

Our Children At Risk

The Five Worst Environmental Threats to Their Health

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Chapter 5

PESTICIDES

INTRODUCTION

Pesticides are chemicals designed to kill, control, or repel insects, plant diseases, weeds, rodents, and germs. Most pesticides are used in agricultural production, suppressing pests on hundreds of different crops including fruits, vegetables, nuts, and cereal grains. Now a standard part of most farming operations, pesticides are one reason that farm productivity has increased 82 percent in the past thirty years.^[1] Pesticides are also used to ward off unwanted organisms in homes, schools, parks, hospitals, and office buildings. Readily available in retail stores or through commercial applicators, pesticides are a popular choice for homeowners grappling with nuisance pests. Seventy-four percent of American households (or 70 million) used some type of pesticide at a cost of \$1.9 billion in 1994.^[2]

Within the past three decades, pesticide use in agriculture and for home and industrial purposes has increased by 50 percent.^[3] Total pesticide use in the United States, including wood preservatives and disinfectants, is about 2.2 billion pounds of active ingredients in a typical year (1994), or eight pounds for every man, woman, and child in the country.^[4] Approximately 875 pesticide active ingredients are formulated into 21,000 different products.^[5] Pesticide products also contain inert ingredients -- which are not identified by name on product labels due to trade secrecy -- that may be hazardous.

Because of their inherent toxicity and widespread use, pesticides pose a serious threat to public health, particularly to infants and children. Children can

routinely come in contact with pesticides and few, if any, of their common surroundings are left untouched by these chemicals. In 1993 the National Academy of Sciences issued a report documenting that children are uniquely vulnerable to pesticides, and that government standards for residues in food do not adequately protect children. Children's exposure to pesticides is greater than adults because of their distinctive diet and play activities. Physiological immaturity also makes them particularly susceptible to the toxic effects of pesticides.

The young are vulnerable to a wide range of health effects related to pesticide exposure. Case reports and epidemiological studies indicate an association between pesticide exposure and the development of certain cancers in children including leukemia, sarcomas, and brain tumors. Most major classes of pesticides have been shown to adversely affect the developing nervous system of experimental animals, impairing both mental and motor development. Parental exposure to pesticides, particularly in agricultural areas, has been associated with the development of certain cancers and birth defects in offspring. And some studies suggest that exposure to pesticides may compromise the immune system of infants and children and exacerbate their risk of infection and disease.

Public concern about children's exposure to pesticides is warranted. Government programs have failed to significantly reduce public exposure to pesticides or educate people about alternative pest control methods. In 1972, Congress passed the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requiring health and safety testing of all pesticides. Although information implicating the hazards of pesticides has been accumulating under FIFRA, government action to adequately protect the public, particularly children, has been insufficient. Pesticide manufacturers continue to aggressively market their products despite mounting evidence of health and environmental effects.

Ultimately, a comprehensive effort by government, business, consumers, parents, and farmers is needed to reduce society's overall reliance on hazardous pesticides. Fortunately, concerned citizens throughout the country are moving toward this goal at the local level. Community leaders are demonstrating how to reduce the need for pesticides and protect the health and well-being of their communities.

HAZARDS OF PESTICIDES

Epidemiological and laboratory studies contribute to a growing body of evidence linking pesticide exposure to adverse health effects including cancer, birth defects, reproductive harm, neurological and developmental toxicity, immunotoxicity, and disruption of the endocrine system.

Based on experiments in laboratory animals, the U.S. Environmental Protection Agency (EPA) has identified at least ninety-six different pesticide active ingredients registered for use that are potential human carcinogens.^[6] Studies of human populations, particularly farmers, also demonstrate the carcinogenic potential of certain pesticides. A 1992 National Cancer Institute review of two dozen epidemiological studies found pesticides to be one of five likely suspects explaining why farmers had elevated risks of several forms of cancer including Hodgkin's disease, multiple myeloma, leukemia, melanoma, and cancers of the lip.^[7] There is some evidence that the breakdown product of the organochlorine pesticide DDT, which is now banned but still persists in the environment, may be associated with breast cancer.^[8]

Studies demonstrate that in addition to acute poisoning, pesticides can cause long-term damage to the nervous system. Every year, an estimated 300,000 farmworkers are poisoned by pesticides.^[9] According to the Office of Technology Assessment, an estimated 4 to 9 percent of agricultural and other workers acutely poisoned by pesticides experience delayed persistent neurological and psychiatric effects including agitation, insomnia, weakness, nervousness, irritation, forgetfulness, confusion, and depression.^[10] Additional studies of agricultural workers indicate that pesticide poisoning can lead to poor performance on tests involving intellectual functioning, motor skills, and memory.^[11]

Some pesticides are associated with diminishing reproductive capacity and causing birth defects. The state of California maintains a list of reproductive toxins that currently includes fifteen pesticides, ten of which are still in use. The California Department of Pesticide Regulation (DPR) evaluates pesticides for their potential to cause birth defects and reproductive harm. Of the sixty-three chemicals evaluated by the DPR, fifteen have tested positive for birth defects and twenty-two have tested positive for other reproductive effects in experimental studies.^[12]

There is growing awareness in the scientific community that toxic chemicals, including pesticides, can damage the immune system. Laboratory animal studies indicate a variety of immunotoxic effects from exposure to certain pesticides, particularly several organochlorine and organophosphate

insecticides.^[13] The immune system plays a critical role in helping ward off disease.

SPECIAL VULNERABILITY OF CHILDREN

Children and infants are uniquely susceptible to the effects of pesticides because of their physiological immaturity and greater exposure to pesticides. Differences in exposure are considered a more important source of differences in risk than age-related differences in toxicological vulnerability.

Greater Exposure to Pesticides

The most important factor determining children's increased risk from pesticides is their greater exposure. Compared to adults, children, on a body-weight basis, consume more food and water and breathe more air. The skin surface area of an infant per unit of body weight is double that of an adult.^[14] The normal respiratory volume of a resting infant is twice that of a resting adult.^[15] Caloric consumption by infants per unit of body weight is approximately two and a half times higher than for adults.^[16]

A child's diet is far less varied than an adult's. In particular children consume large quantities of milk, fruit, and fruit juices. The average one-year-old drinks twenty-one times more apple juice, eleven times more grape juice, and nearly five times more orange juice per unit of body weight than the average American.^[17] Infants and children also drink two and a half times as much water daily than adults do as a percentage of their body weights.^[18] Fruit, fruit juice, and water contain pesticide residues.

