Using data from a study of 294 children living in Mexico City, investigators found a disturbing link between low-level lead exposure and neurodevelopment – the higher the children's blood lead levels at 24 months of age, the lower their scores on tests of mental and psychomotor development. Furthermore, these effects were greater among children whose lead levels were below 10 micrograms per deciliter than among children with lead levels above this threshold.[7] These results suggest that the current screening guideline for blood lead developed by the Centers for Disease Control and Prevention should not be interpreted as a level at which adverse effects do not occur.

Pesticides and Neurodevelopment

Several centers are conducting population studies of families exposed to organophosphates, a class of organic chemicals used for pest control in both rural and urban environments. Researchers at the University of California at Berkeley Center for Children's Environmental Health have found that newborns whose mothers had high levels of pesticide metabolites in their urine scored poorly on tests measuring sucking, rooting, and other motor reflexes. Other studies conducted by the Berkeley researchers will asses the

effects of pesticide exposure on neurodevelopment, growth, and symptoms of respiratory illness in children.

Researchers at the Mount Sinai Children's Environmental Health Center have discovered a link between prenatal exposure to organophosphate pesticides from indoor pest control application, and a significant decrease in the head circumference of the infants at birth.[8] There also was a genetic connection – the effect was observed only in mothers with low levels of paraoxonase, an enzyme needed to detoxify the compound. Investigators at the University of Washington Center for Child Environmental Health Risks are finding that pesticides from local spraying of crops can vaporize and drift miles from the original target site, exposing children through inhalation of the vapors.

At the Friend's Children's Environmental Health Center at the University of Illinois, scientists are investigating the neurological effects of polychlorinated biphenyls (PCBs), toxic compounds used in electrical transformers, and methyl mercury, a highly toxic form of mercury found in many species of fish. Preliminary results from animal studies show that neither compound alone had a significant impact on balance or coordination. However, exposure to both chemicals resulted in marked deficits in neurological function.[9] Researchers also noted significant deficits in learning and memory following exposures to either PCBs or methyl mercury.

Looking to the Future

Children's health is a top priority, and the NIEHS is committed to making the most of every research dollar. To achieve this goal, the Institute is conducting a review of the many ways it can fund research on children's environmental health. The review will evaluate all forms of funding to identify the most effective ways to understand how the environment affects children's health. Supporting research that shows the greatest promise for rapidly identifying links between environmental exposures and childhood disease is a primary focus.

1. Gauderman et al. (2004) The Effect of Air Pollution on Lung Function Development in Children Aged 10 to 18 Years. *New England Jour. Medicine* 351(11):1057-67.

2. Lewis et al. (2005) Air Pollution-Associated Changes in Lung Function Among Asthmatic Children in Detroit. *Environmental Health Perspectives* 113(8):1068-75.

3. Bocskay et al. (2005) Chromosomal Aberrations in Cord Blood Are Associated with Prenatal Exposure to Carcinogenic Polycyclic Aromatic Hydrocarbons. *Cancer Epidemiology Biomarkers Prevention* 14:506-511.

4. Eggleston et al. (2005) Home Environmental Intervention in Inner-City Asthma: A Randomized Controlled Clinical Trial. *Annals Allergy Asthma Immunol.* 95(6):518-24.

5. Chrischilles et al. (2004) Asthma Prevalence and Morbidity Among Rural Iowa Schoolchildren. *Jour. Allergy Clin. Immunol.* 113(3):391.

6. Canfield et al. (2003) Intellectual Impairment in Children with Blood Lead Concentrations Below 10 Micrograms per Deciliter. *New England Jour. Medicine* 348(16):1517-26.

7. Tellez-Rojo et al. (2006) Longitudinal Associations Between Blood Lead Concentrations Lower Than 10 Microgram per Deciliter and Neurobehavioral Development in Environmentally Exposed Children in Mexico City. *Pediatrics* 118(2):323-30.

8. Berkowitz et al. (2004) In Utero Pesticide Exposure, Maternal Paraoxonase Activity, and Head Circumference. *Environmental Health Perspectives* 112(3):388-91.

9. Roegge et al. (2004) Motor Impairment in Rats Exposed to PCBs and Methylmercury During Early Development. *Toxicol. Sci.* 77(2):315-24.

