From the Fields to Inner City, Pesticides Affect Children's IQ

Scientists studying the effects of prenatal exposure to pesticides on the cognitive abilities of children have come to a troubling conclusion: Whether pregnant mothers are exposed to organophosphate pesticides in California fields or New York apartments, the chemicals appear to impair their children's mental abilities.

BY ELIZABETH GROSSMAN

New York City's low-income neighborhoods and California's Salinas Valley, where 80 percent of the United States' lettuce is grown, could hardly be more different. But scientists have discovered that children growing up in these communities — one characterized by the rattle of subway trains, the other by acres of produce and vast sunny skies — share a pre-natal exposure to pesticides that appears to be affecting their ability to learn and succeed in school.

Three studies undertaken independently, but published simultaneously last month, show that prenatal exposure to organophosphate pesticides — sprayed on crops in the Salinas Valley and used in Harlem and the South Bronx to control cockroaches and other insects — can lower children's IQ by an average of as much as 7 points. While this may not sound like a lot, it is more than enough to affect a child's reading and math skills and cause behavioral problems with potentially long-lasting impacts, according to the studies.

"This is not trivial," said Virginia Rauh, one of the study authors, speaking from Columbia University, where she is deputy director of the university's Center for Children's Environmental Health and professor of population and family health. What is particularly significant, she said, is that these

The New York study found the greater the exposure to pesticides, the greater the impact on cognition.

studies involved so many children from such different communities, yet produced consistent evidence of the pesticides' effects on cognitive skills and short-term memory.

Rauh said that the new studies were prompted by the long-standing awareness of the neurotoxicity of these pesticides on animals and the chemicals' widespread use. Given science's growing knowledge about the measurable effects of neurotoxic chemicals and elements, such as lead, on children's cognition and behavior, the three recent studies were a logical next step in such research, Rauh explained.

The studies in New York and California were a continuation of research that has been ongoing for 12 years. Two of the studies, led by researchers at Columbia University and the Mount Sinai School of Medicine in New York City, looked at more than 660 children, ages six to nine, living in the South Bronx, Harlem, and other inner city neighborhoods. The New York mothers were exposed primarily indoors, as they lived in buildings where these pesticides were used in public areas and inside apartments. Previous studies of pregnant women in the same New York City neighborhoods had found organophosphate pesticides in all indoor air samples and in the majority of umbilical cord blood taken from these women when they gave birth.

Rauh and her colleagues began studying the New York City mothers before they gave birth. Organophosphate pesticide levels in several hundred pregnant women were measured and ranked, with the lowest levels being those where the pesticides were non-detectable. The researchers then evaluated their children's cognitive and motor skills at one, two, and three years of age, finding that

prenatal exposure to a common pesticide was associated with neurodevelopmental problems in the three-year-olds. The most recent study then tested the children at age seven. All the children were otherwise healthy and born to healthy, non-smoking mothers who were exposed to these pesticides while pregnant.

The New York studies found that for every increased increment of prenatal organophosphate pesticide exposure, the IQs of the children studied dropped by 1.4 percent and their working memory scores dropped by 2.8 percent. A key finding of the Columbia University study was that the relationship between pesticide exposure and IQ and working memory scores was linear and showed "no evidence for a threshold." In other words, the greater the exposure, the greater the impact on cognition.

The third study, led by researchers at the University of California, Berkeley, looked at 329 children living in agricultural communities in the Salinas Valley, in Monterey County, the country's top vegetable-producing region. The California mothers were predominantly Latino farmworkers, and their exposure resulted from living and working near where these chemicals were used agriculturally; when sprayed on crops, organophosphate pesticides can easily drift with the wind beyond their intended fields.

In 1999 and 2000, the California researchers measured levels of organophosphate pesticides in the blood of 601 pregnant women and initiated a long-term study that would follow their children at regular

More than 3.5 million pounds of organophosphate pesticides are used annually in California.

intervals. In those two years, more than half-a-million pounds of organophosphate pesticides were used in the Salinas Valley. More than 3.5 million pounds of organophosphate pesticides are used annually in California alone, sprayed on corn, strawberries, lettuce, broccoli, oranges, grapes, and almonds, among other products. The study authors note that in addition to ambient air exposures, both groups, in New York and California, were also likely exposed through pesticide residues in the food they ate.

As with the New York study, when researchers measured the IQ of the California children at age seven, those with the highest prenatal exposure scored as much as 7 points lower than the children with the lowest prenatal levels of pesticide exposure.

Bruce Lanphear, director of the Children's Environmental Health Center at Cincinnati Children's Hospital Medical Center, said in an interview that organophosphate pesticide exposure can impair development of the brain's prefrontal cortex. Such damage actually shrinks this area of the brain and can lead to behavioral problems that include ADHD and later-life learning and social problems, including criminal behaviors, he said. This is also the part of the brain where short-term memory and instant gratification responses lie.

The study results are significant because they help show that while these children's social circumstances — they came from low-income communities and families — can put them at an educational disadvantage, they also appear to be starting life with a preventable physiological disadvantage.