Because of their higher rate of breathing, children are more highly exposed to pesticides that remain in indoor air. Compared to their parents, children living in homes with indoor air contaminated with the pesticide pentachlorophenol (PCP), were found to have close to twice as much PCP in their blood as their parents.^[19] Children also spend a lot of time closer to the ground than adults thus they are more likely to come into contact with pesticides that concentrate in this breathing zone. Children also have greater hand-to-mouth activity, increasing opportunities for direct ingestion of pesticide residues in dirt or dust.

Greater Physiological Susceptibility to Pesticides

Of principal concern is that during the first six years of life the central nervous system is still developing and is thus vulnerable to neurotoxic pesticides. And during periods of rapid growth, specifically infancy and adolescence, cells and

tissues are proliferating, so that carcinogenic pesticides can have a greater impact at these stages of life.^[20]

Available human and experimental animal data suggest that children are more vulnerable than adults to the neurotoxic effects of pesticides. In several cases of human poisoning by organophosphate insecticides, fatality rates were higher in children than in adults.^[21] Tests on young rats and mice demonstrate a progressive decrease in susceptibility to organophosphate insecticides with increasing age.^[22]

According to the National Academy of Sciences, concern about children's exposure to pesticides is valid because "exposure to neurotoxic compounds at levels believed to be safe for adults could result in permanent loss of brain function if it occurred during the prenatal and early childhood period of brain development."^[23]

The primary reason infants and children are believed to be more vulnerable to neurotoxic insecticides is because of their increased absorption and decreased elimination through the gastrointestinal tract. Infant kidneys, for example, are immature and cannot excrete foreign compounds such as drugs as quickly as adult kidneys.^[24] The result is that for some organophosphate compounds the lethal dose in immature animals has been reported to be only 1 percent of the lethal dose in adult animals.^[25]

Researchers have documented that the body's ability to metabolize and break down organophosphate insecticides, such as chlorpyrifos, is dependent upon adequate production of a particular enzyme (paraoxygenase-1), and enzyme production is genetically controlled in humans and can differ within the human population by a factor of 15. Children in the first few months of life have very low levels of the enzyme.^[26] In fact, a reported case of an unusually severe poisoning (red blood cell cholinesterase levels reported to be 50 percent below normal) of an eleven-day-old boy exposed to food and clothing in his home contaminated with chlorpyrifos further suggests that children and infants may be more susceptible to chlorpyrifos poisoning than adults.^[27] A study in rats supports this finding: in the seven-day-old rat, the maximum tolerated dose of chlorpyrifos was one-sixth the maximum tolerated dose in the adult; one-day-old rats were found to be four times more sensitive to chlorpyrifos than seven-day-old rats; and one-day-old rats exposed to chlorpyrifos were more deficient in DNA and protein synthesis in the brain than eight-day-old rats exposed to chlorpyrifos.^[28]

Although more comprehensive research is needed, some studies in laboratory animals suggest that, compared to adults, the developing fetus may be more sensitive to the potential immunotoxic effects of exposure to pesticides.^[29] In rats, for example, the developing immune system has been shown to be more vulnerable to the effects of the dioxin TCDD, compared to a mature immune system.^[30] TCDD suppressed the developing immune system of neonatal rats but not of adult rats. TCDD has been found as a contaminant in two forms of the common herbicide 2,4-D and is suspected as a contaminant in at least thirteen other pesticides.^[31]

While not conclusive, laboratory studies indicate that animals can be at greater risk of developing cancer following exposure to a carcinogen if the exposure begins in infancy rather than later in life. This is because during infancy cells are rapidly dividing and any cellular mutation that occurs at this time is likely to be passed on to "daughter" cells before it can be repaired. Secondly, compared to adults, children have a much longer expected life over which carcinogenic action may occur.^[32]

Adverse Health Effects in Children

Pesticides have been associated with certain childhood cancers, found to adversely affect the nervous system, and linked with birth defects and altered function of the immune system.

Leukemia

As well as case reports, several separate epidemiological studies document a relationship between the development of childhood leukemia (cancer which causes an excessive production of abnormal white blood cells) and parental exposure to pesticides.^[33] A study of childhood leukemia cases in Shanghai found a more than threefold increase in risk associated with maternal occupational exposure to pesticides.^[34] In 1989, the Children's Cancer Study Group reported that, among families with children with acute non-lymphoblastic leukemia, pesticide exposure was the most consistently associated potential cause of the disease. Children regularly exposed to pesticides in the household had a 3.5 times greater incidence of leukemia than those not exposed there. In a 1987 National Cancer Institute study, the risk of childhood leukemia increased nearly four times when pesticides were used within the house at least once per week, and increased more than six times when garden pesticides were used at least once per month.^[35] Children of fathers with jobs including pesticide exposure had a 2.7 times higher risk of contracting the disease when compared to controls.^[36]

Brain Tumors

Children diagnosed with brain tumors in the Baltimore area were more than twice as likely to have been exposed to insecticides during household exterminations than children without cancer.^[37] A 1993 study documents a relationship between childhood brain cancer cases in Missouri children and the use of pesticides in and around the home. Compared to healthy children, brain cancer was nearly five times more likely for children treated with Kwell shampoo, which contains the cancer-causing insecticide lindane, to control head lice; five times as likely if parents used pest strips containing the insecticide DDVP; and five times more likely if they used flea collars on pets.^[38] Additional studies are necessary to resolve issues of childhood cancers and household pesticide use.

In a study of cancer incidence among the offspring of parents engaged in agricultural production in Norway, children had a tripled risk for certain types of brain tumors associated with pesticide use.^[48] For other types of brain tumors, pesticide use was associated with a nearly doubled risk. Interestingly, this study indicated that pesticides pose a risk for cancer during infancy and early childhood (birth to four years), whereas contact with agricultural animals and, in particular, poultry and pigs, constitutes a risk for malignancies most typical of late childhood and adolescence.

