●PESTICIDES AND CHILDREN

JIMMY AND JANE'S DAY: A PRECAUTIONARY TALE

How much are children being exposed to pesticides? What hazards do these exposures pose for children? These questions don't have satisfactory answers because we have only a little of the research and information needed to answer them. However, the little information we do have makes precaution compelling. In this article, we follow two fictitious Oregon children, Jimmy and Jane, through a fictitious day in order to explore the research that's been done about children's interactions with pesticides.

Jimmy eats pesticides in his lunch, gets exposed to pesticides when he plays with a recently-sprayed dog, attends a school where pesticides are used to kill ants, and plays soccer on a field that has been treated with herbicides. Jane, who lives in a farming community, has similar exposures but she is also exposed to pesticides in her drinking water and from her parents' work on their farm. These exposures have been linked to changes in the way children's brains develop, an increased risk that they will develop several cancers including leukemia and brain cancer, and higher frequencies of birth defects, stillbirths, and low birth weight.

Jimmy and Jane's message is a triple call to action. First, we need basic information about pesticide use: Which pesticides are being used? Where are they being used? How much are they being used? Second, we need more research about how pesticide exposure affects children's health. Third, we need to support alternative pest management strategies so that we can reduce pesticide use now.

BY CAROLINE COX

Pesticides are a unique class of chemicals. Designed to kill or otherwise damage living things, they are, as the National Research Council has written, "perhaps the only toxic substances that are purposefully applied to the environment."[1] As we move towards the twenty-first century, pesticides, including insecticides, herbicides, fungicides, and more, are ubiquitous in our lives and our children's lives. Millions of pounds of pesticides are used every year[2] on our farms and forests, in our schools and parks, along our roadsides, and in our homes and workplaces. How pesticide use impacts our children, our personal connection to the future, is a compelling question because children are more exposed and more vulnerable to environmental threats than adults.[3] It is therefore shocking how little we really know about children and pesticides. Where, and in what quantities, are pesticides applied? How much are our children being exposed to them? What risks do they pose for our children? All of us have a difficult time finding satisfactory answers to these questions.

This article moves through a day with two Oregon children, Jimmy and Jane, and uses their stories to explore the limited research that's been done about pesticides and the hazards they pose to children. The children are fictional, as are the events which fill their day. We have taken incidents that occurred in separate places and times, and put them together into a single day. However, the incidents we describe and the health hazards of the pesticide exposures we discuss are based on actual incidents that have been reported to Oregon agencies, studies that have been published in scientific journals, or data that have been collected by state and federal agencies. Jimmy and Jane could be any of our children. They have an important message.

First we'll spend a day with Jimmy, an eight-year-old from Tualatin, a suburban town near Portland.

Caroline Cox is JPR's editor.

What's in My Lunch Today?

* * * *

"Jimmy, have you made your lunch yet? You have to leave for school in ten minutes."

"Just a minute, Mom, I have to finish the comics."

Reluctantly, Jimmy puts down the comics and goes into the kitchen to make himself a lunch. Like many kids, he packs a peanut butter and jelly sandwich, a bag of chips, and a drink. Then he stands at the refrigerator trying to decide whether to take an apple or a peach. Peaches are treats this early in the year, but they're so messy. Last week when he took one it got smashed by his math book. Still, he realizes he's taken an apple in his lunch almost every day this year. Something different really sounds good; it's a tough decision.

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While Jimmy's trying to make up his mind, consider what Jimmy, and most of us, don't know about the fruits he's staring at in the refrigerator. These fruits are often contaminated with pesticides. When the U.S. Department of Agriculture

(USDA) sampled produce in 1996 (the most recent year for which data are available) the agency found pesticides on 98 percent of the apples tested, and 96 percent of the peaches.[4] (See Figure 1.)

