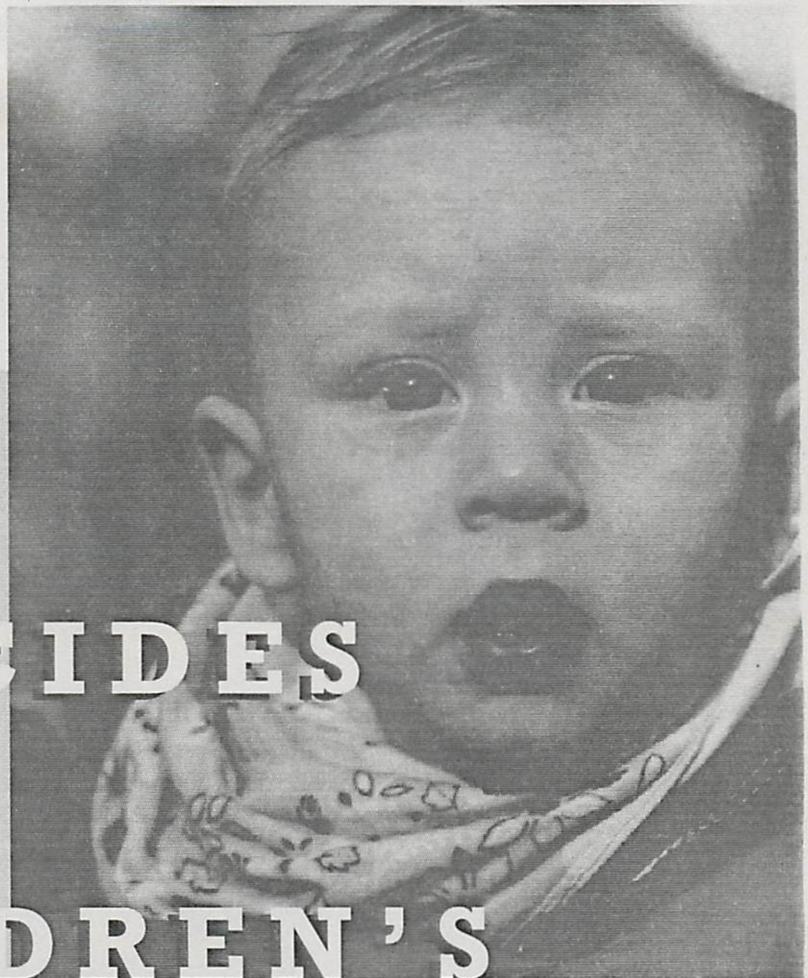

PESTICIDES IN CHILDREN'S FOOD

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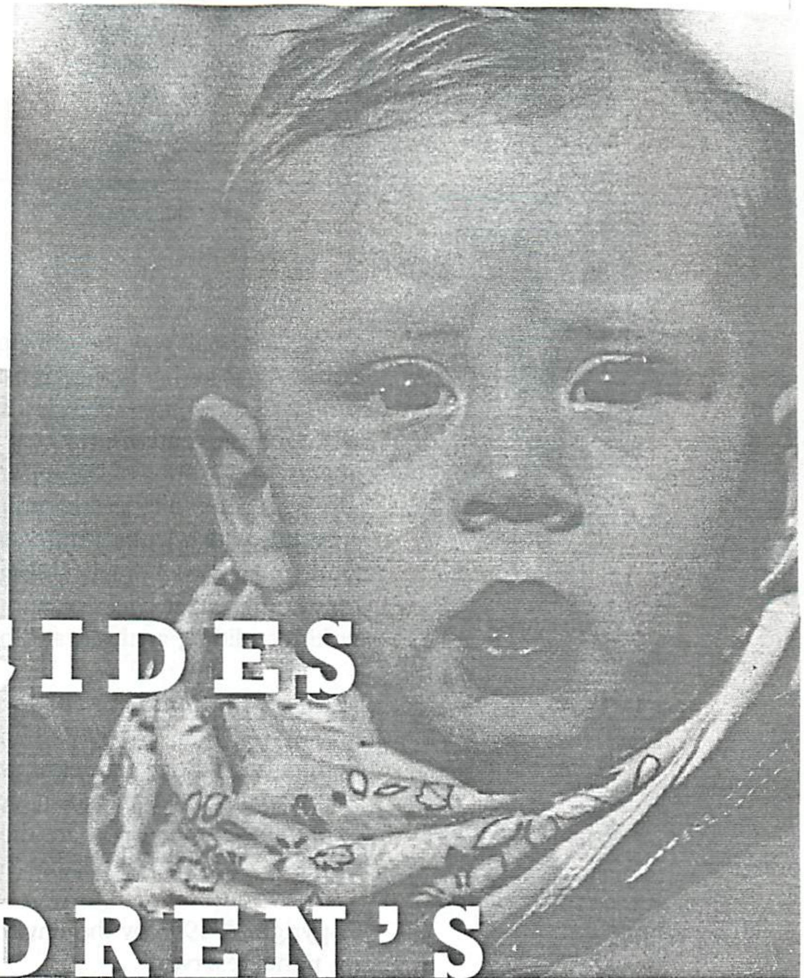

PESTICIDES IN CHILDREN'S FOOD

RICHARD WILES

CHRISTOPHER CAMPBELL

FOREWORD BY KENNETH A. COOK

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Environmental Working Group
Agricultural Pollution Prevention Project
1718 Connecticut Avenue, N.W., Suite 600
Washington, D.C. 20009
(202) 667-6982
FAX (202) 232-2592

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Foreword

Don't toss out those fresh strawberries, mom. Don't dump the lettuce, don't pitch the tomatoes, don't throw out the bananas, and don't pour that apple juice down the kitchen drain.

That is not the response that we want *to Pesticides in Children's Food* or that the report warrants. Throwing away food won't do anything to improve the safety of the foods that you, your family, and the rest of us eat. And any publicized purge in the nation's kitchens, of the sort that the Alar controversy inadvertently generated in 1989, will almost certainly work against efforts to make the food supply safer from pesticides. Food "scares" now admirably serve the interests of the *status quo* crowd in the food and pesticide industry. They are poised to package and parlay any display of mass parental anguish about pesticides as nothing more than unfounded outbursts of consumer hysteria. In truth, such episodes anger farmers to no good purpose. And once such a panic ends, calls for pesticide policy reform or food market adjustments somehow seem more futile, even unnecessary.

No, if you're concerned about pesticides in food, as this report shows you should be, an act of revenge at the refrigerator is not the answer. We recommend instead that consumers and voters take more effective actions—actions that will lead to lasting and eminently sensible measures to make fruits, vegetables, and other staples of the American diet even safer than they are now, especially for young children.

The authors of *Pesticides in Children's Food*, Richard Wiles and Christopher Campbell, make a persuasive case that the U.S. food supply does indeed need to be made safer by reducing or eliminating very worrisome risks that arise from low-level amounts of pesticides that pervade America's foods, in particular the foods that little kids eat most. They used the Freedom of Information Act to obtain 6,000 pages-worth of detailed, previously unpublished data from the Food and Drug Administration's program that monitors pesticides in food, for the years 1990 through 1992. They scanned more than 17,000 FDA records of food test results for pesticides into a computer database. They also compiled a database from another 4,500 records of pesticide residue data developed by a private-sector food testing program.

If you eat in this country, you eat pesticides.

They found that if you eat in this country, you eat pesticides. You eat small amounts of numerous pesticides, you quite likely eat them every day, and quite possibly in nearly every meal. (Even people on a strictly organic food regimen almost certainly ingest small amounts of the long-banned DDT, which still persists in soil and is absorbed by some crops.) As the report illustrates,

Just as supermarkets have slowly evolved to showcase healthful, fresh produce, so must they evolve the next turn and begin offering consumers a chance to shop our way to yet further risk reduction.

infants and young children are exposed to an especially heavy dose of pesticides by virtue of the types and amounts of foods they consume. It happens that a number of the pesticides Wiles and Campbell examined are categorized by the Environmental Protection Agency (EPA) as carcinogens. Using EPA's own methodologies and cancer potency estimates, the authors conclude that Americans encounter a disproportionately high share of their estimated lifetime cancer risk from pesticides in food very early in life.

Pesticides in Children's Foods recommends several measures to reduce that risk. First, the report argues for an emphasis on preventing risks, not simply managing an accumulation of such risks. That means risk assessment should be used to identify pesticides and other toxins to be phased out. Government research and assistance should be deployed to help find substitute processes or technologies. Pesticides that remain on the market or in the food supply should be subject to strict health-based standards. Such a concept, embodied in legislation introduced by Senator Edward Kennedy and Representative Henry Waxman, would go a long way toward protecting infants and children from the very types of risks identified in this study. The full powers of the executive and legislative branches will be needed to institute these and other policy reforms. But the authors also want to unleash an even more potent force for which America is famed.

I refer, of course, to shopping. We Americans now take for granted the lavish offerings of fresh fruits and vegetables that form the centerpiece of the very best grocery stores. Just as supermarkets have slowly evolved to showcase healthful, fresh produce, so must they evolve the next turn and begin offering consumers a chance to shop our way to yet further risk reduction. In the years ahead, consumers should find a proliferation of organic fruits and vegetables on supermarket shelves. We should also be given the choice to buy foods that have been certified as having no pesticide residues at the practical limits of detection.

Which brings us back to the point: What can mom and dad do? First, keep feeding your kids (and yourself) plenty of the fresh fruits and vegetables that form an essential part of every healthful, balanced diet. Second, ask your local grocer to stock organic foods, or foods certified as having "no detected" pesticide residues. When they stock it, buy it. They'll then stock more, just like they eventually learned to do with fresh produce; that will help keep them and their prices competitive. Finally, let the people who represent you in Washington know that you don't like pesticides on your food or in your drinking water—period—and that you expect them to do something about it.

If they suggest that perhaps you're being slightly hysterical, shop elsewhere.

Kenneth A. Cook
President
Environmental Working Group

Executive Summary

Analysis of government food consumption data and data from more than 20,000 samples of food that were tested for pesticides between 1990 and 1992 by the federal Food and Drug Administration (FDA) and private sector laboratories, shows that American infants and children are continuously exposed to a complex, low-level mix of pesticides in the foods they eat. Although the health effects of these exposures are not known, research has shown that exposure to low levels of other types of toxic chemicals can and do pose health threats to young children.