Sarcomas, Lymphomas, and Wilms' Tumors

In a San Francisco Bay Area study, children whose fathers were occupationally exposed to pesticides were found to be six times more likely than other children to develop Ewing's sarcoma, a rare bone tumor. Having fathers with agricultural occupations was found to increase a child's risk of contracting this cancer by ninefold.^[49] A study of children diagnosed with cancer in the Denver area found a strong association between parents' application of pesticides in the yard and the development of soft tissue sarcomas. This same study found that children with lymphomas (cancer of the lymph system) were twice as likely to have been exposed to insecticides during household exterminations compared to healthy children.^[50] In a study of Wilms' tumor (malignant tumor of the kidney) among children in Brazil, consistently elevated risks of Wilms' tumor were associated with parental exposure to pesticides through farm work.^[51]

Nervous System Damage

The nervous system includes the brain, spinal cord, and peripheral nerves and is responsible for regulating and coordinating body activities. Pesticides can cause

both acute and chronic damage to children's nervous systems. Children acutely exposed to neurotoxic pesticides are susceptible to symptoms of poisoning much like adults,^[52] ranging, depending on exposure levels, from headache and nausea to convulsions and death.

Few pesticides have been evaluated for their ability to cause chronic, permanent damage to immature, developing nervous systems. Additional research is critically needed due to the vulnerability of the central nervous system, which continues to develop until puberty. Available evidence, however, suggests that deleterious effects should be expected. Infants exposed before and after birth to residues of the fungicide methyl mercury in contaminated wheat suffered severe impairment of motor and mental development. Another fungicide, hexachlorobenzene, was found to cause muscular weakness, numbness, and convulsions in children exposed immediately after birth.^[53]

Data on polychlorinated biphenyls (PCBs), industrial compounds that are structurally similar to many chlorinated hydrocarbon pesticides, demonstrate that exposure during fetal development and infancy to relatively low levels of PCBs may cause subtle, long-lasting neurological effects. PCBs have been found to cause developmental problems and learning disabilities in children of women who consumed PCB-contaminated fish from Lake Michigan several times per month for six years before pregnancy. PCBs from the fish that accumulated in the mothers' bodies were passed along to their children, who exhibited cognitive, motor, and behavioral deficits shortly after birth and continuing until eleven years of age.^[54]

Experiments in young animals demonstrate that pesticides can alter neurological function and cause subtle neurobehavioral impairments when exposure occurs during the period of nervous system development immediately before or after birth. Processes such as learning ability, activity level, and memory, as well as emotion, sight, and hearing can all be affected. Most major classes of pesticides, including the organochlorines, organophosphates, carbamates, chlorophenoxy herbicides, and pyrethroids have been shown to adversely affect the developing nervous system of laboratory animals.^[55]

Birth Defects

Two to four percent of liveborn children have congenital birth defects, and although much remains unknown about possible causes, environmental agents are an important risk factor.^[56] Although information is limited, available studies suggest that depending on when and to what extent exposure occurs,

pesticides may alter the growth, development, and acquisition of normal organ function.

A few of studies suggest that in selected instances, paternal and maternal exposure to certain pesticides may cause birth defects including anencephaly (incomplete bone development in the skull), cleft palate, limb malformations, biliary atresia (missing or underdeveloped bile ducts), heart defects, and facial and eye deformities.^[57]

Living and working in agricultural areas has been shown in several studies to be associated with an increased risk of delivering a child with birth defects. In California, mothers living in counties of high agricultural productivity or with high pesticide use were found to be at greater risk of giving birth to children with limb reduction defects than mothers living in areas of low agricultural productivity and low pesticide use.^[58] A study of pregnant women in Iowa and Michigan found an association between maternal exposure to multiple pesticides and an increased risk for cleft palate in offspring.^[59] A new study in Minnesota found a significantly increased rate of birth defects in the offspring of private pesticide applicators and in regions of the state with highest frequency of use of chlorophenoxy herbicides and fungicides.^[60] Laboratory animal studies indicate that when exposure occurs at high doses, most pesticides are toxic to developing organisms.^[61]

Immune System Effects

The immune system protects the body against foreign agents and helps ward off infectious diseases and the growth of cancerous tissue. There is increasing awareness within the scientific community that toxic chemicals can suppress the immune system. A recent report reviewing a substantial body of scientific evidence concluded that pesticides now in use worldwide damage the immune system.^[62] Studies in experimental animals demonstrate that pesticides, particularly organochlorine and organophosphate insecticides, play a role in suppressing the immune system.^[63] Evidence for the immunotoxic effects of pesticides in humans is limited. Data are also sparse as to the mechanisms by which pesticides disrupt immune system functioning and the relationship between such damage and the development of clinical diseases in humans.

Several studies of the widely used organochlorine pesticide pentachlorophenol (PCP) begin to establish a possible link between children's exposure to pesticides, immune system dysfunction, and increased susceptibility to disease. PCP is most commonly used as a wood preservative and can be found in the indoor air of homes built with PCP-treated logs. Dioxin, a contaminant of PCP,

has been found to suppress the immune systems of laboratory animals.^[64] Ten families with children at least eight years old living in homes built with PCP-treated logs were found to exhibit a variety of immunotoxic effects at the cellular level. Furthermore, extensive interviews with family members revealed an "excessive incidence and persistence of cold and flu-like illnesses." The individuals in particular complained of nausea, vertigo, skin rashes, headaches, and allergies.^[65]

A recent study of PCP levels in human blood and urine samples found that mean blood serum levels of residents living in PCP-treated log homes were ten times higher than in residents of conventional homes, and PCP blood levels in children were close to twice those of their parents.^[66]

In northern Canada, Inuit Indian infants are highly susceptible to infections, exhibiting thirty times greater incidence of meningitis. Researchers suspect that infants' immune systems are suppressed from high concentrations of organochlorine pesticides and other persistent compounds in the breast milk of nursing mothers. Pesticide residues in breast milk are high because the Inuit traditional diet includes arctic marine mammals which bioconcentrate and magnify residues of persistent organochlorine compounds.^[67]

As discussed in a recent report by the World Resources Institute, epidemiological studies in Moldova, in the former Soviet Union, have implicated pesticide exposure in increased rates of infectious disease. In one study, teenagers in villages with the greatest pesticide applications exhibited rates of infections of the respiratory and digestive tracts two to five times and three times higher, respectively, than controls from areas of lower use.^[68] Based upon this association, researchers conducted a retrospective study of healthy children's immune systems in these villages. Nearly 80 percent of highly exposed infants and children showed significant deviations in more than five immunological parameters.

