

On a Growth Curve: Children's Environmental Health Centers

Until recently, environmental health investigations focused on adult exposures, and extrapolated potential effects in children from adult studies. This approach neglected factors that enhanced children's vulnerability, such as larger exposures on a body surface area basis and immature metabolic pathways. But the 1990s saw a change in this approach, prompted in part by reports such as the 1993 National Academy of Sciences publication *Pesticides in the Diets of Infants and Children* and spurred along by meetings such as a 1997 conference sponsored by the Children's Environmental Health Network, which brought together experts to identify research needs in the area of children's health. The resulting information served as a blueprint for developing a series of children's environmental health research centers.

Eight centers were established in 1998 with funding from the NIEHS and the U.S. Environmental Protection Agency (EPA), and funding for another four centers was announced in October 2001. Research at the centers is interdisciplinary, and projects draw on the expertise of pediatricians, epidemiologists, public health specialists, and others. As part of their mandate, all centers are active in community education and outreach.

Determining the causes of asthma, the role of environmental exposures, and factors



Making housecalls. Workers in the USC "LA CASA" program take dust mite samples from a child's bed, and discuss allergen control and avoidance with a resident.

in individual susceptibility are key research areas for centers housed at the University of Southern California (USC) in Los Angeles, the University of Michigan in Ann Arbor, The Johns Hopkins University in Baltimore, the University of

Iowa in Iowa City, and Columbia University in New York. The centers at the Mount Sinai School of Medicine in New York, Columbia University, the University of California at Berkeley, and the University of Washington in Seattle are working to identify exposures that affect children's mental and physical development, characterize their effects, and develop methods to reduce and prevent them. Suspected exposures include pesticides, polychlorinated



biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

Two of the newly opened centers, at the University of California at Davis and the University of Medicine and Dentistry of New Jersey, will focus on potential environmental links to autism. A center at the University of Illinois at Urbana-Champaign will investigate the effects of dietary exposures to mercury and lead among Asian-Americans consuming large amounts of fish from the Great Lakes. At the Children's Hospital Medical Center of Cincinnati, researchers and community participants will assess the impact of reduced pollutant exposure on children's hearing, behavior, and learning.



Fighting for Air

USC researchers have shown that common genotypes of glutathione-S-transferases, a class of metabolic enzymes, are associated with lung function; other gene-environment interactions are under investigation, too. The researchers have also found that particulate matter (PM) may modulate the immune response in airways. For urban centers, the



Bringing work home. University of Iowa researchers are looking at exposures from animal confinement facilities that may contribute to asthma in children.

potential for information sharing and collaboration is high. Henry Gong, USC center director and a professor of preventive medicine, would like to see further developments along those lines. "There hasn't been as much as I would like, but that's certainly one of the potential interrelationships among the centers," he says.

The University of Michigan center has screened students aged 6-11 in a group of targeted schools to identify children with undiagnosed asthma. The screening revealed that large populations of Detroit children with persistent asthma are not receiving adequate medical care for their condition, according to Edith Parker, an associate professor of public health and a center investigator. Center researchers have also assessed indoor and outdoor exposures to asthma triggers, and have found that residential location is an important determinant of PM_{2.5} exposure. Indoor PM, primarily environmental tobacco smoke, is another asthma trigger under investigation.

At the Johns Hopkins center, researchers have shown that airborne PM in samples taken from the inner city induces significant airway inflammation in mice. Researchers are also working on the genetic variability of individual response to ozone and other environmental pollutants. Of particular interest is *toll-like receptor 4*, a candidate gene for asthma susceptibility. Current community research includes a case-control epidemiology study to compare home environments of approximately 300 inner-city preschoolers with asthma with those of nonasthmatic

children in the same area. An intervention clinical trial will assess the effects of reducing allergens and pollutants in asthmatic children's homes on their symptoms. "The most interesting thing we've found so far is that the exposure to airborne particulates in the homes is surprisingly high, and it is above annual index cutoff limits published by the EPA," says center director Peyton Eggleston, a professor of pediatrics.

