# NIEHS/EPA Children's Environmental Health and Disease Prevention Research Centers:

## Protecting Children's Health for a Lifetime

National Institute of Environmental Health Sciences

United States Environmental Protection Agency

National Institutes of Health • U.S. Department of Health and Human Services

## MISSION:

***Jointly funded by the National Institute of Environmental Health Sciences (NIEHS) and the U.S. Environmental Protection Agency (EPA), the mission of the Children's Centers is to reduce health risks, protect children from environmental threats, and promote their health and well-being in the communities where they live, learn, and play. Beginning with passage in 1997 of Executive Order 13045, Protection of Children From Environmental Health Risks and Safety Risks, our activities and research have increased scientific knowledge of children's environmental health from preconception to young adulthood.***

## Protecting Children's Health

We all want our children to thrive and grow into a healthy and productive adult population. Since 1998, the NIEHS/EPA Children's Environmental Health and Disease Prevention Research Centers (Children's Centers) have studied individual, regional, national, and global environmental exposures and children's health. Contributions from this unique coordinated national network of research centers are leading to long-term economic and social benefits, along with improved health.

## Advancing Research Through Collaboration and Training

The Children's Centers connect basic scientists, social scientists, pediatricians, public health professionals, and community organizations, all working together to improve the health and environments of children. To keep breakthrough discoveries coming and maintain a pipeline of experienced environmental health scientists, the Children's Centers are also dedicated to developing the next generation of researchers.

## What We've Learned: A Good Start Lasts a Lifetime

Pound for pound, children have increased risks from environmental exposures, because their bodily systems — cardiovascular, digestive, immune, nervous, and others — are still developing. Environmental health researchers now recognize that low level exposures, especially during early developmental growth periods, such as *in utero* or neonatal, can have long-lasting effects. This research evolution demonstrates that environmental health effects are complex — not a simple relationship between a particular type and amount of exposure and disease. New science shows that combined chemical exposures affect growth and development in ways not previously recognized.

All Children's Centers produce important insights about children's health and social conditions. Examples provided represent some of the work but don't tell the whole story. More information on the research and findings can be found on the EPA and NIEHS websites.

## Pregnancy and Birth Outcomes

An adverse pregnancy outcome is an event that reduces the chance of having a healthy baby, such as miscarriage, pre term birth, or impaired fetal growth. Nearly a half million babies — one out of every nine — are born premature and too small, costing the U.S. health care system more than $26 billion a year.[1]

- Low birth weight in infants is linked to exposures to low-level arsenic during pregnancy.[2]
- Low thyroid-stimulating hormone levels during pregnancy, in both the mother and baby, are associated with exposure to polybrominated diphenyl ethers (PBDEs), commonly used as flame retardants.[3] Thyroid hormones regulate metabolism, and are critical to normal development of the baby's brain and nervous system.

Epidemiologic literature also suggests associations of prenatal exposures to heavy metals, including mercury, lead, and arsenic, with increased risk for brain damage, neurodevelopmental problems, congenital malformations, and miscarriage.

## Children's Centers:

Previous and current institutions that have contributed to improving our understanding of children's environmental health include:

Brown University
Cincinnati Children's Hospital Medical Center
Columbia University
Dartmouth College
Duke University
Harvard University
Johns Hopkins University
Icahn School of Medicine at Mount Sinai
National Jewish Health
University of California, Berkeley
University of California, Davis
University of California, San Francisco
University of Illinois
University of Iowa
University of Medicine and Dentistry of New Jersey
University of Michigan
University of Southern California
University of Washington

## Neurodevelopmental and Neurobehavioral Disorders

Over the last 12 years, the prevalence of all developmental disabilities increased 17 percent, with the prevalence of learning disabilities found to be 7.6 percent from 1997-2008.[4] The Children's Centers are conducting research to assess how a wide range of chemicals, including certain pesticides; air pollutants, such as polycyclic aromatic hydrocarbons (PAHs); and metals, such as lead, mercury, and manganese; lead to learning and behavioral deficits. Researchers have also discovered that prenatal exposures, not just those that occur after birth, lead to neurological deficits in children.

- High prenatal PAH exposure is associated with a lower mental development index score at age 3 (Bayley Scale) and with increased odds of cognitive developmental delay.[5] In children 6-7, high PAH exposure was associated with symptoms of anxiety, depression, and attention problems.[6]
- Women with higher phthalate exposures during pregnancy report more disruptive behaviors in their children.[7] Phthalates are chemical compounds used in many plastics and some personal care products.
- Children exposed prenatally to high levels of chlorpyrifos, a pesticide, show both enlargement and thinning of certain brain areas, and have lower intelligence testing scores.[8]

## Asthma

One in 11 children has asthma, an inflammatory lung disease. Asthma prevalence more than doubled over the past two decades, especially among urban populations, and costs the U.S. $56 billion annually, with a yearly cost of more than $1,000 for a child with the disease.[11] Discovering asthma triggers will help development of prevention strategies. For example, in the past decade, several researchers, have found that living near dense traffic is associated with asthma or long-lasting problems with lung function in children.