Children of Color

Some evidence suggests that children of color may be more vulnerable to pesticides in certain situations both because of physiological characteristics and because of greater opportunities for exposure. The children of farmworkers are also potentially heavily exposed to pesticides because they accompany their parents to the fields, live in housing contaminated by pesticide drift from nearby fields, and occasionally work in the fields themselves.^[69]

A recent California Department of Health Services pilot project suggests a potential for higher residential exposure to some pesticides for children of farmworkers versus children of non-farmworkers. Homes sampled were within one-quarter mile of agricultural fields where approximately fifty agricultural pesticides were used during the study period.^[70] A total of ten different pesticides were detected in the house dust samples. Half of the homes sampled had at least one resident who was a farmworker. The pesticides (chlorpyrifos and diazinon) were found only on the hands of farmworker children. In two farmworker homes, risk estimates for toddlers' ingestion of diazinon based on concentrations detected in house dust exceeded the EPA's reference dose for cholinesterase inhibition. The study did not look at the ethnicity of the home residents; however, the vast majority of farmworkers in the area of study are people of color.

Children who are African-American, Mediterranean, Middle Eastern, or Asian in ancestry are more likely than European-American children to lack an enzyme that is necessary for breaking down the pesticide naphthalene a common ingredient in mothballs. Without the enzyme, children of color are more likely than European-American children to suffer from acute hemolytic anemia (premature destruction of red blood cells) after exposure to naphthalene.^[71] Children who come in contact with mothballs can be exposed to naphthalene by the inhalation of fumes, absorption through touching, or accidental ingestion.

[BACKGROUND: PESTICIDE USE AT HOME](#)

SOURCES OF EXPOSURE

Children encounter pesticides throughout their environment, including at home, at school, in playgrounds, in hospitals, and in many public buildings and parks. Children also consume water and foods that are often tainted with pesticide residues.

When children come in contact with pesticides, the pesticides enter the body through four possible routes: the skin, lungs, mouth, and eyes. The skin is the largest organ in the body, and for its size a child's skin surface is twice that of an adult per unit of body weight.^[72] When skin is wet, cut, or irritated, pesticides can penetrate even faster.^[73] Pesticides applied as foggers, bombs, and aerosols generally have the smallest particle size and thus are the most readily inhaled.^[74] Children ingest pesticide residues from contaminated food and drinking water and by accidentally ingesting dust.

Parental Occupational Exposure

Children can be directly exposed to pesticides brought home on parents' work clothes or exhaled from parents' lungs. In a review of thirty-two different epidemiological studies involving exposure to pesticides and other chemicals, University of Southern California researchers concluded that parental occupational exposure to chemicals such as pesticides increases the risk of childhood cancer.^[75]

Indoor Air and Surfaces

In 1990, the EPA conducted a study to estimate levels of exposure to selected household pesticides experienced by the general population.^[76] Thirty-two different pesticides and degradation products were detected at least once in air samples taken inside and outside the home. The most frequently detected pesticides were the widely used household insecticides chlorpyrifos, diazinon, and propoxur; ortho-phenylphenol, an active ingredient in disinfectants; and the now banned insecticide chlordane. Indoor air was found to have much higher concentrations of pesticides than outdoor air -- a significant finding given that small children spend close to 90 percent of their time indoors.^[84] Overall, the study estimated that 85 percent of the total daily exposure to airborne pesticides was from breathing air inside the home.^[85]

A study published in the *American Journal of Public Health* examined air and surface residues following indoor treatment for fleas with the insecticide chlorpyrifos (under the trade name Dursban). Three to seven hours after application, insecticide concentrations were found to be much higher in the infant breathing zone nearest the floor than in the more ventilated adult breathing zone. In addition, insecticide residues were found on the carpet twenty-four hours after application. Researchers estimated that the total amount of insecticide that infants would absorb (primarily through their skin) up to twenty-four hours after application was ten to fifty times higher than what the EPA considers an acceptable exposure for adults.^[95]

A review of thirty-seven children poisoned by organophosphate and carbamate pesticides in Dallas revealed that each child was exposed at home and nearly 70 percent of the cases occurred when a child ingested or drank improperly stored products.^[96] In 15 percent of the cases, however, children developed symptoms thirty-six hours after the house was sprayed or fogged. The authors concluded

that children absorb pesticides through the skin from contaminated carpets and linens.

In a pilot study of nine homes occupied by families with children between the age of six months to five years, pesticides were detected in all homes -- with a total of 23 different pesticides detected in the study.^[97] The number of pesticides detected at each home ranged from 8 to 18. The most frequently detected pesticides were chlordane, chlorpyrifos, dieldrin, heptachlor and pentachlorophenol. The greatest number of pesticides and highest concentrations were found in carpet dust, resulting from indoor treatment and track-in, potentially exposing infants and toddlers through dermal contact and oral ingestion.

Household Dust and Soil/Drift

At home or in daycare, small children spend considerable time on the floor, where they come in contact with and ingest dust and soil. Toddlers (under the age of five), through normal play and hand-to-mouth activity, ingest two and a half times more soil around the home than adults,^[98] and overall, children are estimated to consume 0.01 g to 1.3 g of soil every day.^[99]

Pesticides used around the home persist in dust, and those used on lawns, gardens, and nearby farms end up in soil and are tracked into the house on shoes and pets. Pesticides in soil and dust in indoor environments persist longer than they do outside, where exposure to sun and rain helps break down pesticide residues. In general, pesticides concentrate at higher levels in household dust than in soil.^[100] One study measured the transport of lawn-applied herbicides to indoor carpet surfaces and carpet dust. Routine foot traffic across treated lawns brought herbicide residues into residences. Dirt tracked into homes via shoes transferred herbicides to carpet surfaces and carpet dust. Study researchers estimated that 2,4-D would persist in carpet dust up to one year after lawn application.^[101]

Children who live and play in agricultural areas are at higher risk of exposure to pesticides in dust and soil. Researchers in Washington State found that pesticide residues were highest in dust and soil from homes located in closest proximity to agricultural operations.^[102] In California, the children of migrant farmworkers living near sprayed fields experienced depressed cholinesterase activity and symptoms of acute pesticide exposure. Nearly one in five of these children had below-normal cholinesterase levels even though they did not work in the fields. Residential exposure to pesticide drift was considered responsible.^[103]

Pets

Children who play with pets treated for fleas, ticks, and other pests can be exposed to pesticides. Flea collars, shampoos, soaps, sprays, dusts, powders, and dips usually contain an insecticide. Common insecticides for pets include pyrethrins such as permethrin and organophosphates such as chlorpyrifos, diazinon, and phosmet.^[104] A study of 238 households in Missouri found that 50 percent used insecticides to control fleas and ticks on pets.^[105]

Schools

Pesticides are the management tool of choice for most pests that schools contend with including cockroaches and ants in cafeterias, classrooms, and offices, and rodents in waste storage areas and overgrown brush and weeds outdoors. While at school, children come in contact with dust particles and surfaces such as carpets, books, and plastics that can potentially harbor pesticide residues. This means that even if pesticides are applied after school hours, children are still at risk.

