



CHILDREN'S ENVIRONMENTAL HEALTH

Environmental Contaminants and Their Relation to Learning, Behavioral and Developmental Disorders

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Learning disabilities, attention deficit/hyperactivity disorder and emotional and behavioral problems are among childhood disabilities of increasing concern. Genetic, environmental, and social factors have important effects on how children's brains develop and function. Extensive laboratory and clinical studies of several compounds toxic to neural development, including lead, mercury, polychlorinated biphenyls (PCBs), alcohol, and nicotine, have demonstrated how the developing brain of children is uniquely vulnerable to environmental agents at levels that have no lasting effects in adults. Unfortunately, understanding the effects of these toxicants on the developing brain has emerged slowly while children continue to be exposed to unsafe levels.

The NIEHS is committed to understanding the role these contaminants play in how learning and behavioral disorders develop. The NIEHS is also committed to evaluating the best possible ways to remove and treat contaminants in the home, and to decrease any damage done by past exposures to these contaminants. The following sections discuss some of the compounds and chemicals that are being evaluated by the NIEHS, and the recent progress made in this effort.

Lead

Lead has been shown to cause serious injury to the brain, nervous system, red blood cells, and kidneys. Higher levels of lead in the body can cause mental retardation, convulsions, unconsciousness, coma, and even death. Although lead paint stopped being used on most houses in the mid-1970s, many older homes still have surfaces once painted with lead paint. Young children may eat, chew, and suck on lead-painted surfaces they can reach, such as windowsills and railings. Dirt and dust sometimes have lead in them, as do the fumes and dust stirred up during home renovation.

Although it has been known that high levels of lead can lead to development, behavioral, and psychological problems, the effects of exposure to low levels of lead early in life have been under appreciated. Previous studies by NIEHS-supported researchers have shown that levels of lead in blood that were thought before to be safe are, in fact, related to subtle nervous system and behavioral problems in children. These problems include [lower IQ scores](#), impaired coordination, and increased aggression. Based on these findings, the Centers for Disease Control and Prevention (CDC) lowered its acceptable levels for lead in children's blood. However, there is a continuing need to assess the dangers of lead and methods of treating children previously exposed to lead.

At present, the NIEHS is pursuing several research areas to further understand the effects that lead has on growing children. One research project is currently investigating the health and behavioral effects of low lead exposures, including basic research to define the cellular and molecular pathways of lead toxicity, and epidemiological studies that assess the role of lead in neurobehavioral problems such as ADHD and aggression.

The CBPR also has two initiatives to help reduce exposures of children to lead. In both studies, minority and disadvantaged children will be monitored for the prevalence of high blood lead levels. Behavioral and exposure interventions will be assessed for effectiveness in individuals and communities.

Methylmercury and Mercury

Methylmercury (MeHg) is a common environmental contaminant that gets into water, where it is later concentrated in fish, shellfish, and other aquatic plants and animals that we may eat. Methylmercury is neurotoxic and exposure of a pregnant woman to lead simultaneously exposes her developing child. Thus, it is important to understand at what exposure levels methylmercury can cause neurological problems for the developing fetus and child.

A current research project supported by the NIEHS is evaluating the [health risks caused by early exposure to methylmercury through contaminated fish](#). A cohort of 740 children (which includes children of the ages 7-8) from a population in the Seychelles Islands will be assessed for developmental toxicity. These studies will be compared to the results of similar

studies of prenatally exposed infants in New Zealand and the Faeroe Islands. The population represented in this study experiences exposures to a wide range in mercury levels, so the results can be useful in assessing the health risks of mercury in the US population.

Data from a birth cohort of 1,000 children (formed during 1986 to 1987) at the Faeroe Islands, where increased exposure to methylmercury is mainly due to consumption of pilot whale meat and children showed mild deficits associated with prenatal exposures. This group of children will be examined for additional effects of lead exposure. In addition, to determine the long-term implications and the potential reversibility of mercury-associated deficits, follow-up of the cohort at age 14 years will be carried out. Their performance in neurological and behavioral tests will be compared with several signs of mercury exposure that occur both before and after birth.