An unexpected finding at the University of Iowa has been that the prevalence and severity of asthma in rural children rivals that of inner-city children. "The old adage was that children in these rural areas [were] protected from asthma. But that's certainly not true in Iowa," says Gary Hunninghake, center director and a professor of internal medicine. Particular rural exposures that may trigger asthma include grain dust, pesticides, and animal confinement operations. A recent statewide conference narrowed in on potential environmental health effects of animal confinement facilities, prompting a request from the state government for recommendations to minimize exposures. Iowa researchers are also studying endotoxin, a cell-wall component of gram-negative bacteria, and investigating how viral infections may predispose some children to developing asthma. They are especially interested in respiratory syncytial virus, or RSV, which particularly strikes babies born prematurely.

Columbia University, meanwhile, works with children in northern Manhattan, where childhood asthma rates are among the highest in the nation, says Frederica Perera, center director and a professor of public health. Center researchers are investigating perinatal exposures to airborne PM, PAHs, pesticides, environmental tobacco smoke, and home allergens with regard to asthma. A prospective cohort study of more than 600 pregnant women and their infants is collecting exposure data through biomarker monitoring, questionnaires, air monitoring, and a geographic information system. The children will be followed for five years to monitor potential health effects. The study has already generated several findings, including the wide prevalence of maternal and fetal pesticide exposure and the fact that *in utero* sensitization to multiple indoor allergens is common.

Hampered Growth and Development

At Mount Sinai, researchers focus on home pesticide exposures and dietary PCBs among inner-city residents. They have found that pesticide exposure begins before birth, and the impact is being assessed through a prospective epidemiologic study involving more than 450 mothers and their children. The study was begun about three years ago

Children's Environmental Health Centers



Cincinnati Children's Environmental Health Center

Children's Hospital Medical Center, Cincinnati

http://www.cincinnatichildrens.org/Research/Divisions/General_and_community_pediatrics/enviro_health/default.htm

Center for Children's Environmental Health

Columbia University, New York

<http://cpmcnet.columbia.edu/dept/sph/ccceh/index.html>

Center for Childhood Asthma in the Urban Environment

The Johns Hopkins University, Baltimore

<http://www.jhsph.edu/ehs/urban.html>

Center for Children's Environmental Health and Disease Prevention Research

Mount Sinai School of Medicine, New York

http://www.mssm.edu/cpm/dept_research.shtml

Center for Children's Environmental Health

University of California, Davis

<http://www.vetmed.ucdavis.edu/cceh/>

Center for the Health Assessment of Mothers and Children of Salinas

University of California, Berkeley

<http://ehs.sph.berkeley.edu/chamacos/>

Center for Childhood Asthma

University of Iowa, Iowa City

http://www.uiowa.edu/~vpr/research/organize/cca_0320.htm

Michigan Center for the Environment and Children's Health

University of Michigan, Detroit

<http://www.sph.umich.edu/cbph/partnerships/mcech.html>

Friend's Children's Environmental Health Center

University of Illinois, Urbana-Champaign

Center for Childhood Neurotoxicology and Exposure Assessment

Rutgers University/University of Medicine & Dentistry of New Jersey

Robert Wood Johnson Medical School, Piscataway

<http://www.eohsi.rutgers.edu/childhood/index.shtml>

The Children's Environmental Health Center

University of Southern California, Los Angeles

http://www.usc.edu/schools/medicine/academic_departments/preventive_med/occ_environmental/cehc/index.html

Center for Child Environmental Health Risks Research

University of Washington, Seattle

<http://depts.washington.edu/chc/>

and will run indefinitely; so far there have been 400 births among the study population, and as of July 2002 the researchers had conducted 140 one-year assessments and nearly 50 two-year assessments. A preliminary finding reveals an association between prenatal exposure to organophosphate pesticides and smaller head circumference, a measure of brain growth.

Another study at Mount Sinai has found that *in utero* exposure to PCBs is linked in a dose-response fashion with behavioral and psychological dysfunction in adolescence and adulthood. A cornerstone community project is a longitudinal study with more than 200 expectant mothers who are using individually tailored integrated pest management in their homes to effectively reduce pest infestation and reduce chemical use. The project has already resulted in an 80–90% reduction in roach counts in homes and virtually 100% reduction in the use of toxic pesticides.