Consumption of fruits and vegetables is essential to a healthful and balanced diet for people of all ages, and increased consumption of those foods can be expected to improve human health overall. This report argues, however, that the safety of the American food supply can and should be further improved by policy reforms that will reduce or eliminate risks posed by pesticides in food, in particular those foods of special importance in the infant and child diet.

The analyses in this report are based on data obtained under the Freedom of Information Act (FOIA) from the FDA and the U.S. Department of Agriculture (USDA), combined with data from the retail food industry that were made available only recently to the public through the U.S. Environmental Protection Agency (EPA).

Findings

- Millions of children in the United States receive up to 35 percent of their entire lifetime dose of some carcinogenic pesticides by age 5. This pattern is most evident for pesticides used on foods heavily consumed in the first years of life, such as the fungicides captan (35% of lifetime risk by age 5) and benomyl (29%) and the insecticide dicofol (32%).

- Infants and children are routinely exposed to combinations of 2 or 3 (in rare cases as many as 8) pesticides per food. Our analysis of 4,500 samples of fruits and vegetables taken from supermarket warehouses from 1990 through 1992 found *2 or more pesticides* on 62 percent of orange samples, 44 percent of apples samples, and from one-quarter to one-third of cherry, peach, strawberry, celery, pear, and grape samples.

Our analysis of 14,595 samples of the same crops from the FDA confirmed these results. In addition, the FDA found 108 different pesticides in just 22 fruits and vegetables: 42 different pesticides were detected on tomatoes, 38 were detected on strawberries, and 34 were detected on apples.

- Despite findings of multiple pesticide

"When health risks from chemicals are evaluated, the special characteristics of infants and children must be recognized."

—Principles for Evaluating Health Risks from Chemicals During Infancy and Early Childhood: The Need for a Special Approach, World Health Organization, 1986

From birth through age 5, children bear a disproportionately heavy burden from pesticides in food and water. Yet, the Environmental Protection Agency has never set a tolerance for a pesticide in food specifically to protect infants and children.

exposures, the EPA, meanwhile, assesses the health risks from pesticides as though people are exposed to them one at a time. The special sensitivities of young children to chemical mixtures are likewise not examined.

• By the average child's first birthday, the combined cancer risk from just 8 pesticides on 20 foods *exceeds the EPA's lifetime level of acceptable risk* of one-in-one-million additional cancers throughout the U.S. population.[2] Lifetime risks from these same pesticides and foods is slightly more than 10 times the one-in one-million standard. These estimates were derived using the EPA's standard risk assessment methods. No adjustments were made for the potential sensitivities of children.

Further, our risk estimates use average food consumption values for each child in the population. We assume that all one-year-olds eat an average amount of grapes, all two-year-olds eat an average amount of oranges, and so forth. Children who eat any or all of these 20 foods at levels consistently above the age group mean may be at higher risk. The EPA has classified about 70 pesticides used on food as carcinogenic.

These risk assessment calculations also exclude pesticide exposures from milk and water. Residues of carcinogenic herbicides are routinely encountered in Midwestern drinking water (which may be used to mix infant formula and juice at home). Residues are found in other liquids consumed in large quantities by infants and children, such as milk, which is likely to contain low-level residues of cancer-causing pesticides used on dairy cattle feed (*EPA 1990a*).

• Millions of children drink water from Midwestern rivers and reservoirs that are contaminated with carcinogenic herbicides. At typical contamination levels, by age 6 these children will have accumulated about 10 times the EPA's lifetime benchmark of acceptable lifetime cancer risk of one additional cancer per one million people.

• The FDA seriously under-reports pesticide residues in the food supply. From 80 to 100 percent of residue analysis at 5 of 12 FDA regional laboratories were not capable of finding 80 percent of pesticides used in agriculture today. Some of the most toxic and widely used pesticides require special methods to be detected in food. From 1990 through 1992, not one FDA laboratory used a sufficient number of these tests to quantify the overall presence of these pesticides in food.

Recommendations

•The Administration should adopt a targeted pesticide risk reduction strategy that will gradually but completely phase out pesticides that present the greatest hazards to children. This phase-out should include, at a minimum, all pesticides classified by the EPA as known, probable, or possible human carcinogens, and any non-carcinogenic pesticides for which no threshold of toxicity has been identified. As an integral part of this strategy, USDA should spearhead an accelerated program of research and technical assistance to agricultural producers to help them develop alternatives pest control practices for high-risk pesticide/crop systems.

•Reform legislation, introduced by Senator Edward Kennedy (D-MA) and Representative Henry Waxman (D-CA), seeks to establish a strict health-based standard for pesticide residues in food. A strict standard is needed to protect infants and children against the types of risks identified in this report.

Several steps need to be taken to expand consumer access and farmer markets for foods that are produced with fewer pesticides and that contain no pesticide residues.

•USDA should expedite the promulgation of national standards for organically grown foods as authorized in the 1990 Farm Bill.

•The federal government should establish a voluntary "no-detected" or "ultra low" standard for pesticide residues in food. Under such a program, farmers who maintain records of pesticide usage, and who certify that all pesticide residues are below the practical limit of detection, would be able to make a "no-detected residue" or "ultra low residue" claim in the marketplace for foods so grown. Certification of these claims should be conducted in accordance with FDA approved sampling and residue detection methods, and all certifying labs should be accredited by the FDA.

•The FDA must improve and standardize pesticide testing procedures for food across all of its regional laboratories.

Introduction

This report describes the magnitude of exposure early in life to pesticides and to mixtures of pesticides commonly found in foods eaten by young children. The purposes of this study are to:

- Describe, with the best available data, the rates and types of foods consumed in the first years of life.

- Illustrate the actual levels of pesticides on foods consumed at high rates per unit of body weight by infants and young children in the United States.

- Estimate the risks that these pesticides present to infants and children using EPA's existing methodologies.

- Recommend policy changes that will most efficiently protect infants and children from pesticides in their diets.

Background

Each year in the United States about 2.2 billion pounds of pesticides are used in agriculture, in the food distribution system, and in forestry. Pesticides are used to treat water, control home and garden pests, and to preserve wood. About 900 million pounds are applied each year in agriculture alone (*Rosenfeld 1993*). One consequence of this widespread dispersal of pesticides is that virtually all Americans have some trace level of pesticides in their body fat, and everyone in the United States is exposed to pesticide residues in food.

For the majority of young children, exposure to pesticides begins in the womb and continues through breast feeding. Virtually all breast milk in the United States is contaminated with DDT and its breakdown products DDE and DDD, as well as other pesticides such as chlordane, heptachlor, and lindane—pesticides that have been banned for many years, yet remain in the environment and in the food chain (*Jensen and Slorach 1991*). The breast milk of many American women has higher levels of DDT than allowed by the FDA in cows' milk. Cows' milk so contaminated would be seized as adulterated and banned from interstate commerce (*Lambert 1992*).

It is generally understood that children eat more food relative to their size than adults. This higher food consumption per unit of body weight leads to relatively elevated exposures to any contaminant found in food, including pesticides. The precise magnitude of these exposures, and their implications for public policies, however, have yet to be thoroughly examined.

The EPA is responsible for setting legally binding pesticide tolerances—in principle, "maximum safe levels"—for each

"Studies in animals have clearly demonstrated that age of initial exposure to a chemical carcinogen has direct bearing on the carcinogenic response, and the same has been shown to be true for humans."

—Earnest E. McConnell, Comparative Responses in Carcinogenesis Bioassays as a Function of Age at First Exposure, Similarities and Differences Between Children and Adults: Implications for Risk Assessment, ILSI Press pesticide on each food in the U.S. food supply (*see sidebar on setting tolerances*). The FDA enforces these tolerances through its pesticide monitoring program.

In determining safe exposure levels to pesticides in food, the EPA uses food consumption data from a 1977-1978 nationwide survey of 30,000 individuals conducted by the USDA. A basic issue addressed in this report involves the EPA's use of these data. For pesticides to which the population is exposed over a lifetime, and particularly for carcinogens, the EPA assumes, when setting tolerances, that people consume average amounts of 300 foods derived from this sample of 30,000 individuals.

Virtually all breast milk in the United States is contaminated with DDT and its breakdown products DDE and DDD.

EPA's calculation assumes that exposure to pesticides in food occurs evenly throughout a lifetime. A simple investigation of the USDA data, however, reveals that on a per-body-weight basis, exposure is far higher in the first years of life. From a toxicological perspective, using average food consumption estimates assumes that only lifetime dosage produces the chronic effect. Higher than average exposures to pesticides, sensitive phases of human development, exposure to carcinogens early in life, or any combination of such factors are presumed irrelevant to lifetime risk in EPA's assessment methodology.

The EPA tolerance setting process would more realistically reflect risk if explicit adjustments were made for the high dietary exposure and potential sensitivities of young children. Lifetime risks would likely appear higher, and the amounts of pesticides allowed in food would likely be lower, if early childhood exposure and sensitivity were taken into account.

The amounts of pesticides allowed in food would likely be lower if early childhood exposure and sensitivity were taken into account.

The EPA evaluates the safety of dietary exposure to pesticides by totaling the average exposures (average food consumption multiplied by an average pesticide residue level) from all the foods that the pesticide is used on, and then comparing the total food exposure to a reference dose (RfD)[1] or a benchmark of acceptable cancer risk.[2]

This estimate of safety is at best only partial. It applies to the pesticide active ingredient in food. The toxicity of so-called "inert" ingredients, with which pesticide "active" ingredients commonly are formulated, is not evaluated.[3] Exposure to other pesticides that cause similar effects also is not considered, and exposure to the *same pesticide* from other sources—structural, agricultural, or lawn and garden applications—is similarly ignored.

Even drinking water contaminated with the same pesticide is not routinely included in the *dietary* estimate of risk from that pesticide.[4] Nor as a rule are special allowances made for children's higher exposures or potential sensitivities (*Babich 1981, Krewski 1991, U.S. Congress 1991*).

Children and toxins

Infants and young children are generally considered more sensitive than adults to toxins, including pesticides (*WHO 1986, EPA 1990c, Lambert 1992, Kimmel 1992, Gray 1992, NRC 1993, NRC 1989, NRC 1988*).[5] At the same time, there is enormous uncertainty about the precise long-term effects of the scores of pesticides routinely found in the diets of infants and children. This uncertainty is primarily because of the unique complexities of infant physiology, the failure to test for the long-term effects of pesticide exposure in neonatal or infant-equivalent animals, the fact that many toxic end-points are not studied at all, and because the toxic effects of pesticide and "inert" ingredient formulations, and mixtures of different pesticides in the diet, are unknown (*Kacew 1992, Kimmel 1992, Gray 1992, NRC 1988, NRC 1989, Snodgrass 1992*).