Although there has not been a nationwide evaluation of pesticide use in schools, several organizations have documented the extent of pesticide use within school districts in major metropolitan areas, including in the states of California, New York, Texas, and Washington.^[112] In general, these reports conclude that potentially dangerous pesticides are routinely applied in schools with little or no warning to parents or school staff.

The Northwest Coalition for Alternatives to Pesticides has collected information about childhood illnesses related to pesticide exposure in schools. In some instances, illnesses resulted from applications made in accordance with label directions.

- In 1993, chlorpyrifos and dichlorvos were applied for ant control in North Powellhurst School in Oregon. Soon after, at least sixty-five individuals, including infants, children, pregnant teenagers, teachers, and school staff reported nausea, vomiting, diarrhea, massive headaches, rashes, dizziness, itching eyes, sore throats, and other symptoms. The school was closed, cleaned and reopened, and eventually closed early because students and staff continued to experience health effects.^[113]
- In 1992, children, teachers, and staff at New York's Eastchester High School suffered headaches, eye and respiratory irritation, and nausea following their return to school after it had been sprayed for roach control with the pesticides chlorpyrifos, diazinon, and resmethrin. The

- school was forced to close for three weeks to clean up the pesticide residues.^[114]
- In 1989 in Yakima, Washington, a first-grader mistakenly ate several granules of the toxic insecticide Di-Syston. This exposure almost killed the boy and left him permanently sensitized to minute pesticide exposures.^[115]
 - In West Virginia, students and staff at an elementary school were found to suffer from persistent fatigue, nausea, respiratory problems, and numbness in their limbs over a four-year period because the school was contaminated with the now banned termiticide, chlordane. Federal investigators finally closed the school in 1989 after concentrations of chlordane were found eleven times the evacuation threshold.^[116]
 - Close to 300 students and four teachers at Homer Davis Elementary School in Tucson, Arizona, in 1987 became nauseated in class and were evacuated to hospitals after the organophosphate insecticide malathion was sprayed by a neighbor and then sucked into the building ventilation ducts.^[117]
 - In 1986, twenty-eight students and two faculty members at Waianae Elementary School in Hawaii developed headaches, stomach aches, breathing difficulties, and nausea after their school was treated with a flea spray containing chlorpyrifos. It was subsequently discovered that the children became sick from exposure to the "inert" ingredient, xylene, not the active ingredient, chlorpyrifos.^[118]

Food

Pesticide residues are widespread in the U.S. food supply. Data from the Food and Drug Administration (FDA) for the past nine years show that between 33 and 39 percent of the food supply in any given year contains detectable pesticide residues.^[119] In 1995, the USDA's Agricultural Marketing Service tested nearly 7,000 fruit and vegetable samples and detected residues of sixty-five different pesticides. Sixty-five percent of the samples contained pesticide residues.^[120] According to the National Academy of Sciences, diet is an important source of exposure to pesticides, particularly for children, some of whom are exposed to pesticide residues in food above levels considered safe by the federal government.^[121]

Children eat foods containing pesticide residues. An average one-year-old's top ten favorite foods are apple juice, grape juice, oats, bananas, milk, apples, orange juice, pears, wheat, and peaches.^[122] On a body-weight basis, young children consume these foods at levels from three to twenty-one times greater

than the average adult American.^[123] According to monitoring by the FDA, pesticide residues were detected in 50 percent of the samples of these foods.^[124]

Foods commonly consumed by children are likely to carry more than one pesticide. An analysis conducted by the Environmental Working Group (EWG) of the FDA monitoring results found 108 different pesticides in just twenty-two fruits and vegetables; forty-two different pesticides were detected on tomatoes, thirty-eight were detected on strawberries, and thirty-four were detected on apples.^[125] Based on FDA data on U.S.-grown and imported food, the EWG has also ranked the following fruits and vegetables as containing the most residues of the most toxic pesticides: strawberries, bell peppers, spinach, cherries, cantaloupes (grown in Mexico), apples, apricots, green beans, grapes (grown in Chile), and cucumbers. In contrast, avocados, corn, onions, sweet potatoes, cauliflower, Brussels sprouts, grapes (grown in the U.S.), bananas, plums, green onions, watermelons, and broccoli were found to have the least pesticide contamination.^[126] (EWG identified the food's country of origin only where considerable difference between pesticide residue levels existed between foods from different countries.)

Processed baby foods can also contain pesticide residues. According to recent testing by the EWG, sixteen pesticides were detected in eight baby foods sampled. Five different pesticides were found in pears, four in applesauce, and three in peaches, plums, and green beans. Residue levels were generally below those found in fresh fruits and vegetables.^[127]

Children taking certain medications may be at increased risk for adverse effects from pesticide exposure. Children taking anti-epileptic drugs, other drugs that act on the central nervous system, propranolol and digoxin, and drugs that alter hepatic blood flow may be at risk if exposed to certain pesticides. For example, the fungicide thiram may potentiate or magnify the effects of diphenhydramine (Benadryl), dimenhydrinate (Dramamine), and methylphenidate (Ritalin) -- all drugs given to children.^[128]

Playgrounds

Playground structures made of wood are usually treated with wood-preserving pesticides such as pentachlorophenol (PCP) and chromated copper arsenate (CAA), a mixture of arsenic, copper, and chromium. Arsenic is a known human carcinogen,^[129] and PCP is classified as a probable human carcinogen.^[130] Children can absorb wood preservatives through their skin when they climb and touch the wood. They can also ingest the preservatives when they put their hands in their mouths and consume nearby contaminated dirt or

sand. Several studies have found that measurable amounts of arsenic and PCP are dislodged from treated wood structures, particularly those without sealants.^[131]

Drinking Water

Children's exposure to pesticides in drinking water is discussed in [Chapter 7](#).