The Columbia cohort study, in addition to looking at asthma, is evaluating the impact of perinatal exposures to PAHs and nonpersistent pesticides on fetal and child growth and development. Preliminary analyses show that prenatal exposure to both airborne PAHs and chlorpyrifos is associated with reduced birth weight, length, and head circumference in one or both of the ethnic groups—Dominicans and African Americans—being studied. In addition to a communitywide educational campaign on environmental hazards to children, an intervention is in progress in collaboration with the New York City Housing Administration to reduce pesticide use in New York City apartment buildings.

The Berkeley center is participating in a study of the environmental health risks among farmworkers in the Salinas Valley. Children in this area receive chronic low-level exposures to organophosphate pesticides, often through the clothes their parents wear home from work, and the effects on growth and development are unknown. Center researchers are conducting a prospective cohort study of 600 pregnant women and their children, who will be followed for two years. Brenda Eskenazi, center director and a professor of epidemiology, notes that the cohort study design is very similar to those at Mount Sinai and Columbia. “That’s one of the beauties of having centers starting up at the same time doing similar things—they are overlapping but not redundant,” she says. The center is heavily

involved in the farmworker community and active in many community-based projects to reduce children’s exposures to pesticides and other environmental agents. “One of our major strengths is that we have developed a good community base. We have the support of politicians, growers, and farmworkers,” says Eskenazi.

The center at the University of Washington also is interested in agricultural pesticides. “We want to understand how, when, and why children are at greater risk from



Better than Tupperware. A University of Washington intervention program presents pesticide safety information to workers at home parties.

pesticide exposure,” explains center director Elaine M. Faustman. “We have established a risk assessment framework to integrate the spectrum of biochemical, molecular, genetic, and exposure data.” The center works through an advisory board made up of growers and workers in the Yakima Valley to develop and evaluate outreach and education programs. Through biomonitoring, Seattle researchers have found similar pesticide exposures among urban and rural children through most of the year, with higher levels among rural children during specific periods of agricultural spraying. Researchers have identified specific targets for preventive intervention action, and the center has developed culturally appropriate intervention approach-



No picnic. Berkeley researchers study pesticide exposures such as these worker lunches left sitting in a field of strawberries.

es, reaching over 18,000 participants in over 12 distinct agricultural communities.

Centers as a Whole

Besides researching long-term issues, the established framework of the centers permits quick response to unexpected environmental exposures. For instance, after the 11 September 2001 destruction of the World Trade Center, when massive amounts of airborne PM and toxic pollutants were billowing into lower Manhattan, staff at the Mount Sinai and Columbia centers quickly developed a prospective epidemiologic study to measure the exposures and assess how they might affect the physical and mental health of infants whose mothers were pregnant at the time of the attack.

In the coming years, researchers hope to more clearly define the relative contributions of different immune responses and triggers in asthma. At certain centers, continued funding would allow longer tracking of study cohorts, possibly beyond early childhood. A longer time frame would also permit more thorough assessments of intervention and prevention methods. Other center goals include exploring further gene-environment interactions, expanding outreach and communication efforts, identifying currently unknown environmentally linked health effects, and continuing work to prevent the environmentally linked illnesses that affect too many children.

Despite the centers’ promising start, continued funding from the EPA is currently uncertain. Losing this funding would cause work at several centers to slow or even cease, consequently delaying answers to several environmental health questions, says Daniel Swartz, executive director of the Children’s Environmental Health Network, a multidisciplinary research and education organization. He says that defunding the centers might also indirectly affect the multiagency National Children’s Study by depriving it of relevant models for study designs.

“I do think that it’s very important that the government maintains its commitment to funding the children’s environmental health research centers,” says Elizabeth Sword, executive director of the Children’s Health Environmental Coalition, an education group based in Princeton, New Jersey. “Everyone in the human race benefits from research done on children’s health. The degree to which we improve children’s health is the degree to which we improve human health.” —**Julia R. Barrett**

STEERing Doctors to Environmental Health Awareness

Everybody knows American doctors don't make house calls anymore. But in Laredo, Texas, health care students in an innovative program are putting a new twist on the house calls doctors used to make. They are making "environmental house calls," actually looking, for example, inside homes to see what attack-triggering exposures the resident child with asthma may have encountered, or checking kitchen pottery for lead, or testing a family's drinking water for fecal contamination.