Some Substances to Which Children are More Sensitive than Adults

Aspirin
Use has been linked with Reye's syndrome, almost always in children or teenagers with a fever, especially with chickenpox or the flu. Up to 80% of people with Reye's syndrome die (*U.S. Pharmacopeial Convention 1993*).

Hexachlorobenzene
Hexachlorobenzene-contaminated bread in Turkey caused blistered, scarred, and unusually dark skin, excessive body hair, arthritis, liver enlargement, and other abnormalities. Nearly all (90%) of the victims were children under 16. Exposed children showed skin, nervous system, and other symptoms 25 years later (*Peters 1992*).

Hexachlorophene
Hexachlorophene-contaminated talcum powder resulted in neurological damage and death to children in France although it caused no apparent toxicity in adults (*Kacew 1992*).

Lead
Children are so sensitive to lead and its effects on their IQ and nervous system that EPA cannot set a "threshold" level below the point where lead does not cause an effect. The level of lead in the blood affects the central nervous system is at least four times lower in children than in adults (*Doull 1991*).

Mercury
Mercury-induced "pink disease" affects only some infants and young children. Symptoms include skin rashes, swelling, chills, irritability, sleeplessness, and profuse perspiration (*Britt 1978, Friberg 1986*).

Nitrate
Infants are particularly susceptible to poisoning from nitrate, which affects the ability of infants' blood to carry oxygen. "Blue-baby syndrome," and even death, can result (*Doull 1991*).

Phenobarbital
Used to treat seizures, phenobarbital can interfere with learning and the development of higher mental functions, particularly in children (*Spielberg1992*).

Radiation
Children exposed to radiation from atomic bomb blasts in Hiroshima and Nagasaki Japan developed higher rates of certain cancers than exposed adults (*Merke 1992*).

Tetracycline
This commonly used antibiotic can cause permanent discoloration of teeth, weakened tooth enamel, and decreased growth of bones in infants and children under 8 years of age (*U.S. Phamacopeial Convention 1993*).

Tobacco Smoke
Young children are more susceptible to the adverse effects of passive exposure to tobacco smoke than older children and adults. Health effects include increased rates of lower respiratory tract infections, bronchitis, pneumonia, and asthma (*U.S. Surgeon General 1986, EPA 1992*).

Setting Food Tolerances for Pesticides

Pesticides are governed by two laws: The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), and the Federal Food Drug, and Cosmetic Act (FFDCA). Under FIFRA, pesticides receive registrations and legally binding label instructions governing their use. Under FFDCA, the Environmental Protection Agency (EPA) establishes acceptable levels of pesticide residues in food, called tolerances. Before a pesticide can be registered for use on a food crop under FIFRA, it must have a tolerance under FFDCA for the residues it will leave in or on that food.

A tolerance is the maximum residue of a pesticide allowed on a food in interstate commerce. Tolerances are established under sections 408 and 409 of FFDCA. Tolerances are designed to protect the public health, and represent, in theory, levels of exposure to pesticide residues in food that are deemed safe if consumed over a lifetime. Crops with residues over the tolerance are illegal, and deemed unsafe and adulterated under the FFDCA (*NRC 1987*).

Section 408 of FFDCA establishes tolerances for raw food; section 409 establishes tolerances for food additives in processed foods. Pesticides are considered food additives and are governed by section 409 only when they concentrate during processing.

The FFDCA is essentially a health based statute. For raw food, section 408 requires that tolerances be set "to the extent necessary to protect the public health..." taking into consideration factors including "the necessity for the production of an adequate, wholesome, and economical food supply; the other ways in which a consumer may be affected by the same pesticides...and the usefulness of said pesticide" {21 USC S 346 (b) (1984)}. Section 409, which applies only to pesticide residues that concentrate in processed food, applies a tougher general safety standard that requires the sponsor of a pesticide to prove with "reasonable certainty that no harm" will result from pesticide residues at the tolerance level.

Section 409 is further strengthened by the Delaney clause, which states that "no food additive (in this case a concentrating pesticide residue in processed food) shall be deemed safe if it is found to induce cancer when ingested by man or animal, or if it is found, after tests which are appropriate for the evaluation of the safety of food additives, to induce cancer in man or animal" {21 USC S 2348 (c) (3) (A) (1984)}. When pesticide residues do not concentrate in processing, no 409 tolerance is required, and the section 408 tolerance applies.

Tolerances for non-carcinogens

For pesticides that do not cause tumors in animal studies, the EPA estimates a daily dose that is deemed safe over a lifetime. Formerly called the acceptable daily intake (ADI), this dose level is now termed the reference dose (RFD). The RFD is based on the dose level in animal studies that produces no observable adverse effects in the most-sensitive test species. The RFD is set by applying a 100-fold safety factor to this no observable adverse effect level. The-100 fold safety factor is based on the assumptions that humans are 10 times more sensitive to toxicants than test animals, and that there is a 10-fold variation in sensitivity within the human species. When adverse effects are observed at all dose levels, the EPA will typically apply a 1,000-fold safety factor to the lowest dose at which effects were observed.

Tolerances are based on two factors. First, pesticide manufacturers determine the maximum residue likely to result from the highest proposed application rate for the pesticide that is needed for pest control. Second, this residue level is converted to a dietary exposure estimate, and the total of all food crop exposures is compared to the RFD. In theory total food crop exposures at the tolerance levels should not exceed the RFD.

Tolerances for carcinogens

For pesticides that cause cancer in laboratory animals, regulators assume that no dose is completely absent of risk. Thus, for carcinogens, RFDs are not calculated and safety factors are not employed. Rather, a mathematical estimate of risk is developed based on the potency of the carcinogen and human exposure to it. Pesticide tolerances are generally set at exposure levels that would lead to no greater than a one-in-one-million risk from a carcinogen over a lifetime of exposure (*see sidebar "Cancer Risk Assessment," page 39*).

There are many examples of increased infant and child sensitivity to toxic substances (*see sidebar on previous page*). In all of these cases, increased infant and child sensitivity was discovered after the injury and harm had occurred. It is beyond the scope of this report to review the large and growing body of scientific literature that would permit a conclusion regarding increased infant sensitivity to pesticides compared to adults. We present these examples in order to put in perspective the potential risk pesticides may pose to young children.

Estimating exposure and risks

For most toxins, human exposure is highly variable from one situation to the next. To compensate for this variability, exposure models are designed to reflect the drastically different exposure situations encountered in the real world. For example, models that predict exposure to contaminants in drinking water wells can be tailored to the specific geology and hydrology of the location and the pollutants in question. Tocix air pollution models make similar adjustments.

In the case of, for example, benzene, a common organic compound, it is not only the potency of the substance but the different levels of susceptibility and exposure to it that ultimately determine an individual's risk of getting cancer from benzene. A person who lives next to an oil refinery has a much higher exposure to and risk from benzene than the average suburban child.

Exposure to pesticide residues in food is based on two factors: The level of residue in or on foods and the amount of food eaten. People eat vastly different diets, and farmers use varying amounts of many different pesticides to grow crops. However, when assessing chronic exposure to pesticide residues in food, the EPA has yet to adjust a single tolerance to accommodate the extremely variable dietary patterns within the U.S. population of 250 million people. Nor does EPA account for simultaneous exposure to the scores of different pesticides routinely found in food.

EPA's assumptions

EPA makes the following assumptions when estimating cancer risk from pesticide exposure in the diet:

- Everyone in the entire population eats the same average diet.[6]

- People are exposed to one pesticide at a time in the diet and exposure to multiple residues in food is of no toxicological significance.

- People are only exposed to pesticides in food and other routes of exposure to the same pesticides—such as from applications in the home, garden, or workplace, or by consuming drinking water—do not occur or are not significant.

- Pesticide residues are evenly distributed on crops and throughout the food supply and regional variations in pesticide exposure do not exist or are not important.

Organization of this report

Chapter 1 describes what children eat through age five, focusing on fruits and vegetables heavily consumed in those years as a percentage of the diet and in comparison to the national average.

Chapter 2 takes a new look at pesticide residues in the food supply. It describes the methods and data sources that form the foundation of this report and includes an analysis of our principal pesticide residue data sets. It also reveals problems with FDA's pesticide monitoring program that result in underreporting of the prevalance of pesticides in the food supply.

Chapter 3 analyzes pesticides typically found in foods of special importance in the diets of infants and children. It examines multiple residues on single foods, multiple carcinogens on single foods, and multiple residues on a range of foods across the diet.

Chapter 4 estimates cancer risks accumulated in the first five years of life from these multiple exposures to carcinogens in 20 fruits and vegetables. We also analyze early childhood exposure and risk from a mixture of commonly detected carcinogenic herbicides in Midwestern drinking water.

Chapter 5 presents our findings, conclusions, and recommendations.

End Notes

[1] The reference dose (RfD), previously called the Acceptable Daily Intake or ADI, is the daily dose for non-carcinogenic pesticides that is presumed to present no unreasonable risks if consumed over a lifetime. It is calculated by applying a 100-fold safety factor to the dose level in animal studies that produces no observable adverse effects. If adverse effects are observed at all doses, the EPA generally calculates an RfD by applying a 1,000-fold safety factor to the lowest dose that produced an adverse effect.

[2] For dietary risks faced by the entire U.S. population, regulatory agencies (the EPA and the FDA) have used a standard of one additional cancer case per one million people as the standard of acceptable risk.

[3] Toxicity studies, risk assessments, and food tolerances apply only to pesticide active ingredients. Many pesticide products, however, consist predominantly of inert ingredients, chemical mixtures whose composition is protected as a trade secret by the federal law. For example, inert ingredients comprise from 25 to 85 percent of the volume of the two most widely used pesticides in the country—the herbicides alachlor and atrazine (*Arden 1991, Cox 1992*). While product formulations remain a closely guarded secret, many currently used inert ingredients are known to be quite toxic, including xylene, toluene, vinyl chloride, ethyl benzene, and methylene chloride (*Arden 1991*). For the vast majority of inert ingredients, however, the EPA knows virtually nothing. In 1991, EPA released a list of 1,820 chemicals used as inert ingredients. Other than a review of the literature for about 500 of these compounds, the EPA has taken no action on the 1,450 inert ingredients for which the agency has no toxicity data.

[4] The regulatory risk assessments for the pesticides alachlor and aldicarb are the best examples.