[BACKGROUND: CHILDHOOD PESTICIDE POISONING](#)

WHAT YOU CAN DO

Eliminate the Use of Toxic Pesticides In and Around Your Home

Most people do not realize that the pesticides they use in and around their home can be hazardous to their health. People often assume that if a pesticide has been registered for use by the federal government then it must be safe. This is not necessarily true, particularly considering the lack of testing of the effects of pesticides on children. You can reduce your exposure to pesticides and in some cases avoid using them altogether by taking the following steps:

Identify the pest. Don't hire someone to spray your home or lawn without first identifying that a pest problem actually exists. Many lawn care companies and pest control services suggest that you spray routinely on a "calendar" basis without necessarily making sure there is a need first. These services do not prevent pest problems; they simply apply pesticides without identifying a pest infestation or determining the reason it exists. If you need help identifying a pest, you can ask your local garden store or contact the local county agricultural extension officer.

Determine if you can tolerate it. Once you determine what the pest is, decide for yourself whether the level of infestation is tolerable. A few ants, for example, can be managed with a swipe of the sponge, whereas an army of ants marching across your kitchen floor is probably a bit too much.

Try non-toxic methods first. If you need to take action, first try non-toxic methods. This will involve identifying why a pest exists and where it comes from. In many cases, for example, you can reduce ant infestations by caulking and plugging up points of entry. If you have to use a chemical, try those that are less volatile and don't need to be sprayed throughout the house. For example, cockroaches and ants can be managed with boric acid baits and sorptive dusts

applied in a localized area instead of insecticide sprays. Termites can now be controlled with the use of heat instead of chemical fumigants. [\[132\]](#)

Use commercial pest control and lawn care companies with experience in IPM (Integrated Pest Management). If you are in the practice of hiring a lawn care or commercial pest control company, there are a number of basic questions worth asking to ensure your safety and find out if there are options other than the use of synthetic pesticides. Make sure that the business is registered and licensed in your state as a certified pesticide applicator, and doublecheck to make sure it has liability insurance that covers accidents and misapplications. Most importantly, inquire about alternative treatment methods instead of pesticides. Although not widespread, companies specialized in developing integrated pest management approaches that prevent pest problems from occurring in the first place rather than treatment after the fact do exist.

Take extra precautions with pesticides. If you have to use a pesticide, try to avoid exposure by wearing protective clothing or simply by staying away from the application site for a while. Some pesticides volatilize and leave the site relatively quickly, whereas others are likely to stick around. Read the label directions thoroughly and make sure to keep kids and pets out of the area for as long as possible after the application.

Work with School Boards to Reduce Pesticide Use and Adopt IPM Programs

Fortunately, dramatic reductions in pesticide use in schools are possible without threatening the health of students or the financial well-being of educational institutions. The most successful approach has been to implement Integrated Pest Management (IPM) programs. IPM is an approach to controlling pests that relies first and foremost on monitoring to determine whether or not pest problems exist and at what level of infestation mitigation should occur. Instead of applying pesticides on a weekly or monthly calendar basis, as many schools do, IPM calls for determining whether treatment is necessary and then seeking the least toxic method of control. In many cases certain pests can be physically trapped or excluded instead of killed with chemicals. Vacuums, caulking guns, and thick soapy water are often perfectly adequate treatment methods for common school pests. Other techniques for more troublesome pests include boric acid, heat, sandblasting, and insect growth regulators.

According to the EPA, "Schools across the nation that have adopted such programs report successful, cost-effective conversion to IPM. IPM can reduce

the use of chemicals and provide economical and effective pest suppression."^[133] For example, in Gwinnett County, Georgia, the county public school system -- the third largest in Georgia and 33rd largest in the United States -- implemented an IPM program in 1990 that reduced the annual pesticide costs by 44 percent with no reduction in control effectiveness.^[134]

Parents can play an important role in reducing or eliminating pesticide use in schools. In fact, in cases where school IPM policies have been adopted, the parents' role as educators and advocates has been critical.

Buy Organically Grown and In-Season Foods

There are many ways that parents can reduce their children's exposure to pesticides in food. First, buy organically grown foods whenever you can. Organic foods have been grown and processed without the use of synthetic pesticides or fertilizers. Many states have laws defining the term "organic." In addition, third-party organizations exist to certify food as organic. Look for foods certified as organic under established state law or a third-party certifier.

Organic food sales in the U.S. continue to increase dramatically. In 1994, sales of all organic food types were close to \$2.8 billion dollars, a 22 percent increase over sales in 1993.^[135] Purchase food certified by a third party, such as a state or regional organic farming association, to ensure that it is organic.

In addition to fresh fruits and vegetables, a wide variety of processed and packaged foods made with organic ingredients are now available. According to a recent survey by the nonprofit organization Mothers and Others, packaged foods such as cereals, bread, pasta, frozen vegetables, canned fruits, cheese, and crackers made from organic foods are priced competitively with non-organic foods.^[140] Particularly try to buy your child's favorite, heavily consumed foods as organic.

Whether you are buying organic or not, always try to purchase foods that are in season. Buying foods in season is another way to reduce your exposure to pesticides. Fruits and vegetables sold in the dead of winter such as grapes and tomatoes are often imported from other countries where pesticide laws are less stringent than in the United States. In fact, pesticides that have been banned in this country for health and environmental reasons can still be produced here and shipped overseas for use on foods grown for export to the United States. This "circle of poison" not only poses a threat to you as a consumer but also to farmworkers in those countries who are directly exposed to highly hazardous

pesticides. Furthermore, foods shipped long distances are commonly treated with pesticides after harvest.

One way to buy organically grown, in-season foods is to shop at your local farmers' market. You can talk directly to the farmer about his or her growing practices and find out for yourself if they use pesticides or not. Another way to make sure you and your family have a consistent and affordable supply of organic produce is to become part of a local "Community Supported Agriculture" (CSA) system. CSAs take many forms but most often involve contracts between a group of people and a farm to grow certain kinds of foods that are delivered weekly in the neighborhood. CSAs are becoming more and more popular and now total 500 nationwide.^[141]

If you cannot buy organic produce, wash fruits and vegetables and peel where appropriate. This can remove some pesticide residues limited to the surface of the food. However, many pesticides are systemically distributed throughout the produce item or are not soluble in water.