In USDA's monitoring program, fruits and vegetables are purchased from distribution centers just before they are sold to grocery stores and are washed before testing. The goal is to make the testing realistic, "to collect samples as close to the consumer as possible" and to prepare the samples as if they had been washed or peeled by an "actual consumer." Startlingly, 39 different pesticides were found on apples, and 27 different pesticides on peaches. USDA found multiple pesticides in over 50 percent of the apple samples, and over 40 percent of the peach samples. Some apple samples contained 10 different pesticides, and some of the peach samples contained 9.[4]

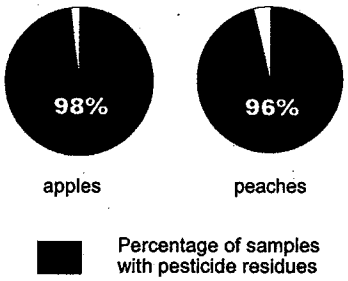
Of the pesticides found on apples and peaches, a family of insecticides called the organophosphates (OPs) are particularly problematic. OPs are neurotoxins; they inhibit an enzyme that is essential for normal transmission of nerve impulses from one nerve to another.[5] This enzyme functions the same way in nervous systems of both insects and humans.[5] USDA found 15 OPs on apples and 8 on peaches.[4] These included some of the most commonly detected pesticides: 54 percent of the apple samples contained the OP azinphos-methyl, as did 33 percent of the peach samples.[4]

Until recently, pesticide regulation in the U.S. considered pesticides individually, without regard for the total number of different pesticides that a person might consume on a single fruit or vegetable. A 1993 report by the National Research Council recommended that the regulatory process be changed so that it could account for simultaneous exposure to multiple pesticides that affect our health the same way.[6] This recommendation was mandated by the Food Quality Protection Act of 1996.

Recently the Environmental Working Group, a nonprofit organization based in Washington D.C., used the USDA data, as well as additional pesticide residue data collected by the Food and Drug Administration and food consumption data collected by USDA, to look at dietary exposure to combinations of OPs. They found that one out of every four times a child under five years of age eats a peach, he or she is exposed to levels of OPs above the level (called a reference dose) that the U.S. Environmental Protection Agency (EPA) considers "acceptable." About one out of eight apples expose a child to similar levels of OPs.[7]

This OP exposure is of particular concern because children's nervous systems

Figure 1
How Often Are Pesticides Found on Children's Food?



U.S. Dept. of Agriculture. Agricultural Marketing Service. Science and Technology. 1998. Pesticide data program: Annual summary calendar year 1996. Washington, D.C., Feb.

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WHAT IS EPIDEMIOLOGY?

Most of the studies cited in this article come from the category of health research called "epidemiology," the study of factors that influence the occurrence of disease in a population.

Epidemiology is unique because it studies people instead of, for example, laboratory animals. This means that its results are directly relevant to people. However, it does not allow strict control over study conditions as does a laboratory study.

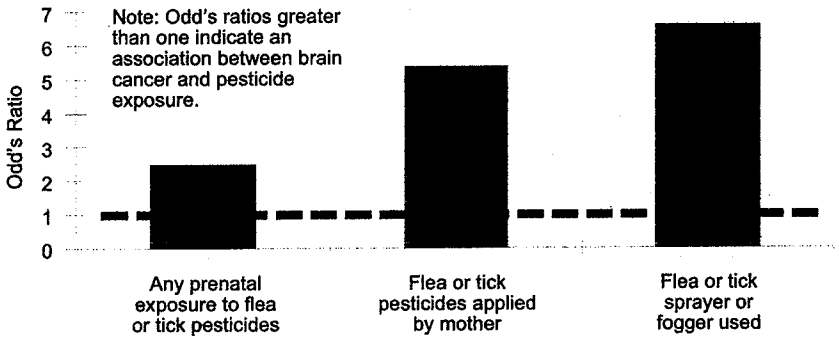
The kind of epidemiological study used most often to investigate health effects of pesticides is called a case-control study. Researchers identify "cases," people who have developed the disease being studied. They compare cases with controls, people who are free of the disease. Typically, controls are selected so that they share characteristics (age, sex, occupation, place of residence, etc.) with the cases. For both cases and controls, researchers determine exposure, usually through an interview or a questionnaire.

Significance in case-control studies is measured with the odd's ratio, the ratio between the number of cases exposed to the pesticide of interest and the number of controls exposed. Odd's ratios greater than one indicate a significant association between the disease and the exposure.

Epidemiology does not establish that exposure causes a disease, simply that the two are associated. To establish a causal relationship requires a biological mechanism that supports the association, consistent results from several studies, and the correct time sequence between exposure and disease.

Ernster, V.L. 1997. Epidemiology. *In McGraw-Hill Encyclopedia of Technology.* 8th edition. New York, NY: Mc-Graw Hill. Vol. 6, pp.503-505

Figure 2
Use of Flea/Tick Pesticides Linked with Increased Incidence of Childhood Brain Cancer



Pagoda, J.M. and S. Preston-Martin. 1997. Household pesticides and risk of pediatric brain tumors. *Environ. Health Persp.* 105:1214-1220.