[5] Sensitivity can be a function of two factors acting separately or jointly: A child's increased absorption and retention of a given amount of a toxin, or the increased susceptibility to the adverse effects of a given dose of a toxin, or both. Increased susceptibility to a given dose can be a function of many developmental and physiological factors.

[6] Examples of EPA regulatory decisions where population average food consumption estimates have been used include widely used compounds such as the fungicides benomyl and captan, or the herbicides alachlor and atrazine. More recently, the EPA has calculated risk and exposure to pesticides through the first six years of life; they have yet to act to reduce exposure, however, on the basis of these calculations.

What Young Children Eat

If, as the saying goes, you are what you eat, then American children under five years old are a breed apart. They eat more per unit of body weight than adults, and for their size, they eat many foods in relatively large amounts. Children ages one through five, for example, eat from 3 to 4 times more per unit of body weight than the average American (figure 1). As the next chapter will show, by virtue of these consumption patterns, young children are exposed to higher rates of pesticides in food than the average person in the population.

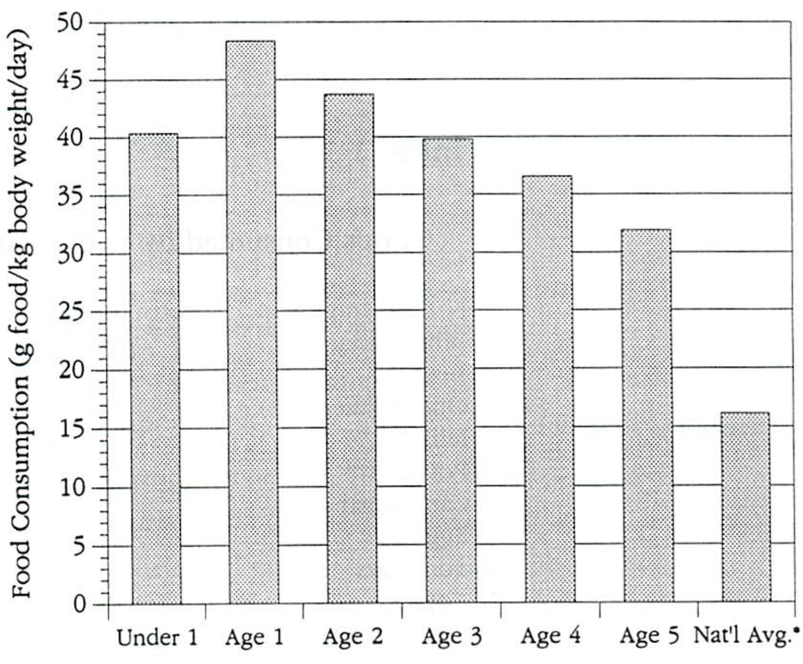
Traditionally, the EPA has made no adjustments for this high consumption when setting food tolerances for pesticides. This failure to factor early childhood exposure raises serious concerns that current pesticide tolerances may not adequately protect human health.

Food consumption data

In order to estimate exposure to pesticide residues in the infant and child diet, we used food consumption data from the U.S. Department of Agriculture (USDA) for 1977-1978 and 1985-1986. Food consumption estimates for one through five-year-olds were derived from the *1985-1986 Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals*. Average food consumption values were used for each

Figure 1

Food Consumption for Young Children per Unit of Body Weight**



* National Average, in this chart and others, represents the average for the entire sample of the respective surveys for the value in reference.
** Food consumption excludes drinking water.

Sources: 1977-78 USDA National Food Consumption Survey. 1985-86 UDSA Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Children 1-5 years.

year of age (for example, average one-year-old orange consumption, average two-year-old banana consumption, and so forth.) Data for children under one year, however, were not reported in the 1985-1986 survey. Food consumption values for children under one are derived from data on non-nursing infants in the *1977-1978 National Food Consumption Survey.* Again, mean food consumption values were used. The national average food consumption data used in this report are from the 1977-1978 USDA survey. As described above, the EPA typically uses national average food consumption values from the 1977-1978 survey in assessing dietary pesticide exposure and risk.

Young children are exposed to higher rates of pesticides in food than the average person in the U.S. population.

The USDA attempted to update the 1977-1978 food consumption survey with a subsequent *National Food Consumption Survey* in 1987-1988. The 1987-1988 effort, however, had several limitations. The original sample size was only half that of the 1977-1978 study design. Response rates also were quite low and inconsistent, compromising the statistical validity of the results. The EPA has since rejected the study, and does not employ it for regulatory analyses. These later data also were not used in this report.

Similarly, a 1991 U.S. General Accounting Office audit of the 1977-1978 USDA survey data set faulted the small sample sizes of some population subgroups, including nursing infants (*GAO 1991*). Food consumption data for these subgroups were not used in this study.

A common criticism of both the 1977-1978 and 1985-1986 data is that they are old and may not accurately reflect

Table 1

Foods Consumed by Young Children From Birth through Age 5

Natl. Average Top 15 Foods †	< 1 yr	Age 1	Age 2	Age 3	Age 4	Age 5
Wheat flour	X	X	X	X	X	X
Beef *	X	X	X	X	X	X
Orange juice	X	X	X	X	X	X
Milk**	X	X	X	X	X	X
Potatoes***		X	X	X	X	X
Cane sugar	X	X	X	X	X	X
Eggs		X	X	X	X	X
Tomatoes		X	X	X	X	X
Apples	X	X	X	X	X	X
Pork					X	X
Chicken		X	X	X	X	X
Beet sugar		X	X	X	X	X
Soybean oil	X	X	X	X	X	X
Corn				X	X	
Bananas	X	X	X	X	X	X
Total Foods	8	13	13	14	15	14

* Beef is a combination of Beef-lean and Beef-fat
** Milk is a combination of Milk-non-fat solids, Milk-fat solids, and Milk-sugar
*** Potatoes are a combination of Potato-pulp, Potato-whole, and Potato-skin

† Sources: 1977-78 USDA National Food Consumption Survey. 1985-86 USDA Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Children 1-5.

current food consumption patterns. Consumption patterns do evolve over time, sometimes as a result of national policies directed at improving nutrition. According to the USDA, average per capita consumption has risen substantially or remained stable for nearly all fruits and vegetables heavily consumed by young children (*see appendix figure 12*). In some cases, the per capita increase was dramatic. For example, per capita strawberry consumption increased 70 percent from 1978 to 1991. Hoping to accelerate this trend, the USDA has embarked on a campaign to further increase consumption of fruits and vegetables—a campaign that we heartily endorse.

The infant and toddler diet (0 - 24 months)

There are many striking aspects of the infant and child diet. Newborn babies are completely dependent on infant formula or breast milk for survival. Any contaminants contained in this lone food source, particularly in breast milk lipids or in the water mixed with infant formula, will be received by the neonate in extraordinarily high doses per unit of body weight.

Babies have diets very different from adults. Prior to the first birthday, only 8 of the 15 most-consumed foods in the infant diet are also in the 15 most-consumed foods for the population as a whole (table 1).

Milk comprises nearly one-quarter of the non-nursing infant diet. Apples, apple juice, peaches, pears, and bananas are consumed per unit of body weight at from 5 to 15 times the national average.

After the first birthday, however, the average child's diet begins to resemble that of his or her parents, although the foods consumed in highest volume remain different. From the first through the second birthday, the foods in common rise to 13 out of 15. By the fifth birthday the top 15 foods in the child diet are essentially the same as those for the overall population.

Table 2

Foods Eaten by Infants Under One Year of Age at More Than Two Times the National Average and Greater Than 1% of their Diet

(Ranked by Multiple of the National Average)

Rank	Food	Multiple of the Natl. Avg.†	Percentage of Diet
1	Coconut oil	39.6	2.5%
2	Apple juice	15.1	8.3%
3	Pears-fresh	12.4	3.8%
4	Peaches-fresh	8.7	4.6%
5	Oats	8.3	1.7%
6	Carrots	8.0	3.4%
7	Rice	7.5	2.9%
8	Milk**	6.6	22.5%
9	Apples-fresh	6.2	7.0%
10	Bananas-fresh	4.5	2.5%
11	Corn sugar	4.2	1.0%
12	Green beans	3.7	1.8%
13	Soybean oil	3.5	2.8%
14	Peas	3.0	1.3%
15	Orange juice	2.3	6.1%
	Total		72.3%

† Based on consumption per unit of body weight
** Milk is a combination of Milk-non-fat solids, Milk-fat solids, and Milk-sugar

Source: 1977-78 USDA National Food Consumption Survey.

Consumption of specific foods

Infants and young children eat more per unit of body weight of almost every food when compared to the national average. One-year-olds, for instance, eat 69 foods at greater than twice the national average (by weight), and consume 24 foods at greater than 5 times the national average (*see appendix table 35*).

Eighty six percent of the one-year-old diet is comprised of foods eaten at a rate greater than two times the national

Table 3

Foods Eaten by One-Year-Olds at More Than Two Times the National Average and Greater Than 1% of their Diet

(Ranked by Multiple of the National Average)

Rank	Food	Multiple of the Natl. Avg.†	Percentage of Diet
1	Apple juice	21.5	9.9%
2	Grape juice	11.1	2.1%
3	Oats	7.5	1.3%
4	Bananas-fresh	7.4	3.4%
5	Milk**	4.2	12.0%
6	Apples-fresh	4.5	4.2%
7	Orange juice	4.5	10.1%
8	Pears-fresh	4.2	1.1%
9	Wheat-rough	3.7	1.1%
10	Peaches-fresh	2.9	1.3%
11	Carrots	2.9	1.1%
12	Beet sugar	2.9	2.0%
13	Cane sugar	2.7	4.2%
14	Eggs-whole	2.7	3.2%
15	Wheat flour	2.6	6.8%
16	Tomatoes-whole	2.3	2.4%
17	Soybean oil	2.1	1.4%
18	Potatoes***	2.0	4.7%
	Total		70.9%

† Based on consumption per unit of body weight
** Milk is a combination of Milk-non-fat solids, Milk-fat solids, and Milk-sugar
*** Potatoes are a combination of Potato-pulp, Potato-whole, and Potato-skin

Sources: 1977-78 USDA National Food Consumption Survey. 1985-86 USDA Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Children 1-5.

average (*see appendix table 35*). Some of those foods, such as wheat germ and cottonseed meal, comprise an insignificant portion of the diet. Most foods consumed in amounts far above the national average (on a g/kg body weight basis), however, comprise a substantial portion of the diet. These foods include milk, juices, and many fruits and vegetables (tables 2 and 3). Seventy two percent of the infant diet and 71 percent of the average one-year-old diet is made up of foods eaten at rates greater than two times the national average and greater than one percent of their diet.

