectual disabilities are increasingly prevalent among children in the United States. These disabilities are both environmental and genetic. Information about environmental toxic contributions to learning disabilities includes:

- Environmental chemicals known to be associated with impaired brain development include lead, methyl mercury, polychlorinated biphenyls (PCBs), manganese, and organophosphate insecticides.
- Environmental chemicals suspected to interfere with brain development include arsenic, BPA, polybrominated diphenyl ethers (PBDEs), and phthalates.
- Fetal exposure to toxic agents such as lead and mercury can directly impair brain and neurological development in children.
- Autism and ADHD appear to result from a complex interaction between genetics and environmental factors.
- According to the National Academy of Sciences, three percent of developmental disorders may be caused solely by toxic environmental exposure, while 25 percent result from a combination of genetic and environmental factors.\(^2\)
- Researchers have estimated the costs of learning disabilities related to exposures to toxic chemicals:
  - New York researchers estimate that intellectual disabilities from lead poisoning and prenatal methyl mercury exposure, and the fraction of learning disorders that are attributable to those exposures, are approximately $74.3 billion in annual U.S. costs.\(^3\)
  - Lowered intelligence from early childhood exposure to lead was estimated to result in about $675 million per year in lost income to those affected in Washington State.\(^4\)

Obesity

An emerging body of evidence suggests a link between environmental chemical exposure and childhood obesity.

- Environmental chemicals known or suspected to be associated with obesity include BPA, perfluorooctanoic acid (PFOA), and organophosphate insecticides. There is suggestive evidence that phthalates, PBDEs, DDT, and PCBs may contribute to obesity as well.

---


Laboratory research has indicated that prenatal and early life exposure to some chemicals can permanently alter metabolism and cause obesity later in life.

Some chemicals affect gene expression and promote cells into becoming fat cells during normal organ and tissue development. Other chemicals increase the size of fat cells, or permanently alter hormone regulation of appetite and energy metabolism.

In 2012, the White House Task Force on childhood obesity recommended that health agencies prioritize research into the effects of possible obesity-causing chemicals. In 2011, the National Institutes of Health launched a three-year effort to fund research exploring the role of environmental chemical exposures in obesity, type 2 diabetes, and metabolic syndrome.

Asthma
Asthma is the most common chronic disease in children, affecting nearly 10 percent of children under 18.

Rates of asthma continue to rise. The number of people in the United States who suffer from asthma has increased significantly in recent years: one in 12 people (about 25 million) had asthma in 2009, compared with 1 in 14 (about 20 million) in 2001.

A panel of experts in environmental and pulmonary medicine estimated that 10 to 35 percent of asthma attacks could be attributed to environmental chemicals, such as indoor and outdoor air pollutants. Toxic chemicals that are released from products in the home can trigger asthma attacks in children with the disease.

One hundred eighty-five children and 3,262 adults died from asthma in 2007. The costs of asthma are significant: in 2002 (the most recent year for which data are available), the total cost of asthma in Washington was estimated at $406 million.

Cancer
The National Toxicology Program in the U.S. and the International Agency for Research on Cancer in Europe have each identified dozens of chemicals that are known to cause cancer. These chemicals are used to make household products and are found in the home environment.

Childhood Cancer

---


7 Read more about asthma and children at the Washington State Department of Health website: [http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-309.pdf](http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-309.pdf)


• Researchers have not established clear links between chemical exposures and childhood cancer. However, exposure to carcinogens in the environment is thought to play an important role in the development of many cancers.
• Children are exposed to many carcinogenic chemicals in household products during key developmental stages.
• From 1992 through 2009 in Washington State, about 200 new cancer cases per year have been reported in children under age 15.10

Bladder Cancer
• Researchers have found a relationship between bladder cancer and high levels of arsenic contamination in drinking water.
• Long-term exposure to disinfection byproducts in drinking water may also cause a small increase in the risk for bladder cancer. These disinfection by-products enter drinking water when water suppliers disinfect water to kill bacteria.11

Breast Cancer:
Researchers have not established clear links between environmental exposures (other than ionizing radiation) and human breast cancer. However, there is research suggesting that there may be a relationship between some chemical exposures and incidence of breast cancer.
• Exposure to chemicals such as polycyclic aromatic hydrocarbons (PAH), benzene, and organic solvents may be linked to breast cancer. Laboratory studies indicate that environmental contaminants can cause breast tumors.
• Pesticides and industrial products may be linked to breast cancer. Because of their presence in the environment, their ability to be absorbed by fat, and their potential to act as endocrine disruptors, researchers are working to determine whether these toxins play a role in breast cancer incidence rates.12
• Forty-seven percent of breast cancer cases that occur in the United States can be attributed to known risk factors; these factors include environmental toxics.