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are immature. Recent laboratory studies have shown that exposure to pesticides while the nervous system is developing can cause long-lasting, possibly permanent, effects on the nervous system. For example, exposure of young rats to relatively small amounts of the OP chlorpyrifos inhibits the formation of two important biological building blocks, DNA (genetic material) and proteins, in the developing brain.[8] Also, the number and size of cells in several parts of the brain are reduced in newborn rats exposed to OPs.[9] Another study, this one of newborn rats whose mothers had been exposed to chlorpyrifos during the last third of their pregnancy, demonstrated "markedly altered reflexes" in two behavioral tests of the newborn rats.[10] Will the functioning of our children's brains be similarly affected by the pesticides they unintentionally consume with their lunches? These experiments can't answer that question, but their results are sobering and suggest that we should be cautious about our exposure to these potent chemicals.

Of course, either apples and peaches are healthy additions to Jimmy's lunch. But parents want to make sure that the fruits in their children's lunches are not contributing pesticides as well as nutrition. In order to do this, we need more information about the pesticides used on children's food, more information about the hazards of these pesticides, and more support for sustainable agriculture.

The Hidden Costs of Pet Sprays

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"Here, Jester, here Jester," calls Jimmy. He's walking down his street on his way to school, and as usual, he stops to play with the puppy at the end of the block. Since Jester loves to retrieve and Jimmy doesn't mind throwing a few sticks for him, they make a good pair. Today Jester comes running down the sidewalk, tail wagging and anxious for their morning game. Just as Jimmy throws the stick, they are interrupted by Debbie, Jester's owner. Jimmy likes Debbie, who's expecting her first child later on in the year. Like most of the kids in the neighborhood, he thinks of her as an honorary aunt.

"Morning, Jimmy," says Debbie. "If you're going to play with Jester today, don't touch him, OK? I had to spray him for fleas this morning."

Jimmy looks a little confused, tosses the stick one last time for Jester, and goes off to school.

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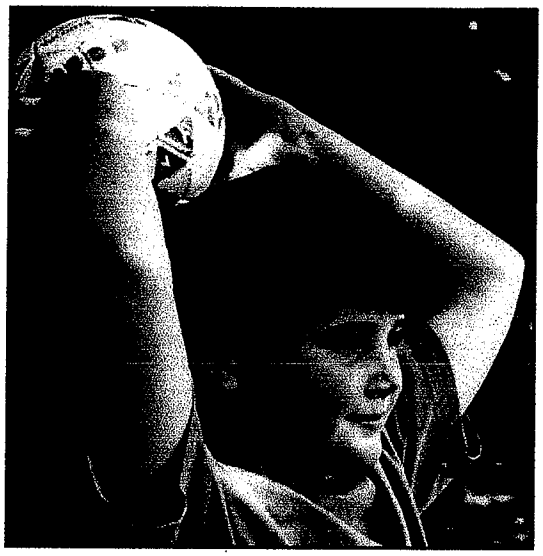
Debbie is being a conscientious neighbor to warn Jimmy about the flea treatment she's given her dog. Most people don't warn their neighbors after they spray their pets.

Despite her care, however, Debbie's treatment of her dog for fleas poses hazards about which she is completely unaware. By using that flea pesticide, Debbie may have increased the risk that her child will develop brain cancer. A recent study of children with brain tumors in Los Angeles County found that these children were twice as likely as children without the disease to have mothers who had treated their dog(s) for fleas and/or ticks during pregnancy. For children who were diagnosed with brain cancer before the age of five, the risk increased five-fold.[11] (See Figure 2.) Multiple studies, conducted in Baltimore, Missouri, and Denver, have shown an association between brain cancer and home pesticide use.[12] The incidence of brain cancers in children over the last 25 years has increased by about 40 percent, and they are the second most common kind of cancer diagnosed in children.[13]

Unfortunately, brain cancer is not the only risk associated with prenatal exposure to household pesticides. Researchers have found a number of striking associations between prenatal exposure to household pesticides and childhood health problems: prenatal exposure of either parent to pesticides is associated with a higher risk for stillbirth or low birthweight babies[14]; exposure to "pest strips" either prenatally or as a baby is associated with an increased risk of childhood leukemia[15];



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the use of pesticides by either parent in the home or garden during pregnancy or nursing also increases the risk of childhood leukemia[16]; and prenatal exposure to pesticides is associated with increased risk of a congenital heart defect.[17] Putting the studies together, it's clear that reducing our exposure to pesticides is an important step towards healthier babies.