The Oswego Newborn and Infant Development Project tracks the development of 224 children born to women who did or did not consume Great Lakes fish during pregnancy. Information on levels in umbilical cord blood for various environmental toxins, such as PCBs, the organochlorine pesticides DDE (dichlorodiphenyldichloroethylene) and HCB (hexachlorobenzene), the insecticide Mirex, and lead, and hair mercury levels are on file for every child in the project. In addition, extensive information on demographic, substance use, and labor/delivery factors, containing well over 100 different types of information, is included with the umbilical cord blood database. These data, combined with extremely low project attrition over the past 6 years, provides the opportunity to assess the impact of PCBs and related contaminants on cognitive development. The project will now track their progress into the early school-age years.

Polychlorinated Biphenyls

PCBs occur throughout the environment because of its widespread uses in electric transformers, paper recycling, and other commercial processes. However, today we know that PCBs can have a lasting impact on a child's development. NIEHS-supported scientists previously have shown that when the child is exposed to PCBs while in its mother's womb, serious neurological problems can develop. Although PCBs have long been banned, partly in response to earlier NIEHS study results; they still contaminate many waters and soils.

Many rural low-income communities rely on fishing as a major source of food. The NIEHS is supporting researchers who are following a group of children born to mothers who ate large amounts of fish that may have been contaminated with PCBs, methylmercury, lead, cadmium, and organochlorine pesticides such as DDT and its breakdown products. The relationships between these exposures and a variety of developmental outcomes are being studied, including infant size, behavior, and neurological function. The project also will track their progress into the early school-age years. In addition, behavioral functions that animal studies have repeatedly shown are affected by PCBs and lead (fixed-interval performance)

will be assessed in the children. All outcome measures will be related to the umbilical cord blood database of levels of PCBs, the organochlorine pesticides DDE, and HCB, the insecticide Mirex, lead, and mercury. The current project will provide critically needed information on the effects on cognitive and behavioral development caused by exposure to low levels of PCBs, and whether the effects of PCBs and related compounds on standard tests of mental function translate into poorer performance in school.

Endocrine Disrupting Compounds and Diethylstilbestrol

Endocrine disruptors comprise a large class of diverse compounds that have the ability to disrupt endocrine function, such as through estrogenic, androgenic, or other hormonal pathways. Some compounds suspected of disrupting the endocrine system include PCBs, chlorinated pesticides such as DDT (dichlorodiphenyltrichloroethane), dioxin, and some plasticizing compounds.

The endocrine system plays a central role in the body, and endocrine disruption can affect the body's neurons, hormones, and immune systems. It is known that animals exposed to environmental endocrine disruptors in the wild can exhibit impaired reproduction and birth defects. What remains to be defined, however, is the effect of these exposures in the human population where exposure levels are generally much lower.

The NIEHS and the National Center for Environmental Health of the CDC are collaborating on a pilot project to quantify approximately 70 chemicals found in human blood or urine that are thought to be endocrine-disrupting agents, including phthalates and phytoestrogens. The blood and urine samples are collected under the National Health and Nutrition Examination Survey, which includes men and women from a range of age, socioeconomic, and ethnic groups. These data will provide estimates of human exposures to endocrine-disrupting agents within the U.S. population and will help identify agents of public health concern.

On behalf of the U.S. Environmental Protection Agency (EPA), the NTP organized a panel of scientists to review research on endocrine-disrupting chemicals (effects and dose-response relationships) at lower doses than normally recommended under the EPA's standard testing guidelines. The panel examined information from major selected studies (not including studies on dioxin and related compounds), looking for the presence or absence of effects in laboratory animals that could also affect humans. The panel also looked at the effects of these substances at very low doses. Diethylstilbestrol (DES), a potent synthetic estrogen once used by pregnant women to prevent miscarriage, was shown to cause health problems later in life for female children whose mothers took DES while pregnant ("DES daughters"). These DES daughters are at risk of developing rare vaginal and other cancers (including clear cell adenocarcinoma), as well as having reproductive abnormalities. To date, DES sons have shown no increased cancer risk, although reproductive abnormalities have been reported. Like DES daughters, DES grandchildren may have an increased risk of

reproductive tract cancer, as suggested from an animal study conducted and published by NIEHS in 1998. These animal studies suggest that irreversible changes exist in developmentally DES-exposed females that can be transmitted to unexposed offspring.