The average one-year-old drinks 21 times more apple juice, 11 times more grape juice, and nearly 5 times more orange juice per unit of body weight than the average American. Grapes, bananas, peanuts, apples, pears, broccoli, strawberries, carrots, tomatoes, potatoes, and peaches are all consumed in substantial amounts by young children, and per unit of body weight, at levels from 2.0 to 7.5 times greater than the national mean.

Above average consumption

It is important to note that age group average food consumption estimates were used in this report. In all likelihood no child eats the "average" amount of any of these fruits or vegetables. Subgroups of young children may well consistently eat greater than the average amount of many of these crops. Children in some such subgroups will likely be exposed to pesticides in food more than the average child. It follows that pesticide-related risks will accumulate more rapidly for these children than this study estimates.

The annual consumption estimates for the average two-year-old of the fruits and vegetables analyzed in this report are presented in table 4.

Table 4

Pounds of Selected Fruits and Vegetables Eaten by the Average Two Year Old per Year*

Food	Lbs Consumed per Year
Potatoes	23.5
Apples	16.4
Bananas	13.4
Tomatoes	9.5
Oranges	7.2
Grapes	6.1
Carrots	3.9
Peaches	3.8
Peas	3.5
Green Beans	3.4
Broccoli	1.9
Strawberries	1.9
Cherries	1.7
Pears	1.7
Lettuce	1.3
Cantaloupes	0.9
Celery	0.7
Blueberries	0.5
Spinach	0.4
Cauliflower	0.2
Blackberries	0.1
Raspberries	0.1

*Consumption based on 30-lb two-year old

Source: 1985-86 USDA Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Children 1-5.

Pesticide Residues in the Food Supply: A New Look

This chapter examines the quality of available data on pesticides in foods that children eat in large amounts in relation to their size. Our analysis focuses on the Food and Drug Administration (FDA) pesticide monitoring program and data on pesticides in fruits and vegetables collected from supermarket warehouses and tested by private-sector labs. We compare the thoroughness of these respective programs and analyze the differences in lab performance among 12 FDA regional pesticide monitoring laboratories. The results reveal dramatic disparity in the thoroughness of FDA labs, and an across the board failure of the FDA to adequately test for many carcinogenic fungicides widely present in foods heavily consumed by children. Data from both the FDA and private sector labs are from 1990 through 1992.

Pesticide residue data

Historically, the principal source of pesticide residue data in food has been the pesticide monitoring program of the Food and Drug Administration (FDA). These data, however, have never been made available in detail to the public in a readily analyzable form. To gain a better understanding of pesticide residues in the infant and child diet, the Environmental Working Group requested three years of FDA pesticide monitoring data in electronic form under the Freedom of Information Act. Our request for data in electronic form was denied. The FDA did, however, release these data in printed form, comprising more than 6,000 pages, covering all pesticide monitoring results for both imported and domestic food for 1990 through 1992. To render these data useful, more than 1,700 pages of data were scanned from hard copy into electronic form for 22 crops heavily consumed by infants and children. These data, derived from more than 17,000 individual food samples, form the basis of the FDA analysis presented in this report.

The FDA pesticide residue monitoring program has many limitations (*see sidebar*). Because of these shortcomings, the agency typically understates the prevalence, levels, and multiplicity of pesticides in the diet. Compounding these flaws is the fact that residue results are not consistent from one FDA lab to another. Some FDA labs have better equipment and more money for pesticide residue monitoring than others. All FDA regional labs have considerable latitude in sampling and residue detection strategies (*GAO 1986a*).

Discrepancies among FDA labs

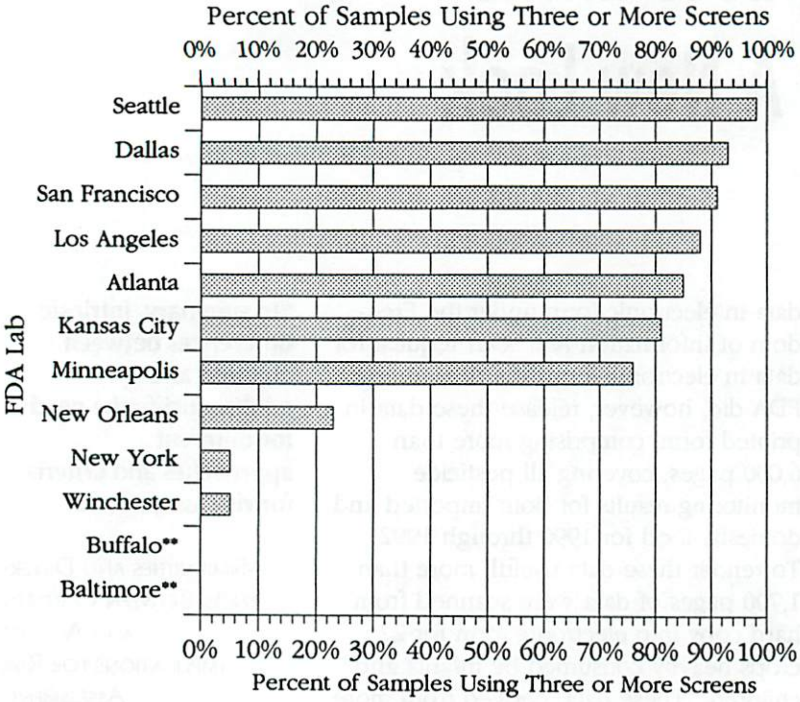
The basic multi-residue pesticide detection method used by most FDA labs is

"In summary, intrinsic differences between children and adults...justify the need for different approaches and criteria for risk assessment."

—Similarities and Differences Between Children and Adults: Implications for Risk Assessment, Conference Overview, ILSI Press, 1992

Figure 2

Percentage of Samples at FDA Labs Tested With Three or More Different Pesticide Detection Screens*



* Samples analyzed include the following 22 foods: Apples, Bananas, Blackberries, Blueberries, Broccoli, Cantaloupes, Carrots, Cauliflower, Celery, Cherries, Grapes, Green Beans, Lettuce, Oranges, Peas, Peaches, Pears, Potatoes, Spinach, Strawberries, Raspberries, and Tomatoes.

** All samples of the 22 foods analyzed were conducted with 2 or fewer screens.

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

the Luke extraction method. When operated using all available detection methods and screens, the Luke extraction method can be used to detect more than 300 different pesticides.[1] Not all FDA labs, however, use every method and screen. Use of fewer methods and screens severely limits the number of pesticides that can be found, potentially under-representing the actual residues present in food.

To determine the variability in FDA lab capacity, and the quality of their results, we analyzed the number of detection screens used per sample for 17,215 individual samples from 12 regional FDA labs. This analysis revealed a dramatic division between labs that used two or fewer detection screens on the vast majority of samples (from 76 to 100 percent), and those who used three or more screens on at least three-quarters of their samples (figure 2).

A comparison of the two lab groups revealed, not too surprisingly, that the frequency of pesticide detections was dramatically influenced by the number of screens employed. The seven labs using three or more screens on 80 to 100 percent of samples found pesticides in a far higher percentage of every food. Those seven most-rigorous FDA labs reported twice the percentage of samples with detectable residues of one or more pesticides in apples, pears, bananas, tomatoes, and green beans (figure 3).

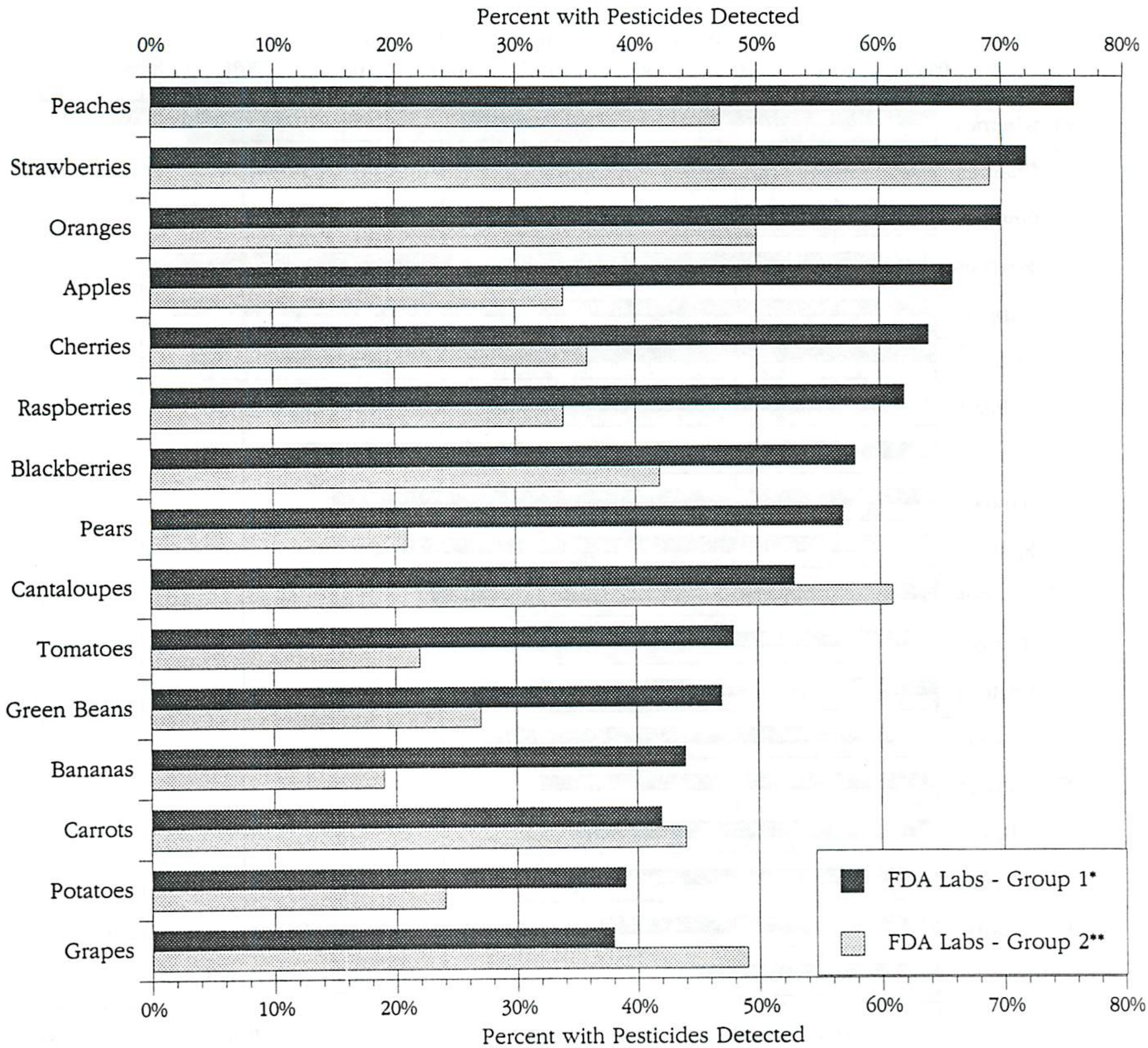
The conclusion from this analysis is straightforward: Labs that fail to look for residues fail to find residues. There is no other compelling reason to explain why the labs using fewer screens have such consistently low pesticide detection rates. It is particularly unlikely that the discrepancy is caused by regional differences in pesticide use. All labs with low detection rates are located in the northeastern, mid-Atlantic, or the deep southern regions of the United States. These areas are characterized by relatively high pesticide use on the fruits and vegetables we analyzed. If pesticide use were the driving factor, one would expect labs in those regions to have the higher pesticide detection rates among FDA labs.