School Surprises

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"Hey dad," Jimmy yells as he comes out of the classroom. "Are you walking me home from school today?"

"Just a minute, OK? I want to talk to Marie for a minute," replies his father.

Marie's daughter Anna went to preschool with Jimmy. Although Anna and Jimmy really don't want to have much to do with each other any more, their parents have remained friends. Since Jimmy doesn't want to play with Anna, he doesn't have much to do besides listen to the adults.

Here's what Jimmy hears them say:

"I walked Anna to school this morning and just by chance, I saw a couple of the custodians working up in the upper wing. They were spraying the school to kill ants," exclaims Marie.

"I guess it's about time," says Jimmy's dad. "If there are ants at the school, somebody's got to do something."

"Oh you don't understand," interjects Anna's mom. "It was diazinon they sprayed."

"Dia-what?" asks Jimmy's dad.

Anna's mom explains. "When Anna was a baby, she had to have checkups every couple of weeks because she had anemia and jaundice as a newborn. At one of her checkups, when she was about three months old, the doctor noticed some muscle problems and diagnosed her with mild cerebral palsy. We were very upset, and got her started right away on some physical therapy."[18]

"After a few months," she continues, "we happened to mention to the doctor that we had the house sprayed with diazinon just before that checkup. Anna and I were both there. In fact, even though months had gone by, the house still smelled! The state came and tested for pesticides in the dust and air. By then it was actually five months after the spraying. Still, there was enough diazinon that they told us we should move. Things were fine after we moved to this neighborhood, and Anna didn't show any more signs of cerebral palsy."

Jimmy's dad interrupts, "Good grief, I'm glad she's OK."

"Since then, we've always worried about Anna and pesticides. We don't spray our house any more, obviously. There are lots of other ways to deal with pest problems. But we had no idea they would spray her school. They never told us! Did they tell you?"

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Unfortunately, most parents are left in the dark about school pesticide use. Schools are often sprayed with insecticides, and only a few school districts let parents know ahead of time that spraying is going to take place. Most schools don't have easily available records of their past treatments, either. There's no convenient way for parents to find out what pesticides have been used in their child's classroom.

Research supports Marie's fears that Anna's exposure to diazinon as an infant could affect her health for years. Diazinon is an OP, chemically related to the insecticides on the apples and peaches discussed earlier. EPA recently reviewed studies of chronic (long-term) neurological and behavioral effects of OPs and found that symptoms were visible up to 10 years after exposure.[19] In addition, children who are exposed to insecticides are at increased risk for later developing childhood leukemia.[20] These potential hazards are a compelling justification for minimizing further exposure.

The Price of Perfect Turf

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"Hey Jason, take your soccer ball and

get off the field! My game is just about to start and my team can't play if you're on the field." Jimmy pushes his little brother off the field just as the referee gets ready to start the game.

The game begins on the school soccer field. Jimmy's team plays hard. By halftime everyone is sweaty and thirsty and they crowd around the water jug.

Jason comes over to join the team. He's been playing with his soccer ball at the edge of the field. Jimmy notices that there are some unusual white things stuck to Jason's fingers and shoes.

"Coach, come here. My brother's gotten into something weird, " says Jimmy. The coach takes a look at the granules, and then notices that they're actually all over the soccer field. He talks for a few minutes with the referees and the other coach, then calls his team together.

"Hey team," yells Jimmy's coach over the general hubbub. "We're going to have to put off this game. Someone's sprayed the field with something. Everybody can go home, and I'll try to reschedule this game for next weekend.[21]

* * * *

Later on, Jimmy's coach finds out that the granules are a mix of fertilizer and herbicides, including the phenoxy herbicide 2,4-D. The coach is glad that he trusted his instincts and stopped the soccer game, especially since some parents call him because their children aren't feeling well later on that evening. But what the coach doesn't know is that exposure to the herbicide 2,4-D has been linked to an increased risk of non-Hodgkin's lymphoma, a kind of cancer. One study highlighting this link looked at lymphoma in dogs and found that the owners of dogs with lymphoma were more likely to have treated their lawns with 2,4-D.[22] A study of children's cancers in the Denver area found a similar association: children with soft tissue sarcoma (a general category of cancer that includes lymphoma) were more likely to live in houses with pesticide-treated yards.[15] 2,4-D is the pesticide most commonly applied to lawns.[23]

What does this mean for Jimmy's soccer team? There's no way to say, but the results of these studies are certainly unsettling and reinforce our need to know about how, when, and where these toxic chemicals are used around our children.