Health Effects from Specific Toxic Exposures
This section describes the known health effects associated with exposure to a selection of toxic substances or categories of toxics: arsenic, lead, pesticides, mercury, and air toxics. This is not a

10 Information on cancer incidence rates in Washington State can be accessed via the Washington State Department of Health’s Washington State Cancer Registry, available online: https://fortress.wa.gov/doh/wscr/WSCR/
11 For more information on cancer trends, see the Centers for Disease Control’s website: http://epitracking.cdc.gov/showCancerMain.action
12 For more information on endocrine disruptors and cancer, see the Centers for Disease Control’s website: http://epitracking.cdc.gov/showCancerMain.action
comprehensive list of toxic chemicals, but rather serves to highlight several toxic substances that are known to negatively impact human health. Significant data gaps still exist about the health effects of many chemicals:

- For some chemicals, health effects have only been researched on laboratory animals and so the effects on humans are not known.
- Much is unknown about how multiple chemicals interact in the body to create additional health impacts beyond those from single chemicals.
- For many substances, significant research has not yet been conducted at all.

More comprehensive information about human exposure to toxic substances can be found in the National Report on Human Exposure to Environmental Chemicals, in which the Centers for Disease Control (CDC) summarizes known data on the health effects of more than 200 chemicals that are part of a biennial Biomonitoring survey: http://www.cdc.gov/exposurereport.

**Arsenic**

- Exposure to arsenic at high levels can lead to death. People can be exposed to arsenic through ingesting small amounts in food and water or breathing air containing arsenic.
- At lower levels, exposure can cause skin discoloration and small warts.
- Breathing high levels of arsenic can cause a sore throat or irritated lungs.  

**Lead**

- Scientists have established that lead poisoning can cause learning disabilities, behavioral problems, and, at very high levels, seizures, coma, and even death.
- Since lead-based paints were banned from use in homes in 1978, blood lead levels in the U.S. have been declining.
- In the United States, lead exposure among children often comes from lead-based paint and lead-contaminated dust found in older buildings.
- Children can be exposed to lead by eating lead-based paint chips, chewing on objects painted with lead-based paint, or swallowing house dust or soil that contains lead.

**Mercury**

- Exposure to high levels of any form of mercury can cause permanent damage to the brain and kidneys. Because the nervous system of a developing fetus or newborn is particularly susceptible to damage due to mercury exposure, experts advise pregnant or breastfeeding women to follow federal recommendations of selecting fish or shellfish.
- Adults and older children are also at risk of negative health effects from mercury exposure.
- Consumption of methyl-mercury-contaminated fish is the most common way people in the U.S. become exposed to and poisoned by mercury.

---

14 Read more about childhood lead poisoning and the environment at the Centers for Disease Control and Prevention’s site: http://ephtracking.cdc.gov/showLeadPoisoningEnv.action
15 Read more about mercury risks and health effects at the Agency for Toxic Substances & Disease Registry: http://www.atsdr.cdc.gov/mercury/
• Exposures can also result from contaminated air from spills (e.g., broken thermometers) or industries that burn mercury-containing fuel, breathing mercury vapor from dental fillings and medical treatments, and practicing certain cultural rituals that include mercury-containing substances.

Pesticides
• Health outcomes that have been linked to pesticide exposure include increased risk for diabetes, cognitive decline, Parkinson’s Disease, some cancers, and some reproductive health problems.\(^{16}\)
• Research shows that children can experience chronic exposure to low doses of pesticides through hand-to-mouth behavior and time spent on the floors of their homes and in contact with soils. Exposures can also occur through food, drinking water, and indoor and outdoor use of pesticides.

Air Toxics
• Air toxics, also known as hazardous air pollutants, are known or suspected to cause cancer and other serious effects such as reproductive and neurological problems, birth defects, asthma and other respiratory conditions, and damage to the cardiovascular system.
• Examples of air toxics include benzene, perchloroethylene, methylene chloride, dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.
• People are primarily exposed to air toxics by breathing contaminated air (e.g., from vehicle emissions, factories, refineries, and power plants). Exposure can also result from food and water on which air toxics have been deposited, or through contaminated soil, dust, or water. Children can also be exposed by eating contaminated soil.\(^{17}\)

Conclusion
While key data gaps exist in our knowledge about the impacts of toxic substances on human health, researchers have established links between many chemicals and certain negative health consequences. Exposure to toxic chemicals has the greatest potential for negative effects for fetuses, infants, and children. Where links have been established between some toxic chemicals and health effects, much is yet unknown about the effects of multiple chemicals in the body at the same time. Toxic chemical policymakers face the difficult task of confronting both known consequences of chemical exposures as well as that which is yet unknown. More information can be found at the Centers for Disease Control and the Washington Department of Health.\(^{18}\)

\(^{16}\) Read more about the health effects of pesticides at The National Institute of Environmental Health Sciences’ site: http://www.niehs.nih.gov/health/topics/agents/pesticides/index.cfm
\(^{17}\) Information about air toxics is available on the US EPA’s site on Toxic Air Pollutants: http://www.epa.gov/air/toxicair/newtoxics.html
\(^{18}\) Washington Department of Health toxic chemicals fact sheets: http://ephtracking.cdc.gov/showHealthEffects.action