Data from labs using an insufficient number of multi-residue screens were eliminated from our analysis. For the seven labs that generated the data analyzed in this report, all reported data were used, including all samples where

Figure 3

Percent of Food Samples with Pesticides Detected

Differences Among FDA Labs, 1990-1992



* FDA Group 1 Labs using 3 or more pesticide detection screens on at least 75% of samples tested. These regional labs are: Atlanta Regional Lab, Seattle, San Francisco, Minneapolis, Los Angeles, Kansas City, and Dallas.

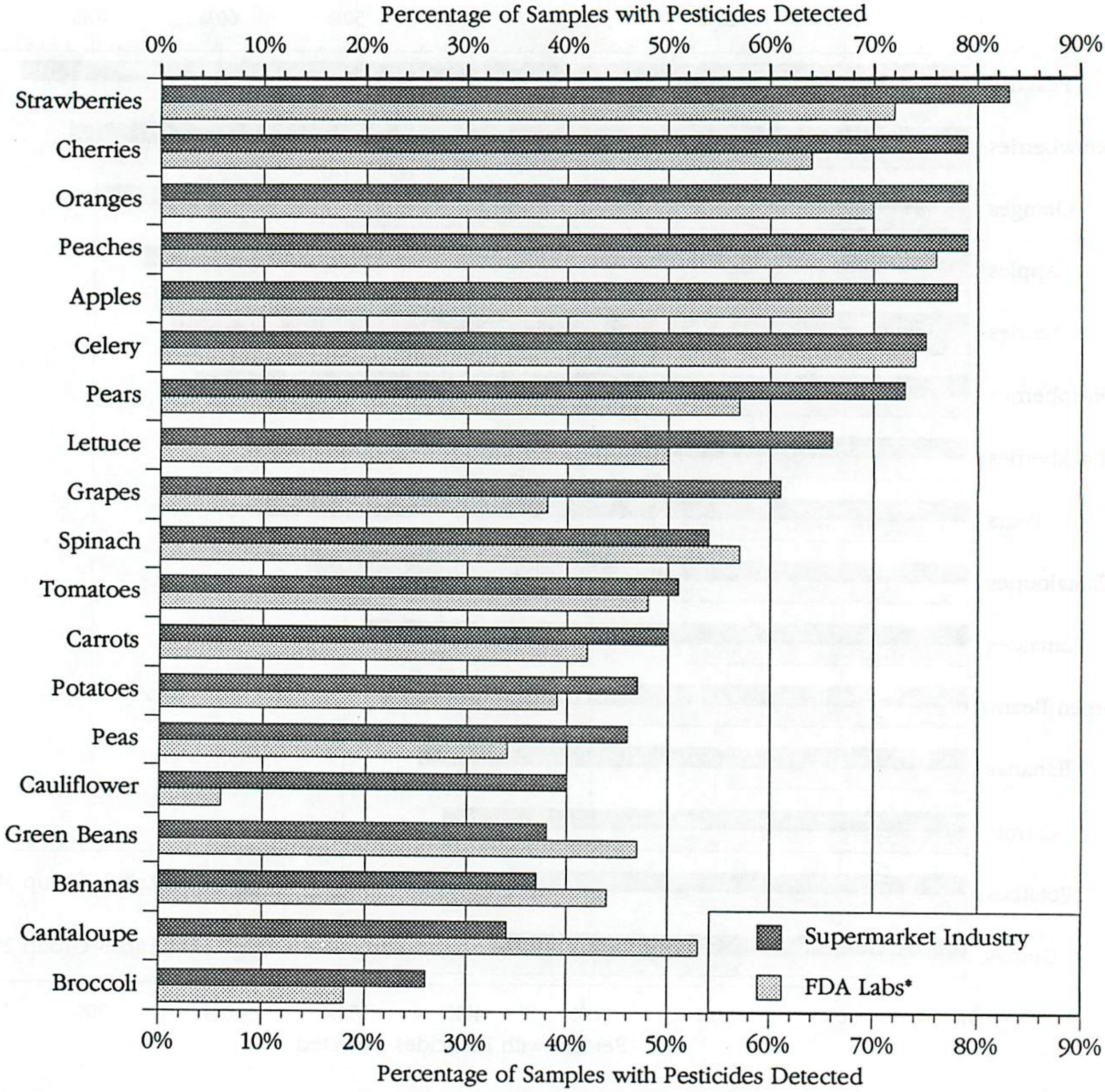
** FDA Group 2 Labs using two or fewer pesticide detection screens on at least 75% of samples tested. These regional labs are: New York, Winchester Electronic Analytical Center, New Orleans, Buffalo, and Baltimore.

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Figure 4

Percent of Fruits and Vegetables Heavily Consumed by Young Children with Pesticides Detected:

A Comparison of Supermarket Warehouse Data and FDA Labs*



* FDA Labs using 3 or more pesticide detection screens on at least 75% of samples tested. These regional labs are: Atlanta Regional Lab, Seattle, San Francisco, Minneapolis, Los Angeles, Kansas City, and Dallas.

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

no residues were detected. The removal of labs using an insufficient number of screens lowered the overall sample size from 17,215 to 14,629.

Data from the FDA are further compromised because of the general failure of all FDA labs to use the single-residue, analytical methods needed to find several high-toxicity, high-use fungicides, including benomyl, the EBDCs, and O-phenylphenol (table 5). The FDA tested only 1 percent of apple samples and 4 percent of peach samples for benomyl, compared to 67 percent and 52 percent, respectively, taken from supermarket warehouses and tested by private-sector labs (*described below*). For the EBDCs, FDA tested only 1 percent of potatoes and 2 percent of apples, compared to 38 percent and 21 percent, respectively, tested from supermarket warehouses.

Not surprisingly, when single-residue analyses are well targeted, residues are found. Of the apples and peaches tested by private-sector labs for benomyl, 41 percent of apple samples and 54 percent of peach samples were positive. For potatoes and apples tested for EBDC fungicides, 38 percent of potato samples and 21 percent of apple samples were positive.

Supermarket warehouse data

Data from FDA were supplemented with additional data from the retail food industry obtained from EPA. These data were generated as part of a dock-sampling program at supermarket warehouses by a third-party certification company, and utilized by supermarket chains representing more than 460 stores on the east and west coasts.

The program is designed to augment FDA's monitoring program and to provide retailers with data about pesticide residues in and on the food they sell. These data were not generated from crops with known pesticide treat

FDA's pesticide residue monitoring program

The FDA pesticide monitoring program has many well documented shortcomings (*GAO 1986a, GAO 1986b, GAO 1986c, U.S. Congress 1987, U.S. Congress OTA 1988*). Some of the most fundamental problems are:

- FDA's routine multi-residue test can only detect about one-half of the pesticides used in agriculture today. Detecting many of the most toxic and pervasive pesticides requires more expensive and complicated single-residue detection techniques that are not routinely used by the FDA.

- FDA's pesticide monitoring program is an enforcement program. Its purpose is to find residues in violation of federal tolerances. It is not designed to provide a statistically valid picture of pesticide measure in the food supply.

- FDA's residue monitoring program is not targeted toward pesticides most likely to be found on certain foods. Rather, monitoring is basically random.

- FDA's residue monitoring program analyzes less than one percent of the food supply. This seemingly small percentage, however, could provide adequate sample sizes for many pesticides in food if the monitoring program were statistically designed and focused on food/residue combinations of concern. It is not.

- FDA's residue monitoring program is in no way targeted toward the pesticides most likely to be found in the infant and child diet.

Table 5

Comparison of Single-Residue Analysis for Carcinogenic Pesticides Used on Crops Heavily Consumed by Children

Supermarket Warehouse and FDA

1990-1992

Benomyl

	Supermarket Warehouse			FDA		
	Number of	Samples Tested for Benomyl		Number of	Samples Tested for Benomyl	
Food	Samples	Number	Percent	Samples	Number	Percent
Apples	542	263	49%	1,038	11	1%
Celery	114	60	53%	393	18	5%
Green Beans	249	71	29%	368	16	4%
Peaches	246	127	52%	513	18	4%

EBDCs

	Supermarket Warehouse			FDA		
	Number of	Samples Tested for EBDC's		Number of	Samples Tested for EBDC's	
Food	Samples	Number	Percent	Samples	Number	Percent
Apples	542	115	21%	1,038	17	2%
Carrots	252	61	24%	345	2	1%
Green Beans	249	43	17%	368	17	5%
Potatoes	258	97	38%	765	7	1%
Tomatoes	395	116	29%	1,164	32	3%

O-Phenylphenol

	Supermarket Warehouse			FDA		
	Number of	Samples Tested for O-Phenylphenol		Number of	Samples Tested for O-Phenylphenol	
Food	Samples	Number	Percent	Samples	Number	Percent
Oranges	237	44	19%	502	16	3%
Cantaloupe	225	36	16%	781	0	0%

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

ment histories nor from crops produced for sale bearing the market claim of no detected pesticide residues. This supermarket, dock-sampling program uses the same crop sampling procedures, sample preparation protocols, and analytical detection methods recommended and employed by the FDA. Samples are gathered in warehouses, typically when produce arrives at central distribution facilities. Neither samplers nor laboratories have any knowledge of the pesticides applied to the produce being tested. FDA, food industry, and independent labs perform the residue analyses for this program, using FDA's approved pesticide analytical methods.