Meet Jane

Let's leave Jimmy now and go to visit Jane, a seven-year-old girl who lives on a farm outside of Medford in southwestern Oregon.

Like Jimmy, she can be exposed to pesticides on her food, in her home, and at her school. Living in an agricultural area, however, she is likely to be exposed to more pesticides than her urban counterpart. For example, a recent study of food eaten by farm families found that their food contained increased concentrations of the pesticides used on the farm during the seasons when those pesticides were being applied.[24] Another recent study looked at OP insecticides in dust and soil from children's play areas. The study found OPs more often and in higher concentration in samples from farm homes: household dust was contaminated with OPs in 62 percent of the samples taken from farms.[25]

In addition, children from farming families face some unique hazards. Let's look at what a few scenes from Jane's day can tell us about these hazards.

Drinking Water: Not Just Tea for Dolls

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"Samantha, you can sit here next to Violet," Jane greets her dolls. "Baby Fairy Princess, you sit over here. I'm so glad you could all come over for tea." Jane puts a cracker on each doll's plate. "Here's cake, and I'll go get the tea from the kitchen." Jane carefully carries her teapot into the bathroom and fills it with clear water. She pours a cup for each of her dolls, and even drinks a cup or two herself.

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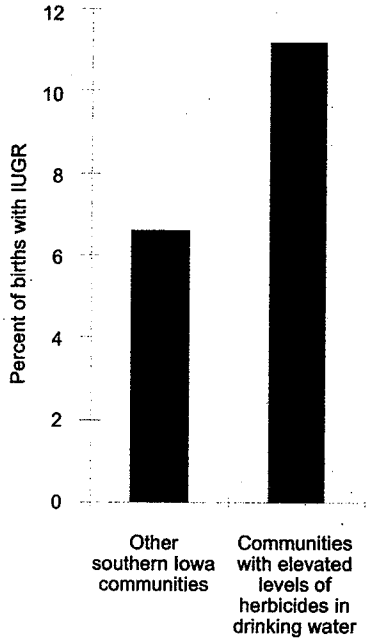
As is the case with half of all Oregonians, the water Jane drinks and bathes with comes from a well.[26] In Jane's case, the well is in the field behind her house, on the farm where she lives with her parents. What neither Jane nor her dolls know is that their "tea party" may well have a hidden surprise: pesticides.

The Department of Environmental Quality (DEQ) monitors Oregon wells for pesticides, and in 1997 the agency summarized for the legislature studies

Figure 3
Intrauterine Growth Retardation in Communities with Herbicide-contaminated Water



Munger, R. 1997. Intrauterine growth retardation in Iowa communities with herbicide-contaminated drinking water supplies. *Environ. Health Persp.* 105:308-314.

NORTHWEST COALITION FOR ALTERNATIVES TO PESTICIDES/NCAP
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conducted since 1980. The agency found pesticides in wells in nine Oregon counties, both east and west of the Cascade Range. DEQ found 5 herbicides, 2 soil fumigants, 1 insecticide, and a wood preservative.[27] In addition, the U.S. Geological Survey has tested wells in the Willamette basin; the agency found pesticides in one-third of the 69 wells tested. This study found 11 herbicides, 1 herbicide breakdown product, and 1 insecticide. The widely-used herbicide atrazine was found in almost 90 percent of the pesticide-contaminated wells, and some wells were contaminated with as many as 5 different pesticides.[26]

What effects on our health can we expect from drinking pesticide-contaminated water? A partial answer to this question comes from Iowa, where pesticide contamination of water has been significant and the problem has been studied more than in other parts of the country. Researchers from the University of Iowa studied communities served by a reservoir that was contaminated with two parts per billion of the herbicide atrazine. (This small amount of atrazine is just below the level EPA considers acceptable in drinking water.) Overall, the researchers found twice as many birth defects in communities drinking the pesticide-contaminated water. Heart defects were increased threefold, as were defects of the urinary and genital systems, and "limb reduction" defects, arms or legs that do not develop their normal length, increased almost sevenfold.[28]

The same researchers also looked at the incidence of "intrauterine growth retardation" (IUGR) in these Iowa communities. IUGR refers to babies that are born smaller than would be expected according to their gestational age, that is, the amount of time they have spent in the womb. In the communities with pesticide-contaminated drinking water, the incidence of IUGR was almost double that in communities with uncontaminated water.[29] (See Figure 3.)

