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Organophosphates: A Common But Deadly Pesticide

Organophosphates attack the nervous system in the same way as nerve agents like sarin.

BY KER THAN, FOR NATIONAL GEOGRAPHIC

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The pesticides blamed for killing at least 25 children in India are widely used around the world, including in the United States, and health experts have raised safety concerns about this class of chemicals in the past.

Known as organophosphates, the pesticides were developed in Germany in the 1940s and soon became an important defense against agricultural pests. "They are very effective and pose minimal environmental problems," said Lucio Costa, a toxicologist at the University of Washington in Seattle.

A serious downside, however, is that they also happen to be extremely toxic. "They're considered junior-strength nerve agents because they have the same mechanism of action as nerve gases like sarin," explained Dana Boyd Barr, an exposure scientist at Emory University in Atlanta, Georgia, who has studied organophosphate poisoning.

The Indian children, aged four to 12, fell ill on Tuesday after eating a lunch consisting of rice, soybeans, and lentils in the village of Mashrakh in the eastern state of Bihar.

The school that the children attended provided free meals under a nationwide program known as the Mid-Day Scheme. Early reports suggest the food—perhaps the rice or the cooking oil used to prepare the food—contained unsafe levels of the pesticide.

The swiftness of the deaths—in some cases, hours after exposure—suggests the dose could have been quite high.

"It looks like the [organophosphate] was rapidly absorbed and that the dose was quite high," said Costa, who called the deaths an "avoidable tragedy."

Highly Toxic

Organophosphates are so toxic to humans that the U.S. Environmental Protection Agency has taken steps to limit their availability to the public.

"The EPA has asked manufacturers to voluntarily eliminate its use [for residential purposes]," Boyd Barr said. "There are a couple still available for residential garden use, but they're few."

In addition to their use in agriculture, organophosphates are also used in public health applications—like the elimination of the mosquitoes that harbor the West Nile virus—in some countries.

Upon entering the body—through ingestion, inhalation, or contact with skin—organophosphates inhibit cholinesterase, an enzyme in the human nervous system that breaks down acetylcholine, a neurotransmitter that carries signals between nerves and muscles.

When cholinesterase is inactivated, acetylcholine builds up in the nerves, which become overactive. Victims of organophosphate poisoning typically die because they can't breathe.

"It's a painful way to die," Boyd Barr said. "You end up suffocating because you are essentially paralyzed."

The risk of death depends on the amount of exposure and the age of the victim. The symptoms tend to be more severe in young children.

"They're more vulnerable because their detoxification systems are more immature, so they can't eliminate the pesticide as well," Boyd Barr explained.

Doctors typically treat organophosphate poisoning with atropine to alleviate the symptoms and help the patient feel better, and oxime to help replenish the body's store of cholinesterase.

Small Amounts Tolerated

In the United States, a small amount of organophosphates on crops after harvesting is tolerated and farmers take care to ensure that the amounts don't reach dangerously high levels.

But in countries such as India, where regulations may not be as strict or the implementation and enforcement of regulations are not as effective, the likelihood of organophosphate poisoning through the contamination of food can be higher, Boyd Barr said.

The Indian school case is not the first instance of organophosphate poisoning: In 1986, more than 20 people in Sierra Leone, many of them children, died after eating bread made with flour that was transported in a truck that was previously used to carry organophosphates.

Dangers of Chronic Exposure

While high-level exposure to organophosphates can lead to death in the short term, several studies have suggested that chronic low-level exposure can also have serious health consequences, especially for infants and young children.

A 2010 study by Boyd Barr and colleagues that looked at Mexican-American children living in agricultural regions of California found that prenatal and early childhood exposure to organophosphates can increase the risks of neurological disorders such as attention-deficit/hyperactivity disorder, or ADHD.

"This chronic low-level exposure that we all might be exposed to"—and which is considered safe in the U.S.—"could functionally

decrease the neurological capacity of children," Boyd Barr said.

According to Jay Feldman, executive director of the nonprofit advocacy group [Beyond Pesticides](#), the United States and many other countries do a good job of evaluating the health risks of short-term exposure to pesticides such as organophosphates, but not the potential dangers of chronic exposure.

"The focus tends to be on acute exposure," Feldman said. "For chemicals whose risks are aggregated as a result of ongoing exposure ... that is not adequately tested by regulators anywhere in the world."

A similar predicament exists for evaluating the environmental risks of chemicals, Feldman noted. While the EPA does conduct what is known as "Ecotox" studies on organophosphate pesticides, the studies tend to focus on short-term exposure risks.

"We have the same problem that we have on the human side," Feldman said, "which is that we're not adequately assessing the risk of chronic, low-level exposure" to wildlife and the environment.

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