These data have their own limitations. In some cases sample sizes are small, although minimum sample size requirements were imposed for our analysis (*see appendix tables 14-34*). As with the FDA data, the sampling strategy is not designed to provide a statistically accurate picture of residues throughout the entire food supply. And, while multi-residue scans make up the majority of tests employed by industry as well as FDA, the retail-sector data differ in an important respect: They use a greater number of additional screens and single analytical methods capable of detecting residues of high toxicity pesticides (table 5).

The percentage of pesticide detections in the supermarket warehouse data is similar to the seven FDA labs that test most rigorously for pesticides (figure 4). This commercial-FDA concordance stands in contrast to the dramatic disparity previously described, between the seven most rigorous and five less rigorous FDA labs. When results on a given crop from the supermarket warehouses are compared with the seven FDA labs with more rigorous testing procedures, pesticide detection rates are usually within 10 to 20 percent of each other. The private-sector testing program more

Pesticides in Apple Juice

Infants and young children drink 15 to 21 times more apple juice per unit of body weight than the average American. Pesticides in apple juice, therefore, may be cause for concern. It is generally assumed, however, that pesticide levels in apple juice are lower than those on raw apples. Based on available data, this appears to be true. Yet apple juice is far from residue free.

Most apple juice consumed in the United States is a blend of juices and concentrate from domestic and foreign sources. Hungary, Argentina, and Canada are among the leading importers of apple juice concentrate, providing about 40 percent of currently consumed juice stock.

Many pesticides not registered in the U.S. are allowed for use on apples in these and other foreign nations that supply apple juice to the United States. For example, Canada allows Alar for use on domestic apples.

The FDA examined only 41 samples of apple juice for pesticides in three years—1990, 1991, and 1992. Seven juice samples contained residues of one pesticide; two samples had residues of two pesticides. Not one FDA sample was analyzed using single-residue techniques needed to detect carcinogenic pesticides widely used on apples, such as benomyl, the EBDC fungicides and their breakdown product ETU, or the banned growth regulator Alar.

Supermarket data present a very different picture. In 1991 and 1992, supermarket sources analyzed 25 samples of apple juice, examining 11 samples for benomyl, 7 for Alar, and all 25 samples for pesticides detectable with the standard Luke extraction method. Five of 11 samples were positive for benomyl and 4 of 7 samples were positive for Alar. In total, 14 of 25 samples were positive for one or more pesticides; 4 samples contained residues of two pesticides. The majority of samples with pesticide residues were from Canada and Argentina. All samples testing positive for Alar were from Canadian sources analyzed in the late summer and fall of 1992.

While these sample sizes were inadequate to permit exposure and risk calculations, they do rebut the claim that apple juice contains no detectable pesticides. Given the rates of positive detections in supermarket warehouse data, a well-targeted FDA juice monitoring program, using the necessary single-residue techniques, appears warranted.

often detected a higher percentage of pesticides primarily because of greater use of single-residue scans.

This strong concordance between the seven more-rigorous FDA labs and the private-sector program supports the elimination of data from the five less-rigorous FDA labs from our analysis. Together, these two sources provide a reasonable—and new—picture of pesticide residues in many foods heavily consumed by infants and children.[2]

The special case of milk and juice

Juices and milk account for more than one-third of the one-year-old diet by weight. These foods were left out of our analysis, however, because of limited sample size from our two data sources. Available data indicate that pesticide residues occur less frequently in juices than in fresh produce. Juices heavily consumed by young children, however, are far from residue free. Juices appear to contain detectable residues of many different pesticides (*see sidebar "Pesticides in Apple Juice" on previous page*).

Milk is the food most consumed by children between 6 months and 5 years of age. The occurrence of any contaminant in milk, therefore, can be a serious concern. Carcinogenic herbicides used in dairy cattle feed are present in milk at trace levels (*EPA 1990a*). Current analytical techniques, however, are not capable of detecting many pesticide residues in milk, even at levels that may present substantial risks to children. Atrazine, the most widely used herbicide in feed corn, is a potent breast cancer agent in female rats. Yet atrazine cannot be detected in milk at a level deemed safe by the EPA (*EPA 1990a*). While the actual levels of atrazine may be quite low, the EPA can only estimate levels in milk based on studies that identify atrazine in cattle feed with radioactive carbon. The EPA is currently evaluating the results of these studies.

End Notes

1 Even when the Luke method is augmented with all available screens and detectors it can only detect one half of the pesticides used in agriculture today.

2 Critics of the program typically argue that these data overstate risks because samples are taken in commerce (from warehouses or at border crossings) and that residues will degrade prior to sale and consumption. While it is possible that residues on raw fruits and vegetables may degrade slightly from the warehouse to the point of consumption, this is not always the case, and it is certainly not a sound basis for national policy. In many cases degradation produces more toxic breakdown products; for example ETU from the EBDC fungicides, the sulfone derivative of the insecticide aldicarb, the chlorinated degradate of the herbicide atrazine, and the M1 metabolite of the fungicide vinclozalin. The principal shortcoming of both the FDA and food industry data used herein is that currently available residue detection methods allow many pesticides and metabolites to pass through monitoring programs undetected. This problem is particularly acute with imported produce, on which many pesticides are used that simply cannot be detected by the FDA, either because the necessary analytical technique is unknown or not used or because the necessary equipment is not available at the FDA labs.

Chapter 3

Pesticides in the Diets of Infants and Children

Low-level residues of many different pesticides are far more prevalent in the food supply than previously reported. Some of the pesticides are carcinogens and some are neurotoxins. Some have been shown to cause reproductive defects in test animals, some cause poorly understood immune system responses, and still others appear to affect the endocrine system in ways that scientists are just beginning to analyze. Many pesticides cause more than one of these effects, and all of them may cause effects in combination that science currently has little or no capacity to measure.

This pervasiveness of pesticides in the diets of young children raises two basic concerns. One is that young children are routinely exposed to mixtures of pesticides, including mixtures of carcinogenic pesticides, on single foods. The second concern is that overall exposure to pesticides in the infant and child diet is greater than EPA recognizes when it sets policies to protect human health from pesticide risks.

We base our conclusions on analysis of previously unpublished data on pesticide residues from the FDA and the private sector. These data are summarized in appendix tables 14 through 34. Both data sets include import and domestic sources of food. All data are for 1990, 1991, and 1992.

Majority have residues

One half of the 14,629 FDA samples we analyzed had detectable, if generally low, residues of at least one pesticide. At least one pesticide residue was detected in 76 percent of the peach samples and 73 percent of strawberry samples. At the other end of the spectrum, pesticides were detected in only 7 percent of cauliflower samples and 18 percent of broccoli samples (table 6). A total of 108 pesticides were detected on 22 foods, with 38 pesticides found on 5 or more of these 22 crops (table 7).

Fifty nine percent of nearly 4,500 supermarket industry samples we analyzed had detectable residues of pesticides (table 8). This ranged from highs of 82 percent for strawberry samples and 80 percent for orange samples, to lows of 36 percent for banana samples and 35 percent for cantaloupe samples. Eighty one different pesticides were detected on 19 foods; 29 pesticides were detected on 5 or more of these 19 foods (table 9).

Multiple pesticide residues in the American diet

Pesticide regulatory policy is built on the assumption that individuals are exposed to pesticides one at a time. In part this is because of a lack of information on the risks that may arise from multiple exposures. Researchers rarely study the

"...what is apparently low dose exposure for the majority of the population could have serious effects in a small segment of the same population."

—Subcommittee on Mixtures, National Research Council, 1989
Safe Drinking Water Committee, Drinking Water and Health, vol. 9, 1989

Table 6

Pesticide Residues Detected on Fruits and Vegetables Heavily Consumed by Young Children

FDA 1990-1992

Food	Number of Samples	Number with one or more Pesticides Detected	Percent with one or more Pesticides Detected	Number of Different Pesticides Detected
Apples	1,044	673	64%	34
Bananas	478	210	44%	14
Blackberries	136	79	58%	19
Blueberries	252	89	35%	18
Broccoli	641	118	18%	26
Canaloupes	781	414	53%	33
Carrots	345	143	41%	24
Cauliflower	419	29	7%	11
Celery	393	290	74%	16
Cherries	455	291	64%	23
Grapes	970	361	37%	30
Green Beans	389	185	48%	26
Lettuce	2,402	1,204	50%	29
Oranges	502	354	71%	20
Peaches	513	389	76%	28
Pears	550	311	57%	26
Peas	752	249	33%	29
Potatoes	765	307	40%	31
Raspberries	302	189	63%	26
Spinach	388	218	56%	24
Strawberries	988	720	73%	38
Tomatoes	1,164	543	47%	42
Total	14,629	7,366	50%	108

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

toxic effects of multiple pesticides in single foods or across the diet. Regulators, meanwhile, approach each pesticide in isolation as though segregated exposures are biologically plausible even as multiple pesticides are applied to the same crop, and scores of pesticides are present on different foods.

Several basic conclusions arise from our analysis. First, human exposure to complex mixtures of low-level pesticide residues is the norm, not the exception. Our analysis of FDA data found 42 different pesticides on some portion of the tomato samples, 38 different pesticides on the strawberry samples, 34 on apples, 33 on cantaloupes, 31 pesticides on potatoes, 30 on grapes, and 28 on peaches, to name just a few (table 6). Second, not many residues exceed the legal limits, or tolerances. EPA has acknowledged, however, that exposure at current tolerances would not protect public health, particularly the health of infants and children. According to the EPA and the National Research Council, exposure to tolerance-level residues of many widely used pesticides would result in risks several thousand times greater than the safe daily dose, and several hundred times the acceptable level of cancer risk (*NRC 1987 and EPA 1992c*). Residues below current food tolerances, therefore, do not necessarily provide adequate protection for the young. Third, while some of those pesticides are present on a very small percentage of the crops studied, others exist on substantial portions of many fruits and vegetables (*see appendix*).

Multiple pesticide exposures have to be analyzed in two basic ways. First is the likelihood of exposure to more than one pesticide on a single food. Second is the probability of being exposed to multiple residues through various foods in the diet. While the chances that multiple exposures will occur seems obvious, the available data only recently have begun to be analyzed in this fashion.