- Specifically, diesel soot particulate matter is the component of air pollution most responsible for several respiratory problems among inner-city children.[12]
- Children living in moldy homes are three times more likely to develop asthma by age 7.[13]
- Early childhood exposure to the chemical bisphenyl A (BPA) is associated with an elevated risk for asthma in young children.[14]

## What We Want to Learn Next

New and often interconnected areas of research to be addressed include:

- **Obesity:** What is the role of environmental factors in the epidemic of childhood obesity?
- **Endocrine Disrupting Chemicals:** How are widespread exposures to these chemicals affecting children, particularly during vulnerable windows of development?
- **Epigenetics:** How do modifications to DNA, resulting from diet, aging, stress and environmental exposures, affect our children or our grandchildren?
- **Microbiome:** How do helpful microorganisms in the gastrointestinal tract affect children's health? How is the microbiome affected by environmental exposures, including diet, antibiotic use, and chemicals?
- **Immune System:** What is the role of environmental triggers in autoimmune diseases? How do early life exposures affect immune responses?
- **Cumulative Exposures:** Recognizing that people are not exposed to one chemical at a time and are exposed to many chemicals over time, how can assessment be improved?

## Environment and Autism Risk: More Than Genetics

The prevalence of autism increased 289.5 percent over the last 12 years.[9] Autism is a developmental disorder long attributed to genetic factors. While changes in diagnostic criteria and increased awareness have been thought to contribute to the rising incidence of the disorder, these factors alone cannot explain the dramatic increase in the number of children affected.

Researchers have found evidence that links certain environmental exposures with autism risk. For example, living near a freeway may be associated with increased risk of autism, according to a study by a team from the Children's Hospital Los Angeles, University of Southern California, and University of California, Davis.[10] Researchers are investigating chemicals in air pollution, such as PAHs, that may affect neurodevelopment and contribute to autism risk. Further research is needed to understand potential gene-exposure interactions and to identify autism prevention strategies.

## Childhood Leukemia and Benzene

Leukemia is the most common type of childhood cancer, placing considerable stress and financial burden on affected families. Environmental causes of childhood cancer, although long suspected, are difficult to pin down. But, in a breakthrough discovery, benzene, known to be a human carcinogen, was linked to leukemia by the University of California, Berkeley. Benzene's association with childhood leukemia stems from its toxicity to certain cells. Researchers say there is probably no safe level of exposure to benzene, and all exposures constitute some risk.[15]

## Community Engagement is Essential

Many parents are eager to learn about simple steps they can take to minimize harmful exposures for their children. To this end, the Children's Centers apply community-based participatory research techniques, in which community partners play a vital role in informing, implementing, and sharing what the findings mean. Additionally, each center has a designated physician-scientist to ensure research is translated into practical information for health care providers.

## Policy Advances Based on Science

Concerns about the health effects of hazardous environmental exposures have led to federal and local policies designed to inform and protect the public.

- Nationally, the Mercury and Air Toxics Standards limit air pollutants emitted from utilities. This policy will help avoid 130,000 asthma attacks every year.[16]
- In New York City, the passage of two landmark bills in 2005 was bolstered by the testimony of Columbia University researchers, who linked smaller birth size and prenatal pesticide exposure. The bills reduce exposure to certain pesticides through better notification and a reinforced commitment to adopting integrated pest management strategies.
- In any locality, reduction in children's air pollution exposures can be achieved by considering local traffic volume, not just regional air quality, when siting schools, sports fields, or new homes.[17] Some jurisdictions have called for less idling in school bus operations as a way to reduce diesel fume exposures at minimal cost.

## For More Information

NIEHS: https://go.usa.gov/xNF38

EPA: https://go.usa.gov/xN5bS

**Watch past and upcoming webinars at** https://go.usa.gov/xN5jC

## Contacts


### NIEHS

**Kimberly Gray, Ph.D.**
Health Scientist Administrator
Division of Extramural Research and Training
gray6@niehs.nih.gov

### EPA

**Richard Callan, M.P.H.**
Environmental Health Scientist
National Center for Environmental Research
callan.richard@epa.gov

**Nica Louie, M.S.**
Environmental Scientist
National Center for Environmental Research
louie.nica@epa.gov



[1] CDC (Centers for Disease Control and Prevention). 2013. Preterm Birth. Available: http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/PretermBirth.htm [accessed 30 September 2013].