NIEHS
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New Directions in Children's Environmental Health Research

Young children are highly vulnerable to the negative health consequences associated with many environmental exposures. Pound for pound, children receive proportionately larger doses of environmental toxicants than adults. And the fact that their organs and tissues are rapidly growing and developing makes them particularly susceptible to chemical insults. In addition, they are not fully equipped to process and remove these toxicants from their bodies.

"The effects of childhood exposures to environmental toxicants can last a lifetime, which is why the NIEHS is committed to supporting the best possible research on children's environmental health," said David A. Schwartz, M.D., Director of the federal National Institute of Environmental Health Sciences.

New Strategies for Disease Prevention

In response to these challenges, NIEHS has developed several innovative new programs designed to address important issues in children's health. These new approaches incorporate the latest advances in basic research in order to focus on exposures that carry the highest risk to the largest populations, and diseases for which there is a strong environmental component. The programs emphasize the translation of basic knowledge obtained from the laboratory into new strategies for reducing the incidence of environmentally-related disease.

As one example, NIEHS recently unveiled a new funding program called **DISCOVER** *(Disease Investigation through Specialized Clinically Oriented Ventures in Environmental Research)* that will bring together basic, clinical and population-based scientists to conduct research on the interplay between environmental and genetic factors in disease risk. This program is one of several new initiatives designed to provide support for state-of-the-art research conducted by the country's leading experts in children's environmental health.

Another emerging area of interest is the impact of environmental exposures received early in life on disease risk in later adulthood. In response to this concern, NIEHS has developed a Fetal Basis of Adult Disease Program that supports research on the role that prenatal exposures play in influencing a child's susceptibility to disease much later in life. Because the fetus is more sensitive to toxic exposures, the effects of these exposures on development

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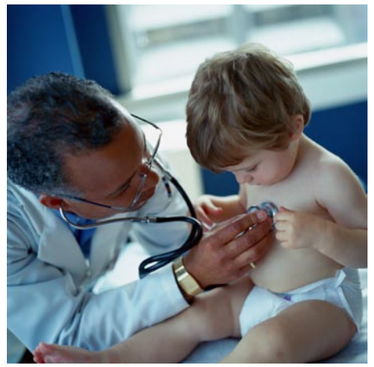
may be more devastating than exposures received during adulthood. More research is needed to determine how prenatal exposures alter the subsequent risk of cardiopulmonary disease, neurodegenerative disorders, reproductive diseases and behavioral problems.

Finally, the NIEHS is developing an Exposure Biology Program that will make use of new technologies for detecting and measuring human exposures to environmental pollutants. This includes the use of personal monitoring devices, field monitoring techniques, and surveillance methods in order to obtain accurate, personalized measures of environmental exposures. This also includes the development of biological markers that can assist researchers in detecting subtle changes in tissues and organs as a result of toxic exposures. Armed with these new tools, researchers will be better able to identify and understand environmental contributors to childhood diseases.

Searching for Clues: Children's Environmental Health Centers

NIEHS has traditionally played a pivotal role in funding research on children's health. For the past eight years, the Institute has partnered with the U.S. Environmental Protection Agency to support thirteen research centers devoted exclusively to children's environmental health and disease prevention. These centers utilize the expertise and resources of top universities and medical centers

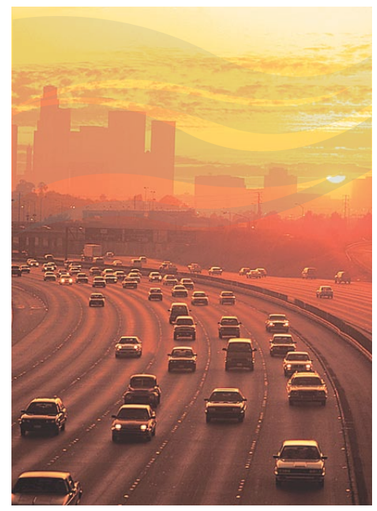


to focus on the important role that environmental toxicants play in growth and development, asthma, autism, and a host of other childhood illnesses.