[BACKGROUND: HEAD LICE: A GROWING PROBLEM](#)

EXAMPLES OF COMMUNITY ACTIONS TO REDUCE PESTICIDE USE AND EXPOSURE

People throughout the country are successfully organizing within their local communities to reduce their exposure to pesticides. The following examples illustrate the power of individual citizens to effect change.

Phyllis Marburger of Snellville, Georgia, recently convinced her local Kroger's supermarket to stock organic produce. Phyllis first sent Kroger's a petition requesting the store to carry organic foods, signed by twenty-five parents at a local school fair. After the store refused the request, she approached the produce manager, and when he wasn't interested she convinced the produce buyer for the entire southeastern region to give it a try. Three years later, Kroger's still carries a wide variety of organic fresh fruits and vegetables as well as organic processed foods. Fueled by her success, Phyllis and several other concerned parents formed a non-profit organization, Parents for Pesticide Alternatives (PPA). In addition to their efforts to increase the availability of organic foods, PPA conducted a letter-writing and media campaign and convinced the Georgia Department of Transportation to mow instead of spraying 2,4-D along roadsides.^[142]

Joet Calabrese of Buffalo, New York, was pregnant with her first child when she noticed the city spraying pesticides on the elm trees along her street. Outraged that she had received no notice or warning of the spraying, she launched what turned into a six-year effort to halt the application of the carcinogenic insecticide carbaryl (Sevin) throughout Buffalo. Joet developed a network of friends and experts who could help her educate the media, the citizens of Buffalo, and their elected officials. They approached each member of the city council, district by district, until they received unified support for their efforts. Eventually the city stopped spraying, and individuals within their districts helped manage elm leaf beetle populations using physical barriers around each tree. Their hard work led to the creation of a Pest Management Board that includes physicians, IPM experts, and representatives from the community to advise the city regarding whether or not to use pesticides. They are now looking for ways to reduce pesticide use in schools.^[143]

William Forbes is a pest control operator with the Montgomery County Public Schools in Maryland. Under his leadership, the district adopted an IPM program that resulted in savings of \$36,000 over three years. Approximately 500 public schools throughout the state of Maryland have adopted or are in the process of adopting IPM programs as a result of the successful effort in Montgomery County.^[144]

Sharon Taylor first became concerned about pesticide use after she and her son became seriously ill from an aerial application of pesticides to tomato fields near her home. As soon as her health improved, Sharon committed herself to finding ways to reduce pesticide use in her community. In 1987 she began what turned into a four-year effort to convince 180 schools in the San Diego Unified School District to stop indiscriminate pesticide use. Sharon first met with the plant operations and landscape maintenance staff to educate them about the availability of non-toxic alternatives to pesticides. She then went to countless PTA and Teachers Association meetings and worked with the media to let people know about the hazards of pesticides and the importance of trying other alternatives first. In 1991 she and the plant operations staff developed an Integrated Pest Management policy that was adopted throughout the entire district. According to Sharon, it just makes good common sense to avoid putting more poisons in the world, particularly when there is no safe dose for children.^[145]

Sonya Kugler of Chicago, Illinois, has been active in her community for years in an effort to educate consumers about the environmental and public health benefits of eating organic and locally grown foods. Most recently she

persuaded the grocery store chain Dominic's to greatly expand sales and marketing for organically grown foods. In 1988 Dominic's started carrying minimal amounts of organic foods in their 101 stores in the greater Chicago area. Two years ago, Sonya asked Dominic's to participate in a "Shopper's Campaign for Better Food Choices," started by the nonprofit group Mothers and Others. It didn't take long for Dominic's to respond by expanding their shelf space for organic foods from practically nothing to sixteen feet in thirty-three of their stores. They are now carrying numerous products from twenty-seven new companies that produce and manufacture organic foods. Dominic's is an active participant in Organic Harvest Month every September, and they also conduct shoppers' tours throughout the year to educate consumers about how they can eat a "green diet." Sonya believes that the real success of this program stemmed from Dominic's realization that consumer demand for organic food was reality not fiction.^[146]

Marta Milchman of Nassau County, New York, first became concerned about the health risks of pesticides after being poisoned by exposure to chlordane used to kill termites in her house. Since then she has worked with others in her community to stop the use of pesticides in her school district. She first spoke with parents at PTA meetings, and together they succeeded in persuading the superintendent to adopt a district-wide IPM policy. Now, instead of spraying 2,4-D, bendiocarb (Ficam), and other pesticides, the emphasis is on using techniques that prevent pest infestations, such as keeping rooms clean, repairing structures to eliminate points of entry for pests, and using traps and spot treatment when necessary.

After this success, Marta and other concerned parents established the organization Long Islanders Against Pesticides (LIAP). LIAP, along with the Long Island Coalition for Alternatives to Pesticides and One in Nine, an organization fighting breast cancer, began working together to establish an IPM policy for the entire county, with a population of 1.5 million. As of April of 1995, Nassau County requires the implementation of IPM for all county facilities and properties and the development of educational materials about the dangers of pesticides and the availability of alternatives. The Nassau County Health Department has also established a Pesticide Advisory Committee that includes citizen groups.^[147]

Staff of the East Bay Regional Park District in California's Alameda and Contra Costa Counties have been working for the past twenty years to reduce the use of hazardous pesticides throughout the district's fifty-three parks. According to Jean Peters, a staff member of the district's Ecology Committee, it

all began in 1972 after a freeze in the Berkeley hills destroyed thousands of eucalyptus trees. To prevent tree stumps from sprouting, field staff were required to apply the hazardous herbicide 2,4-D. When staff became ill and complained of stomach aches, dizziness, and headaches, management reassured them that 2,4-D was perfectly safe.

While attending a Certified Pesticide Applicator training, staff learned that they had been illegally applying 2,4-D without adequate safety equipment. As members of the American Federation of State, County and Municipal Employees (Local 2428), they set out to organize a campaign to develop a health-protective policy and program for pesticide use. They began by educating themselves about the health effects associated with 2,4-D exposure and alternative weed control strategies such as Integrated Pest Management (IPM). They then involved the community and used the media and local organizing efforts to get the word out about pesticide use throughout the district.

