



Key Findings & Interventions

Mothers & Newborns Study, Northern Manhattan / South Bronx

The Center's largest study focuses on 725 African-American and Latino pregnant women and their children whose health is monitored from birth through eleven years of age. Families participating in the study are typically low-income and live in New York City's Washington Heights, Harlem, and South Bronx neighborhoods, which are disproportionately exposed to pollutant sources such as diesel bus depots, major commercial roadways, and deteriorated public housing that is often infested with cockroaches and mice. Children living in these vulnerable communities bear the unequal burden of poor health outcomes such as high rates of asthma, growth and developmental delays.

Over the past ten years, this study has shown that exposure beginning in the womb to polycyclic aromatic hydrocarbons (PAHs) from traffic-related air pollution, pesticides in common home pest control products, and pest allergens in the home can result in asthma and other respiratory symptoms, delays in cognitive development, and changes at the molecular level that could increase children's cancer risk. These pollutants can cross the placenta and expose the developing fetus. Children may be more vulnerable to environmental exposures than adults because their bodies are still developing, and they are less able to clear toxins from their systems.

Exposures of concern in this study include PAHs in ambient air pollution, secondhand smoke, pesticides, endocrine disrupting chemicals such as phthalates and bisphenol A, and indoor pest allergens. PAHs are a group of chemicals released into the air during the incomplete burning of fossil fuels such as gasoline, diesel, coal, and other organic substances. Secondhand smoke gets into the air when tobacco products are burned in cigarettes, cigars, and pipes, and contains thousands of toxic chemicals, many of which are known to be cancer-causing. Harmful pesticides can be inhaled following the use of spray pesticides indoors, and young children also have greater exposure because they spend more time on the floor where pesticides are commonly applied. Plastics and other consumer products contain chemicals that mimic or block natural hormones and thus are capable of disrupting early development. In addition, exposure to pest allergens from cockroaches, dust mites, and rodents can cause serious allergic and asthmatic reactions.

Children in the CCCEH study cohort are representative of children living in other urban areas, particularly populations that are disproportionately exposed to harmful pollutants. Following is a summary of key findings from the Center's research study:

Exposure

- All pregnant women in the study and their babies are exposed to multiple common pollutants that can harm fetal and child development, respiratory health, or increase cancer risk. Exposures include PAHs in outdoor and indoor air (produced by fuel burning from motor vehicles, power plants, industry, incinerators, residential heating) (*Perera et al., 2003*); pesticides used in homes (*Whyatt et al., 2004*); and secondhand smoke (*Perera et al., 2004*).

- There was widespread phthalate exposure during pregnancy among the study participants. Phthalates were detected in 99%-100% of maternal personal air samples. Two or more of the DEHP metabolites (a particular type of phthalate) were detected in 100% of urine samples. Levels of exposure were generally higher among the CCCEH cohort women than among women of reproductive age (18-40 years) sampled through the National Health and Nutrition Examination Survey (NHANES) (*Adibi et al., 2008*).

Fetal Growth and Neurobehavioral Development

Our research is showing that prenatal exposures to PAHs, pesticides, and secondhand smoke are linked to reduced fetal growth and developmental problems in children. These findings have important implications for health and learning ability because early developmental delays and attentional/behavioral problems such as Attention-deficit/Hyperactivity Disorder (ADHD) can affect later school performance.

PAHs

- Prenatal exposure to PAHs reduced birth weight and head circumference in African-American babies born to women who were more highly exposed to the air pollutants (Perera et al., 2003). Several studies have reported that reduction in head circumference at birth or during the first year of life correlates with poorer cognitive functioning and school performance in childhood
- Children with high prenatal exposure to PAHs had significantly lower test scores at age 3 on the Bayley test for cognitive development and were more likely to be developmentally delayed (*Perera et al., 2006*).
- Prenatal exposure to PAHs at levels encountered in NYC air can adversely affect child IQ scores at 5 years of age (*Perera et al., submitted 2009*).