Toxins in the Air We Breathe

Among the centers' top priorities is research on outdoor and indoor air pollution. Leading scientists at the University of Southern California Children's Environmental Health Center are exploring the role of outdoor air pollution in asthma development. Their research shows that the closer children live to a freeway, the greater their chances of being diagnosed with asthma. The researchers also found that children who lived in areas with higher levels of nitrogen dioxide, a pollutant found in motor vehicle exhaust, were more likely to develop asthma symptoms. Another landmark study conducted by the Southern California researchers in 2004 shows that children who live in polluted communities are five times more likely to have clinically low lung function – less than 80 percent of the lung function expected for their age.[1]

In a study of low income families living in Detroit, researchers at the Michigan Center for the Environment and Children's Health examined the effects of ozone and fine particulate matter, two primary components of urban air pollution, on children with asthma. Among children who used maintenance medication to control asthma symptoms, researchers observed a significant decrease in lung function with increasing exposures to these pollutants. This effect was not observed among children not using maintenance medication.[2]



At the Columbia Center for Children's Environmental Health in New York, researchers are finding that common air pollutants from motor vehicle exhaust, residential heating, and power generation can have profound effects on the health of children who live in urban areas. A 2005 study of 60 newborns found that exposure of expectant mothers to these combustion-related pollutants may alter the structure of babies' chromosomes while in the womb.[3]

Asthma Triggers

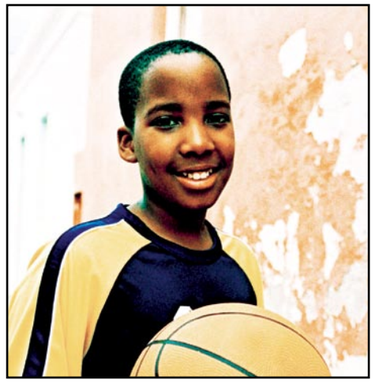
Scientists at the Johns Hopkins Center for Childhood Asthma are studying the environmental and hereditary factors involved in asthma development. Their research shows that exposure to indoor allergens from house dust mites, cockroaches, and rodents are among the most important environmental triggers for childhood asthma symptoms. Results from their 2005 intervention study show that simple measures – putting allergen-proof covers on mattresses and box springs, washing bed sheets in hot water, and exterminating cockroaches and rodents – can reduce airborne allergen levels.[4] "We noted a 45 percent reduction in asthma symptoms among inner-city children whose parents participated in the intervention program," said former center director Peyton A. Eggleston, M.D.

An unexpected finding by researchers at the University of Iowa Children's Environmental Health Center suggests that asthma may be under diagnosed in rural communities. Their data show that the prevalence and severity of asthma in two rural Iowa communities were comparable to that observed in several large Midwestern cities. Some of the rural exposures that may trigger asthma symptoms include grain dust, pesticides, and hazardous dusts and gases from animal confinement operations.[5]

CHARGE Study: Probing the Causes of Autism

NIEHS-funded researchers at the University of California at Davis Children's Environmental Health Center are conducting studies on the potential causes of autism and autism spectrum disorders. One of these is the **CHARGE** *(Childhood Autism Risk from Genetics and the Environment)* study, the first large-scale, human population-based study on the environmental causes of autism ever conducted. Study investigators are examining a range of environmental exposures, including toxic chemicals, medications, vaccination history, household exposures, diet and other lifestyle factors, and their effects on early development. The study also will include an examination of genetic factors that may, through complex interactions with environmental exposures, influence a child's susceptibility to autism.

Investigators at the University of Medicine and Dentistry of New Jersey Children's Center are also conducting studies to identify the role of gene-environment interactions in autism development. Comprehensive assessments of personal, home and community environments are underway to identify potential exposures that are associated with regressive autism. Preliminary results from this work suggest that children with autism may be more susceptible to oxidative stress, a condition marked by the formation of destructive molecules called free radicals, when exposed to environmental agents.



Lead and Other Heavy Metals

Although lead poisoning is declining among American children, NIEHS continues to support research on its health effects. Data collected by researchers at the Cincinnati Children's Environmental Health Center show that children with blood lead levels below the federal guideline of 10 micrograms per deciliter scored seven points lower on intelligence tests than children who had not been exposed to lead.[6] A follow-up study is being conducted to determine whether children's behavioral problems may be linked to prenatal or postnatal exposures to pesticides, environmental tobacco smoke, and lead.

Studies conducted by researchers at the Harvard Center for Children's Environmental Health and Disease Prevention are raising similar questions about blood lead levels previously thought to be safe.