A dependable source of clean drinking water is something that we take for granted. But as this research shows, the small concentrations of herbicides that have contaminated our water have important consequences for our children.

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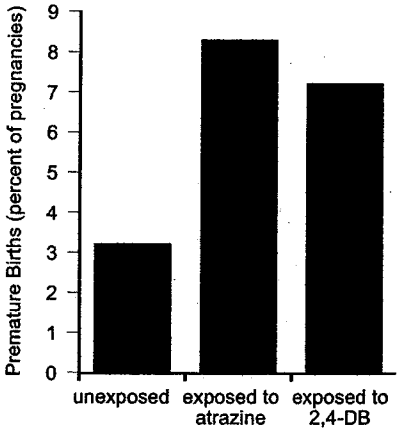
Figure 4
Father's Herbicide Exposure Linked with Increased Risk of Premature Birth



Savitz, D.A., et al. 1997. Male pesticide exposure and pregnancy outcome. *Am. J. Epidemiol.* 146:1025-1036.

Bedtime Story

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"Daddy, will you read to me now? Now? Right now!" Jane is tuckered out after playing in her softball jamboree earlier in the day, and as bedtime gets close she doesn't have much patience.

"OK, OK, take it easy. I'll be there as soon as I finish these last few dishes." Jane's dad is tired too after a long day. He's also a little angry. The nursery next door had a plane out spraying today, and the plane turned wide over his fields and sprayed him and his dog.[30] He is proud of being careful about his own pesticide use, and it makes him angry when his neighbors are careless. Jane's dad puts this all aside and settles down on Jane's bed with a dog-eared copy of *Ramona the Pest* and starts reading. When Jane's mom finishes the barn chores she joins them.

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This heart-warming scene is one that most Oregonian parents want to have with their children. But what about the pesticides sprayed on Jane's dad today? Can they disrupt heart-warming scenes like this? The answer may well be yes.

The increased exposure of farmers to pesticides has been linked with a wide variety of health problems in their children. For example, limb reduction birth defects are more common in counties in California with a high agricultural pesticide use[31]; the children of farmers in Minnesota who apply pesticides on their farm (particularly 2,4-D) are more likely than other families to have children with birth defects[32]; use of the insecticide carbaryl was associated with a increased incidence of miscarriage in a farm family health study from Ontario, Canada; in the same study, use of the herbicides atrazine and 2,4-DB was associated with an increased risk of premature birth[33]; fathers' occupational exposure to pesticides was associated with an increase in the risk of bone cancer (Ewing's sarcoma)[34] and leukemia[20] in their children; and, in 10 California counties, mothers' occupational exposure to pesticides increased, up to threefold, the risk of stillbirth.[35] (See Figure 4.)

What are Jimmy and Jane Telling Us?

The message that Jimmy and Jane have for us is simple. All of us can be exposed

to pesticides through the food we eat, the air we breathe, the water we drink, and in countless other ways. We don't yet have answers to some important questions. Where are pesticides used? How much are they used? Which chemicals are used? How do these chemicals impact our children's health? The little that we do know, however, suggests that it's crucial to get answers to these questions now.

Although Jimmy and Jane would say it differently, a report from the American Medical Association's Council on Scientific Affairs outlined their message. "Pesticide risks need to be assessed for infants and children because of anatomical and physiological differences that may make children more vulnerable," states the AMA.[36] "Particular uncertainty exists regarding the long-term health effects of low-dose pesticide exposure."[36] The association then suggests, "Considering these data gaps, it is prudent for homeowners, farmers, and workers to limit pesticide exposures ...and to use the least toxic chemical pesticides or nonchemical alternatives." Finally, the AMA recommends "improved state and national systems ... for the reporting of pesticide usage and pesticide-related illness."[36]

Jimmy and Jane's message is a triple call to action. First, we need basic information about pesticide use: Which pesticides are being used? Where are they being used? How much are they being used? Second, we need more research about exactly how pesticide exposure affects children's health. Third, we need to act on the research conducted so far that implicates pesticide exposure in a variety of health problems. We need to support alternative pest management strategies enthusiastically so that we can reduce pesticide use.

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