[2] Fei DL, Koestler DC, Li Z, Giambelli C, Sanchez-Mejias A, Gosse JA, Marsit CJ, Karagas MR, Robbins DJ. 2013. Association between in utero arsenic exposure, placental gene expression, and infant birth weight: a U.S. birth cohort study. Environmental Health 12:58.

[3] Chevrier J, Harley KG, Bradman A, Gharbi M, Sjodin A, Eskenazi B. 2010. Polybrominated diphenyl ether (PBDE) flame retardants and thyroid hormone during pregnancy. Environ Health Perspect 118(10):1444-1449.

[4] CDC (Centers for Disease Control and Prevention). 2011. Developmental Disabilities Increasing in U.S. Available: https://go.usa.gov/xN5j5 [accessed 7 July 2017].

[5] Perera FP, Rauh V, Whyatt RM, Tsai WY, Tang D, Diaz D, Hoepner L, Barr D, Tu YH, Camann D, Kinney P. 2006. Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children. Environ Health Perspect 114(8):1287-1292.

[6] Perera FP, Tang D, Wang S, Vishnevetsky J, Zhang B, Diaz D, Camann D, Rauh V. 2012. Prenatal polycyclic aromatic hydrocarbon (PAH) exposure and child behavior at age 6-7 years. Environ Health Perspect 120(6):921-926.

[7] Engel SM, Miodovnik A, Canfield RL, Zhu C, Silva MJ, Calafat AM, Wolff MS. 2010. Prenatal phthalate exposure is associated with childhood behavior and executive functioning. Environ Health Perspect 118(4):565-571.

[8] Rauh VA, Perera FP, Horton MK, Whyatt RM, Bansal R, Hao X, Liu J, Barr DB, Slotkin TA, Peterson BS. 2012. Brain anomalies in children exposed prenatally to a common organophosphate pesticide. Proc Natl Acad Sci U S A 109(20):7871-7876.

[9] CDC (Centers for Disease Control and Prevention). 2012. Autism Spectrum Disorders: Data & Statistics. Available: http://www.cdc.gov/ncbddd/autism/data.html [accessed 30 September 2013].

[10] Volk HE, Hertz-Picciotto I, Delwiche L, Lurmann F, McConnell R. 2011. Residential proximity to freeways and autism in the CHARGE study. Environ Health Perspect 119(6):873-877.

[11] CDC (Centers for Disease Control and Prevention). 2010. Asthma's Impact on the Nation. Available: http://www.cdc.gov/asthma/impacts_nation/asthmafactsheet.pdf [accessed 30 September 2013].

[12] Spira-Cohen A, Chen LC, Kendall M, Lall R, Thurston GD. 2011. Personal exposures to traffic-related air pollution and acute respiratory health among Bronx schoolchildren with asthma. 2011. Environ Health Perspect 119(4):559-565.

[13] Reponen T, Vesper S, Levin L, Johansson E, Ryan P, Burkle J, Grinshpun SA, Zheng S, Bernstein DI, Lockey J, Villareal M, Khurana Hershey GK, LeMasters G. 2011. High environmental relative moldiness index during infancy as a predictor of asthma at 7 years of age. Ann Allergy Asthma Immunol 107(2):120-126.

[14] Donohue KM, Miller RL, Perzanowski MS, Just AC, Hoepner LA, Arunajadai S, Canfield S, Resnick D, Calafat AM, Perera FP, Whyatt RM. 2013. Prenatal and postnatal bisphenol A exposure and asthma development among inner-city children. J Allergy Clin Immunol 131(3):736-742.

[15] Smith MT. 2010. Advances in understanding benzene health effects and susceptibility. Annu Rev Public Health 31:133-148.

[16] EPA (Environmental Protection Agency). 2013. America's Children and the Environment, Third Edition. Available: https://go.usa.gov/xN5Db [accessed 7 July 2017].

[17] Gilliland FD. 2009. Outdoor air pollution, genetic susceptibility, and asthma management: opportunities for intervention to reduce the burden of asthma. Pediatrics 123 Suppl 3:S168-S173.



National Institute of Environmental Health Sciences
National Institutes of Health
U.S. Department of Health and Human Services

United States Environmental Protection Agency

MIX
Paper from responsible sources
FSC® C004281
www.fsc.org

NIEHS: 111 TW Alexander Drive, PO Box 12233, Research Triangle Park, NC 27709
919-541-3345
**www.niehs.nih.gov**

USEPA: 1200 Pennsylvania Avenue NW
Mail Code 8723P, Washington, D.C. 20460
703-347-8051 or 703-347-8125
**www.epa.gov/ncer**

Printed on 30% post-consumer content using soy-based inks

October 2013