NIEHS researchers propose to systematically analyze and detect alterations produced by DES exposure. They also propose to compare the similarities and differences in how humans and mice show the effects of exposure to DES, to better understand the differences between the species.

Air Pollutants

Prenatal and postnatal exposures to airborne particulates, polycyclic aromatic hydrocarbons, environmental tobacco smoke, and home allergens increase the risk of developmental impairment. The developing lungs and nervous system of young children are suspected of being unusually vulnerable to even low levels of environmental tobacco smoke. Therefore, additional studies into the effects of these contaminants are severely needed. One of the Children's Health Centers is focusing on community-based research and methods to prevent children from being exposed to environmental risks. This research investigates health effects associated with exposures in the womb and in infants to harmful air pollutants (e.g. polycyclic aromatic hydrocarbons, airborne particles including diesel exhaust, environmental tobacco smoke, pesticides, and indoor allergens).

Pesticide Residues in Food

In 1993 the National Academy of Sciences released a report revealing gaps in our overall understanding of health effects of exposure to pesticides early in life. To help fill these gaps, which continue to this day, the NIEHS is conducting several basic studies on treatment and prevention to understand the risks and to eliminate these risks to children.



One study will focus on reducing how much pesticide residue farm workers take home with them after work, and so reducing how much their children are exposed to these chemicals. The study will follow families for several years to see whether their pesticide exposures continue to be lower. The researchers plan to produce instructions for other communities to use.

Other research will study how exposures to low levels of toxins in the womb affect neurodevelopment in children. The neurodevelopmental effects will be correlated to intrauterine exposures of environmental contaminants, such as PCBs, DDE, MeHg, and lead.

Another set of researchers proposes to identify sensitive toxic endpoints and sensitive populations for chlorinated hydrocarbon (CHC) toxicity. This project focuses on how these pesticides collect in the bodies of animals over time (bioaccumulate).

Center for the Evaluation of Risks to Human Reproduction

The NIEHS, under the auspices of the NTP, established the Center for the Evaluation of Risks to Human Reproduction (CERHR). This is a unique center that provides expert assessment for the public on how compounds affect adult fertility and the development of their children. A panel of scientists reviews all known information on a chemical, evaluates its probable effects on reproduction and development, and identifies areas where more research is needed.

The first review conducted by the center was on seven phthalate compounds (butyl benzyl phthalate, di(2-ethylhexyl) phthalate (DEP), di-isodecyl phthalate, di-isononyl phthalate, di-n-butyl phthalate, di-n-hexyl phthalate, and di-n-octyl phthalate). Phthalates are used commercially as plasticizers in such products as shower curtains, medical tubing and IV bags, upholstery, raincoats, balls, and soft-squeeze toys. People are exposed to these chemicals when they migrate out of the plastic and are absorbed into the body. Because of this, exposure to low levels of these compounds is likely widespread. Reports on the panel's conclusions can be found on the CERHR website (<http://cerhr.niehs.nih.gov/>). Both the FDA and Health Canada used the CERHR report on phthalates to develop their reports on the health risks resulting from the presence of DEP.

Currently, the CERHR is requesting comments from the public on its draft reports on methanol, 1-bromopropane, and 2-bromopropane. These drafts also may be viewed on the CERHR website.

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Additional Information:

- **NIEHS:** [Centers for Children's Environmental Health and Disease Prevention Research](#)
- **NIEHS Health Topic:** [Children's Health](#)
- **NICHD:** [National Institute Health of Child Health & Human Development](#)

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