Pesticides

- Prenatal exposure to two household pesticides, chlorpyrifos and diazinon, which transfer easily from the mother to her fetus, reduced birth weight by an average of 6.6 ounces – the equivalent of weight reduction seen in babies born to women who smoked (*Whyatt et al., 2004*).
- Children prenatally exposed to high levels of chlorpyrifos were significantly more likely than children exposed to low levels to experience delay in both psychomotor and cognitive development, and to show symptoms of attentional disorders, Attention-deficit/Hyperactivity Disorder (ADHD), and pervasive personality disorder at age 3. Although the EPA banned residential use of chlorpyrifos in 2001, this pesticide is still widely used in agriculture (*Rauh et al., 2006*).
- Pyrethroid insecticides appear to be replacing the organophosphorus insecticides like chlorpyrifos and diazinon for residential pest control among participants in this cohort. Specifically, levels of permethrin, a common pyrethroid insecticide, and piperonyl butoxide, a pyrethroid synergist, have increased in personal air samples collected from subjects during pregnancy. Also following the 2000-2001 EPA restrictions, both reporting of cockroaches in the home and use of spray pesticides during pregnancy have increased. Insect resistance to pyrethroids may be one possible explanation for these trends (*Williams et al., 2008*).

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Secondhand Smoke

- Children prenatally exposed to secondhand smoke – especially children experiencing material hardship (unmet basic needs food, clothing and housing) – had significantly reduced scores on tests of cognitive development at two years of age (*Rauh et al., 2004*).

Phthalates

- Prenatal exposure to the phthalate DEHP was associated with shorter gestation. Gestational age was shorter by 1.1 days for each log-unit increase in metabolite concentrations and averaged 5.1 days less among the most exposed. Given inconsistencies with prior findings in other study populations additional research is warranted (*Whyatt et al., submitted 2009*).

Asthma Risk

Childhood asthma in urban communities is a serious disease that accounts for a significant proportion of emergency room visits, hospitalizations, and deaths. Asthma is a chronic disease of the lungs and airways that causes difficulty breathing, and occurs most commonly in people who become sensitized to certain allergens in our environment. Different people with asthma react to different triggers. Common triggers include air pollution, diesel exhaust, environmental tobacco smoke, cockroach particles, dust mites, cat or dog dander, and mold. These exposures may also contribute to the early development of the disease.

- Over half the babies in the study have been born with an immune response to cockroach proteins that may increase the risk of asthma in certain children (*Miller et al., 2001*).
- Pest infestation, allergen levels, and pesticide use are higher among women and babies living in the most deteriorated housing (*Rauh et al., 2002*).
- Combined prenatal exposure to airborne PAHs and postnatal secondhand smoke results in the increased likelihood of respiratory symptoms at one and two years of age that may be associated with increased children's asthma risk (*Miller et al., 2004*).
- In the Center's evaluation of the New York City Housing Authority's intervention to reduce toxic pesticide use in public housing, high cockroach and mouse allergen levels were significantly associated with asthma prevalence among children and adults (*Chew et al., 2006*).
- Developing antibodies to cockroach and mouse proteins is associated with a greater risk for wheeze, hay fever, and eczema in preschool urban children as young as three years of age (*Donohue et al., 2008*).
- CCCEH has linked epigenetic alterations associated with prenatal exposure to PAHs in cord blood with parental report of asthma by age 5 (*Perera et al., 2009*). Epigenetic changes may disrupt the normal functioning of genes by affecting how they are expressed, but do not cause structural changes or mutations in the genes.

Cancer Risk

This study is finding that exposure to air pollution during pregnancy is associated with genetic damage in babies before they are even born. This type of genetic damage has been generally associated with increased cancer risk later in life.

- Approximately 40% of babies in the study were born with DNA damage associated with PAHs. Such damage has been tied to an increased risk of cancer in other studies. Of particular

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concern, newborns had higher (approximately 10-fold) levels of adducts than mothers per unit of estimated exposure, indicating greater fetal susceptibility and potential risk from these pollutants (*Perera et al., 2004*).

- Prenatal exposure to PAHs was linked to structural changes in babies' chromosomes (*Bocskay et al., 2005*), (*Orjuela et al., in prep.*). Such genetic alterations have been related in other studies to increased risk of cancer in children and adults.