Organophosphates are well known neurotoxins — some were developed as nerve agents for use in chemical weapons — and work on insects by targeting the nervous system. They have been on the market since after World War II, but their use increased in the 1960s and 1970s, when they were promoted as an environmentally preferable, rapidly degrading

These children appear to be starting life with a preventable physiological disadvantage.

alternative to more persistent organochloride pesticides, such as DDT. By the 1990s, organosphosphate pesticides were one of the world's most widely used type of insecticides. Such pesticides include chlorpyrifos — used in household bug sprays, termite control, lawn care products, domestic pet flea and tick collars, and commercial agriculture — and malathion, used to control mosquitoes, fruit flies, and lice. Roughly 33 million pounds of organophosphate pesticides were used in the U.S. in 2007, the last year for which government statistics are available.

Rauh explained that when used indoors, these pesticides persist much longer than they do outside, where their degradation is hastened by sunlight and environmental disturbance.

"That organophosphate pesticides are not persistent does not mean that they're not toxic," explained Lanphear. And their widespread use has resulted in what he called "chronic exposure" of certain populations. There also is increasing evidence that organophosphate pesticides have adverse biological impacts that extend beyond their intended target insects. "We're currently bringing new, very targeted types of pesticides onto the market without fully understanding their health effects," said Amy Liebman, director of environmental and occupational health for theMigrant Clinicians Network.

But DowAgroSciences, which manufactures chlorpyrifos, says the pesticide is safe when used properly. "More than US $100 million has been spent examining the uses and impact of chlorpyrifos-containing products on human health and the environment," the company says on its chlorpyrifos information website. "In terms of human health and safety, no pest control product has been more thoroughly studied." Dow Chemical has called chlorpyrifos, which was first marketed by the company in 1965, "one of the great success stories in pest control."

In addition to examining the outcomes of organophosphate pesticide exposures, the Mount Sinai research team looked at how the body responds biochemically to these alien compounds. As study co-author Stephanie Engel explained, she and her colleagues studied a gene that is key to how

The EPA has banned a number of these insecticides for residential use.

the body processes organophosphate pesticides. Several versions of this gene exist, and depending on which version a person possesses, it can have "relatively large effects on the metabolism of organophosphates," said Engel, associate professor of epidemiology at the University of North Carolina's Gillings School of Public Health. The study showed that the negative effects of pesticides occurred primarily in children whose mothers metabolize these pesticides less efficiently.

That effect indicates, Engel said, that the pesticides — rather than some unrelated outside factors — are causing the cognitive deficiencies. In response to the new studies, Dow and other chemical manufacturing groups have contended that "childhood IQ and development are strongly influenced by the complex interaction of many long-established factors (e.g., maternal intelligence, maternal education, quality of the home environment, etc.) which the researchers could only control for imperfectly." Dow also criticized the studies' data analysis and methodology, and said it would conduct a review of the findings.

Concern about the health effects of organophosphate pesticides, particularly on children, has been growing. As a result, the U.S. Environmental Protection Agency (EPA) has banned a number of these insecticides — including chlorpyrifos, diazanon, and methyl parathion — for residential use. Still, more than 30 organophosphate pesticides are currently registered for use in the United States. Many are now undergoing further evaluation by the EPA. Between 1997 and 2007, overall organophosphate pesticide use dropped by more than 50 percent in the U.S. With this decline came a

drop in blood levels of these chemicals measured in biomonitoring studies, said Rauh.

But these bans do not affect agriculture and some other commercial uses, says Brenda Eskenazi, professor of public health at the University of California, Berkeley and lead author of the California study. Her study notes that despite the overall declines in organophosphate pesticide use, the quantity of these pesticides used in the Salinas Valley remained steady between 2001 and 2007, important years in the development of the children she studied. And continuing exposure is an important factor in these children's health.

"For every increase in exposure there was an increase in impacts and for every decrease in exposure, a corresponding decrease in effect," Eskenazi said. "We found there was no threshold or base limit of exposure that did not produce an effect."

MORE FROM YALE e360

A Warning by Key Researcher On Risks of BPA in Our Lives

The synthetic chemical, BPA — found in everything from plastic bottles to cash register receipts — is a potent, estrogen-mimicking compound. In an interview, biologist**Frederick vom Saal** harshly criticizes U.S. corporations and government regulators for covering up — or ignoring — the many health risks of BPA.
READ MORE

This is important to consider since it's now known that organophosphate pesticides can cross the placenta and that prenatal development is very vulnerable to disturbance, including by synthetic chemicals.

Learning more about the specific mechanisms by which individual chemicals act — and and the effects they trigger — can point the way to which insecticides should be banned. In their next studies, Rauh and her colleagues plan to follow the children in their study group as they progress through school, using brain-imaging studies, blood analysis, and continued intellectual testing. Engel's group plans to examine additional genetic factors that may help explain susceptibility to organophosphates.

Two generations after the U.S. stopped widely using the pesticides that Rachel Carson wrote about in *Silent Spring*, scientists are just beginning to get a distinct picture of how replacement pesticides are affecting the health of children. "We now have additional safety regulations for pesticides," says Lanphear, "but that doesn't mean they're safe."

POSTED ON 16 MAY 2011 IN BUSINESS & INNOVATION FORESTS POLICY & POLITICS POLLUTION & HEALTH POLLUTION & HEALTH NORTH AMERICA