It's all part of the Environmental Medicine/Border Health course at the University of Texas Health Science Center at San Antonio. Eight times each year, the course sends medical and other health profession students for a month-long stay at the Texas-Mexico border. There, they slog through polluted water, test indoor and outdoor air quality, and track exotic pathogens to learn firsthand about environmentally related health problems that plague people throughout the world. The course was the first—and is still the only—environmental medicine training elective of its kind in the United States. It is run by the university's South



Texas Environmental Education and Research (STEER) Center.

The course is designed to "unite medicine with public health," says Claudia Miller, an associate professor in the Department of Family and Community Medicine who started the STEER Center in 1995. Many doctors receive only minimal environmental health training during their time in medical school—maybe a chapter in a textbook or a few lectures in a classroom. "In many ways, doctors are not as aware of environmental health as the public has become," Miller says. "If doctors receive training in environmental medicine, they become more aware of possible environmental explanations."

The course covers more than 30 topics, including indoor and outdoor air quality, wastewater treatment, food sanitation, heavy metals, pesticides, risk management, epidemiology, and zoonosis control. The students also learn about traditional folk healers called *curanderos* who use alternative healing methods in conjunction with herbal medicines to treat patients.

To date, 175 full-time health profession students and more than 500 part-time students have completed the course. Each session is limited to six students—or as many as can be hauled around in the center's Chevy Suburban.

In essence, the course is a face-to-face encounter with public health and environmental problems in the fast-growing sister

environmentally related illnesses such as hepatitis, salmonella, dengue fever, asthma, and tuberculosis. The area also suffers high rates of diarrheal diseases, especially in children. These play out in communities that are as much as 95% Hispanic, a minority group that often lives in communities eligible for environmental justice remediation.

But the course does more than just teach students about these types of problems. Equally stressed is "service learning," becoming part of and giving back to the community. Students have participated in health fairs, animal vaccination events, and "environmental house call" outreach in the community to help, for example, schoolchildren with asthma reduce the triggers in their home environments.

Experiencing international health without really leaving home "opens the eyes, minds, and hearts of students," says registered nurse Joan Engelhardt, who coordinates STEER student training and developed the Environmental Medicine/Border Health course along with Roger Perales, a registered sanitarian. Perales says the lessons learned in Laredo are applicable everywhere, urban or rural. "A lot of people think public health is for the poor," he says. "They don't understand that water pollution, waste management, and control of pathogens affects everyone."

Steering in the right direction. A series of environmental outings are part of a program to immerse medical and other students in environmental health issues.

cities of Laredo, Texas, and Nuevo Laredo, Mexico. With a combined population of more than 700,000 residents, these cities have doubled in size in 10 years, due in part to the power of the North American Free Trade Agreement (NAFTA).

Laredo, on the banks of the Rio Grande, is the busiest inland port in the United States, handling more than half of the NAFTA trade between the two nations. Concerns over materials storage and handling (especially hazardous materials and hazardous waste) and the potential for spills, as well as concern over diesel emissions, are growing along with the numbers of tractor trailers that fill Laredo's streets and back up on its bridges waiting to cross the border.

This rapid urbanization has also exacerbated existing problems; the term "border health" refers to a complex and multifaceted set of health stressors rising up out of disproportionate poverty and disease rates for

The STEER Center has won some significant public awards, including one of the 2001 Olympic Games Spirit of the Land Awards, given for excellence in environmental education, and the Texas Environmental Excellence Award, given by Texas governor Rick Perry in April 2002. Because of its success, plans are under way to expand the STEER program into the lower Rio Grande Valley as part of the new regional academic health center for the medical school.

"This is an absolutely unique training program in environmental health," says Lucy Peipins, a senior epidemiologist in the Division of Health Studies at the Agency for Toxic Substances and Disease Registry. "This allows students, who receive little such information in medical school, to step back and look at the environmental factors that play into people's health."

Peipins teaches epidemiology at the STEER Center several times a year because she feels the program is so important. "I don't know of any other effort like this, and there should be many more," she says. —Renée Twombly