Interventions and Impact on Policy

- From its inception, the Center has worked in close partnership with, and provided data to, a Community Advisory Board of health service and environmental advocacy organizations in Northern Manhattan and the South Bronx, including WE ACT for Environmental Justice (WE ACT). With WE ACT, the Center developed the *Healthy Home Healthy Child* (HHHC) community education campaign in 2000. The campaign provides families, physicians, and their patients with practical tips for reducing harmful environmental exposures and protecting children's health, and information on clean air campaigns in the community. HHHC has also provided training workshops for community leaders and health professionals.
- CCCEH data on the health effects of air pollution have been used by local and national groups to support clean air policies in New York City. From 1998 to 2006, PAH levels from personal monitoring of pregnant mothers in the cohort decreased significantly over time (*Narvaez et al., 2008*).
- Center investigators have drawn links between fossil-fuel related health effects in children and larger health problems associated with climate change, including the predicted effects of climate disruption such as heat waves, flooding, infectious disease, malnutrition, and trauma on children, in a commentary in *Environmental Health Perspectives* (*Perera, 2008*).
- CCCEH estimated the economic burden of one aspect of developmental delays associated with prenatal secondhand smoke exposure—Early Intervention Services—to be over \$50 million per year for New York City Medicaid births and \$99 million per year for all New York City births (*Miller et al., 2006*).
- Governmental regulations such as the 2000-2001 EPA restrictions on residential use of the organophosphorous insecticides, chlorpyrifos and diazinon, have positive impacts on children's health. These regulations significantly reduced use of and exposure to these compounds during pregnancy (*Whyatt et al., 2004*).
- Despite a regulatory ban on residential use of chlorpyrifos, agricultural applications continue in the US and abroad. In September 2008, at a public hearing of the Scientific Advisory Panel, Federal Insecticide, Fungicide and Rodenticide Act ("Scientific Issues Associated with Chlorpyrifos and PON1"), the Panel unanimously recommended that the EPA accept the epidemiologic evidence that chlorpyrifos may act as a neurotoxicant in human beings. The panel cited the Columbia data as epidemiologically-sound and recommended that the Agency should attempt to use the cohort data to inform the risk assessment process for bounding exposure levels, address current human exposures, and determine the final reference dose or reference concentrations.
- CCCEH conducted a pilot intervention using Integrated Pest Management (IPM) to reduce pest infestations and residential insecticide exposures among pregnant women living in New York City. Residential IPM is a pest control method that minimizes exposure to toxic pesticides in the home through the use of lower-toxicity pesticides, such as sticky traps, bait

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stations, and gels; cleaning; and repairing leaks and holes. Insecticides measured in indoor air samples and in maternal cord blood decreased significantly after the intervention. These pilot data suggest that IPM is an effective strategy for reducing pest infestation levels and the internal dose of insecticides during pregnancy (*Williams et al., 2006*).

- CCCEH has collaborated with the New York City Housing Authority (NYCHA) and the New York City Department of Health (NYCDOH) in the development, implementation, and evaluation of Integrated Pest Management (IPM) intervention in public housing. The evaluation has shown that IPM is more effective than the conventional use of more toxic pesticides in reducing levels of cockroach and cockroach allergens in apartments (Kass et al., submitted 2009).
- WE ACT conducts regular education seminars, promotes health events, and supports and translates institutional research for the education of Northern Manhattan residents. The organization developed a citywide network, *Our Housing is Our Health*, which is comprised of several organizations collaborating to empower communities to mitigate health effects of environmental exposures related to poor quality housing. WE ACT has also organized a number of briefings, presentations, case-studies for publication, and testimony to public interest groups and government agencies. Center investigators routinely provide information and testimony for these and other efforts.
- Other recent impacts of WE ACT's work, informed in part by CCCEH research, include:
 - The introduction of the Asthma Free Housing Act by Public Advocate Betsy Gotbaum and City Council member Rosie Mendez in April 2008. The bill seeks to improve indoor air quality in the homes of NYC asthma sufferers;
 - The coordination of the inaugural taskforce meetings on rodent control with NY State Senator Bill Perkins; and
 - The organization of several successful community workshops throughout Northern Manhattan on topics ranging from lead poisoning to pest infestation.