In the early 1980s, the union's efforts were heard by the publicly elected District Board of Directors, and they stopped the use of 2,4-D and negotiated the establishment of an Ecology Committee charged with developing an IPM policy. Since the policy's inception in 1984, overall pesticide use has been reduced by 75 percent, and the union has a full-time staff person dedicated to implementation of IPM throughout the district. The union's success also spread to the establishment of a Natural Resources Committee that addresses how the regional park system can implement waste reduction, utilize recycled products, and protect wildlife. Jean Peters believes their success is due to the hard work and courage of union members. ^[148]

Early in the summer of 1996, the Residents' Committee of the Henry Horner Homes Public Housing Development in Chicago decided effective pest control was one priority in their housing rehabilitation efforts. They invited the **Safer Pest Control Project** to help them develop a safe, less-toxic, cost-effective plan to control the pests (roaches and rodents) that plague many public housing residents. Rodent and roach infestations can trigger asthma attacks, but the pesticides sprayed to control these pests can also set off asthma. Based on IPM, the plan calls for a clean-out of all vacant units, cleaning by residents in occupied units, less toxic and non-toxic baits, and preventive measures like caulking, screening, and better trash disposal. In addition, there are educational programs and outreach for Horner residents, including a comic book explaining non-toxic pest control that was illustrated by a 17-year-old Horner resident. ^[149]

In October 1996, **San Francisco** adopted an ordinance immediately banning the use by the City of San Francisco of pesticides known to be carcinogens or reproductive toxins, reducing pesticide use by 50 percent by 1998 and eliminating pesticide use by city departments by the year 2000.^[150] Pesticides intended to protect public health, such as chlorine in the city's swimming pools, are exempt. The legislation, among the toughest in the nation, stemmed from a newspaper analysis revealing that three dozen of the sixty pesticides used by the city's Parks and Recreation Department were probable or possible carcinogens or otherwise potentially hazardous to humans.^[151]

CURRENT REGULATORY FRAMEWORK

Pesticides are principally regulated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act (FFDCA). Under FIFRA, the EPA is required to review toxicological and environmental fate studies and assess the relative risks and benefits of a pesticide before it can be registered for use. If a pesticide is applied to food crops, the EPA must also establish a legal limit or "tolerance" for each pesticide/crop combination.

Minimum protective standards exist for some pesticides in drinking water under the Safe Drinking Water Act (SDWA). If pesticides end up in the air they are virtually unregulated, with the exception of the Safe Drinking Water and Toxics Enforcement Act, a state law in California that requires warnings for people exposed to chemicals known to cause cancer or reproductive harm.

Historically, the EPA has failed to address children's unique vulnerability to pesticides in establishing regulations to protect public health. For example, tolerance levels for the majority of pesticides on the market have been established based on adult eating habits, and risk assessments have failed to take into account the fact that children are exposed to pesticides from multiple sources. In 1993, the National Academy of Sciences issued a series of recommendations for improving pesticide regulations to better protect children. As of November 1995, EPA established a new policy stating that risks to infants and children are considered "consistently and explicitly" as a part of all risk assessments developed for EPA decisions and policies.^[152] During the summer of 1996 Congress passed the Food Quality Protection Act (FQPA) amending the federal Food, Drug and Cosmetic Act to require that all pesticide tolerances are revised in order to protect children.

[BACKGROUND: HORMONE DISRUPTORS: EMERGING EVIDENCE OF A FUTURE THREAT](#)

REFORMS NEEDED

Although the U.S. has one of the most stringent pesticide regulatory programs in the world, substantial reforms are necessary to adequately safeguard children's health. The best protection for children would be a dramatic reduction in the use of pesticides nationwide. National pesticide and agricultural policies need fundamental restructuring to provide broadscale incentives for reducing the use of hazardous pesticides and promoting safe alternatives. While this type of change cannot be accomplished overnight, there are many encouraging signs of progress, including large-scale agricultural producers who have eliminated pesticide sprays and parents who have succeeded in convincing schools to replace the use of hazardous pesticides with alternative, non-toxic methods.

Regulatory standards designed to minimize exposure to pesticides in food, drinking water and air must be established to specifically protect children. With the enactment of the Food Quality Protection Act and the EPA's establishment of a new policy of considering risks to children from environmental hazards in various media, important steps to address children's health have been taken. If this new approach is to effectively protect children from exposure to hazardous pesticides, however, the EPA must take into account a variety of factors that have thus far been ignored in establishing pesticide safeguards. Specifically, decisions must be made based on an assessments of risk that account for children's disproportionate exposure to pesticides compared to adults and their exposure to pesticides from multiple sources, including food, drinking water, indoor air, and surfaces. Consideration must be given to children's greater susceptibility to the effects of certain pesticides, particularly nerve toxins.

Last year, as a result of a long and aggressive effort by the public interest community, federal pesticide laws were substantially overhauled and a comprehensive new law, the Food Quality Protection Act (FQPA) was passed. The FQPA codifies the most explicit and stringent protection of children ever adopted in a federal environmental law. The new statute not only requires a "reasonable certainty of no harm" from pesticides to children and infants, but also explicitly requires the EPA to consider the cumulative risk of aggregate exposure to pesticides from all sources (such as food, drinking water, air, indoor use, etc.) when evaluating pesticide safety. Moreover, in another precedent-setting provision, the EPA is required to evaluate whether multiple pesticides may interact with each other due to a common mode of toxicity, and it must assure that people have a "reasonable certainty of no harm" even considering these interactive effects.

As with any other new law, "watchdogging" the EPA and ensuring proper legal implementation of the FQPA will be essential. Otherwise, successes achieved legislatively will be whittled down administratively. Given the enormous financial stakes involved, the pesticide industry is poised to allocate immense resources to persuade or force the EPA to weaken, evade, or undermine the language of the FQPA.

To accurately characterize risks to children and to establish sound policies to protect them, the EPA will need additional data from pesticide manufacturers, including the toxicity of pesticides to immature and developing systems and the potential of pesticides to disrupt the endocrine and immune systems and cause long-term neurological harm. The EPA will need to require more in-depth and accurate exposure data, including the monitoring of pesticides in indoor air, dust, and on surfaces, and up-to-date food consumption surveys specific to children's dietary patterns.

The Department of Agriculture should require all farmers to keep and report accurate records of pesticide applications in the field. Such reporting data will allow the EPA to determine whether children, particularly those living in agricultural areas, are likely to be exposed to pesticides from drift or contaminated drinking water. The EPA should also assess pesticide use in schools nationwide. Research is also needed to characterize the extent to which children of color are at disproportionate risk from pesticide exposure.

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