Our analysis of 4,500 samples[1] of fruits and vegetables taken from supermarket warehouses from 1990 through 1992, reveals a high probability of multiple residues in single foods. According to these data, residues of *two or more pesticides* occur on 62 percent of the orange samples, 44 percent of the apple samples, and between one-third and one-quarter of the samples of cherries, peaches, strawberries, celery, pears, grapes, and leaf lettuce (figures 5 and 6).

It is possible that children occasionally eat single fruits or vegetables with up to 8 different pesticides on them (figure 7). Our analysis found samples of carrots, grapes, leaf lettuce, pears, and spinach with residues of 5 pesticides on them, peach and strawberry samples with 6 different residues, green bean and orange samples with 7 pesticides, and 2 apple samples with 8 different pesticides. It is not uncommon to find residues of 2 or more carcinogenic pesticides on a single food sample (figure 8). Between 2 percent and 20 percent of the 12 crops examined had residues of 2 (in one case 3) cancer-causing pesticides.

Table 7

Pesticides Detected in Five or More Foods Heavily Consumed by Young Children

FDA 1990-1992

Pesticide	Number of crops with the pesticide
Endosulfan	21
Chlorpyrifos	20
Carbaryl	19
Dimethoate	19
Methamidophos	19
Chlorothalonil	18
Diazinon	18
Dicloran	18
Malathion	18
Parathion	18
Acephate	17
Captan	17
DCPA	14
Mevinphos	14
Permethrin	13
Thiabendazole	13
Azinphosmethyl	12
Iprodione	12
DDT, DDE, DDD	11
Dicofol	10
EBDCs	10
Benomyl	8
Fenvalerate	8
Phosmet	8
Tributyl Phosphate	8
Carbendazim (MBC)	7
Ethion	7
Demeton Sulfone	6
Dieldrin	6
Disulfoton Sulfone	6
Esfenvalerate	6
Imazalil	6
Lindane	6
Methomyl	6
Quintozene	6
Cypermethrin	5
Methoxychlor	5
Tetradifon	5

Foods include (22): Apples, Bananas, Blackberries, Blueberries, Broccoli, Cantaloupes, Carrots, Cauliflower, Celery, Cherries, Grapes, Green Beans, Lettuce, Oranges, Peas, Peaches, Pears, Potatoes, Spinach, Strawberries, Raspberries, and Tomatoes.

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

It is clear that infants and children are continuously exposed to low levels of numerous different pesticides, including at least 8 different carcinogens.

Our analysis of the FDA data confirmed these findings. The greatest number of residues on a single sample was 6 residues, found on a small number of apple, lettuce, tomato, and cherry samples (figure 9). Residues of 2 or more pesticides were found on 41 percent of the cherry samples, 39 percent of the apple samples, 38 percent of celery samples, 35 percent of the peaches, and 33 percent of strawberry samples[2] (figure 10).

From these analyses, it is clear that infants and children are continuously exposed to low levels of numerous different pesticides, including at least 8 different carcinogens. The health effects of these multiple exposures are unknown, and they are not being evaluated by regulators. At the same time, experience suggests that the toxicity of chemical mixtures may be more severe, and certainly may be different than anticipated, based on the toxicity of single chemicals.

As noted by the Committee on Methods for the In Vivo Toxicity Testing of Complex Mixtures of the National Research Council/National Academy of Sciences: "...human responses often have differed substantially from what might have been expected on the basis of data from controlled laboratory exposures to pure materials" (*NRC 1988, pp. 30-31*).

Table 8

Pesticide Residues on Fruits and Vegetables Heavily Consumed by Young Children

Supermarket Warehouse Data 1990-1992

Food	Number of Samples	Number with one or more Pesticides Detected	Percent with one or more Pesticides Detected	Number of Different Pesticides Detected
Apples	542	425	78%	25
Bananas	368	134	36%	9
Broccoli	63	16	25%	9
Cantaloupes	225	78	35%	19
Carrots	252	125	50%	12
Cauliflower	65	26	40%	13
Celery	114	85	75%	13
Cherries	90	72	80%	13
Grapes	313	192	61%	22
Green Beans	249	95	38%	20
Leaf Lettuce	201	136	68%	22
Oranges	237	190	80%	25
Peas	191	87	46%	19
Peaches	246	194	79%	20
Pears	328	240	73%	11
Potatoes	258	120	47%	17
Spinach	163	88	54%	19
Strawberries	168	138	82%	17
Tomatoes	395	203	51%	22
Total	4,468	2,644	59%	81

Source: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol.56(117):27961.

Pesticide Use on Fruits and Vegetables

Tens of millions of pounds of carcinogenic, neurotoxic, immunotoxic, and otherwise hazardous pesticides are applied each year to foods that infants and children eat at substantially higher levels than the U.S. population average. The USDA reports that in 1991, a total of at least 48 different fungicides and insecticides were applied to apples overall. While no single orchard would be treated with all of these pesticides, 13 of these pesticides were applied to more than one-quarter of the domestic apple crop, and four—captan, guthion, chlorpyriphos, and petroleum distillates—were applied to more than half the apple acreage (*USDA 1992*).

Apples are not unusual when it comes to pesticide use. Nationwide in 1991, cherries were treated with a total of 31 different fungicides and insecticides, grapes received a total of 26 pesticides, peaches and pears were treated with 35 pesticides, and at least 20 fungicides and insecticides were applied to oranges (*USDA 1992*). Multiple applications of different pesticides result in multiple residues on single foods and scores of different residues in the food supply.

Pesticide use on fruits and vegetables has risen over the past few decades. A recent study by Public Voice for Food and Healthy Policy, a national consumer organization, found that per acre pesticide application rates increased by 125 percent over the past 25 years (*Rosenfeld 1993*). As a result, substantial amounts of pesticides are applied each year to crops children eat at higher rates than adults.

Each year on average, 77 pounds of fungicides and insecticides per acre are applied to pears, 60 pounds to peaches, and 51 pounds of pesticides are applied to nectarines. Grapes receive an average 47 pounds of pesticides per acre, 46 pounds are applied to apples, and tomatoes and citrus each receive 33 pounds of pesticides per acre (*see appendix table 41*).

Per acre fungicide application rates increased by 100 percent from 1966 through 1991 (*Rosenfeld 1993*). Many of these fungicides are of substantial health concern for carcinogenicity or other effects. Five carcinogenic fungicides—benomyl, captan, chlorthalonil, and two EBDCs, mancozeb and maneb—are frequently applied to fruits and vegetables highly consumed by children. These include peaches, pears, strawberries, raspberries, blueberries, cherries, apples, broccoli, peanuts, tomatoes, and potatoes (*see appendix table 42*).

"...human responses often have differed substantially from what might have been expected on the basis of data from controlled laboratory exposures to pure materials."

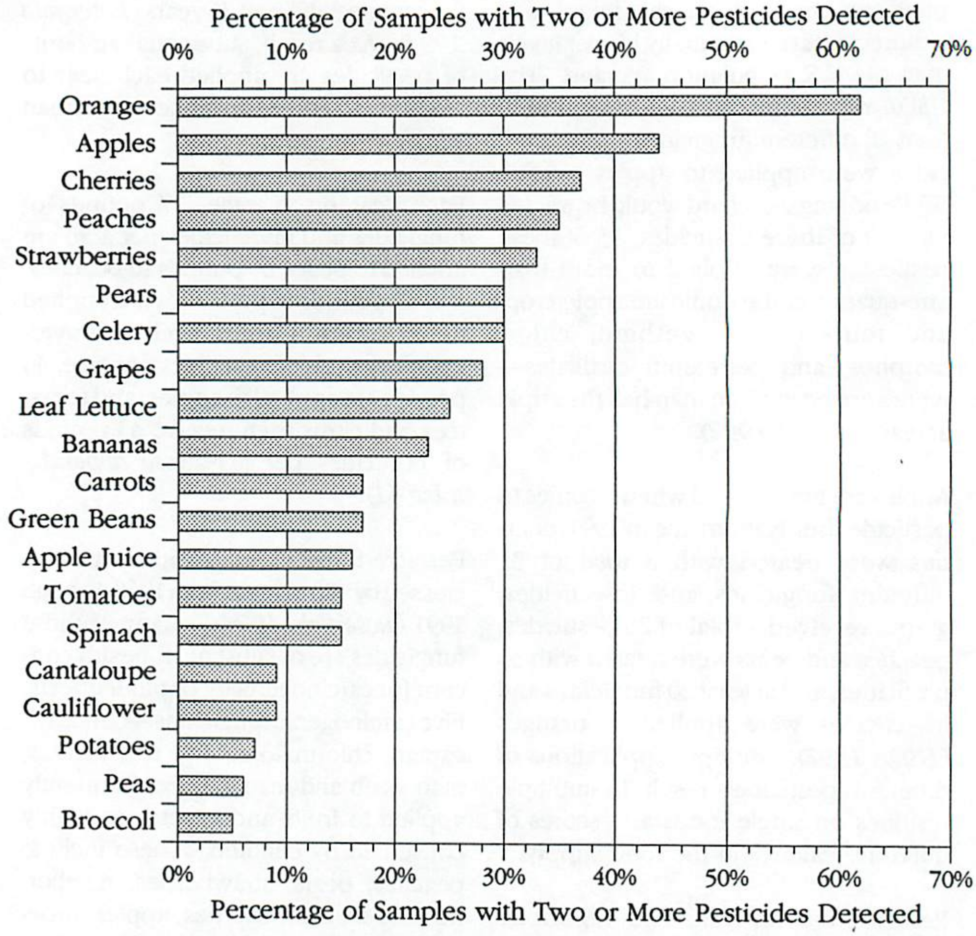
—Committee on Methods for the In Vivo Toxicity Testing of Complex Mixtures National Research Council, 1988

Continual low-level exposure to multiple pesticides in the diet raises basic questions about the effectiveness of current policies, and the need for a preventative approach to pesticide use and regulation. It is neither prudent nor realistic to base national policy on the hope that the effects of pesticide mixtures in food can ever be comprehensively studied or understood.

According to the National Research Council Safe Drinking Water Committee, even if the resources currently devoted to the studies of chemical interactions were multiplied by a factor of 1,000 or more: "...these studies would provide only a small portion of the information required to determine precisely the toxicity of complex mixtures prevailing in the environment" (*NRC 1989, pp.*

Figure 5

Percentage of Fruits and Vegetables With Two or More Pesticides Heavily Consumed by Young Children



Source: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961.

121). The possible combinations of pesticide residues in food overwhelm any plausible research agenda designed to determine their effects. Consider the following assessment, again by a committee of the National Academy of Sciences:

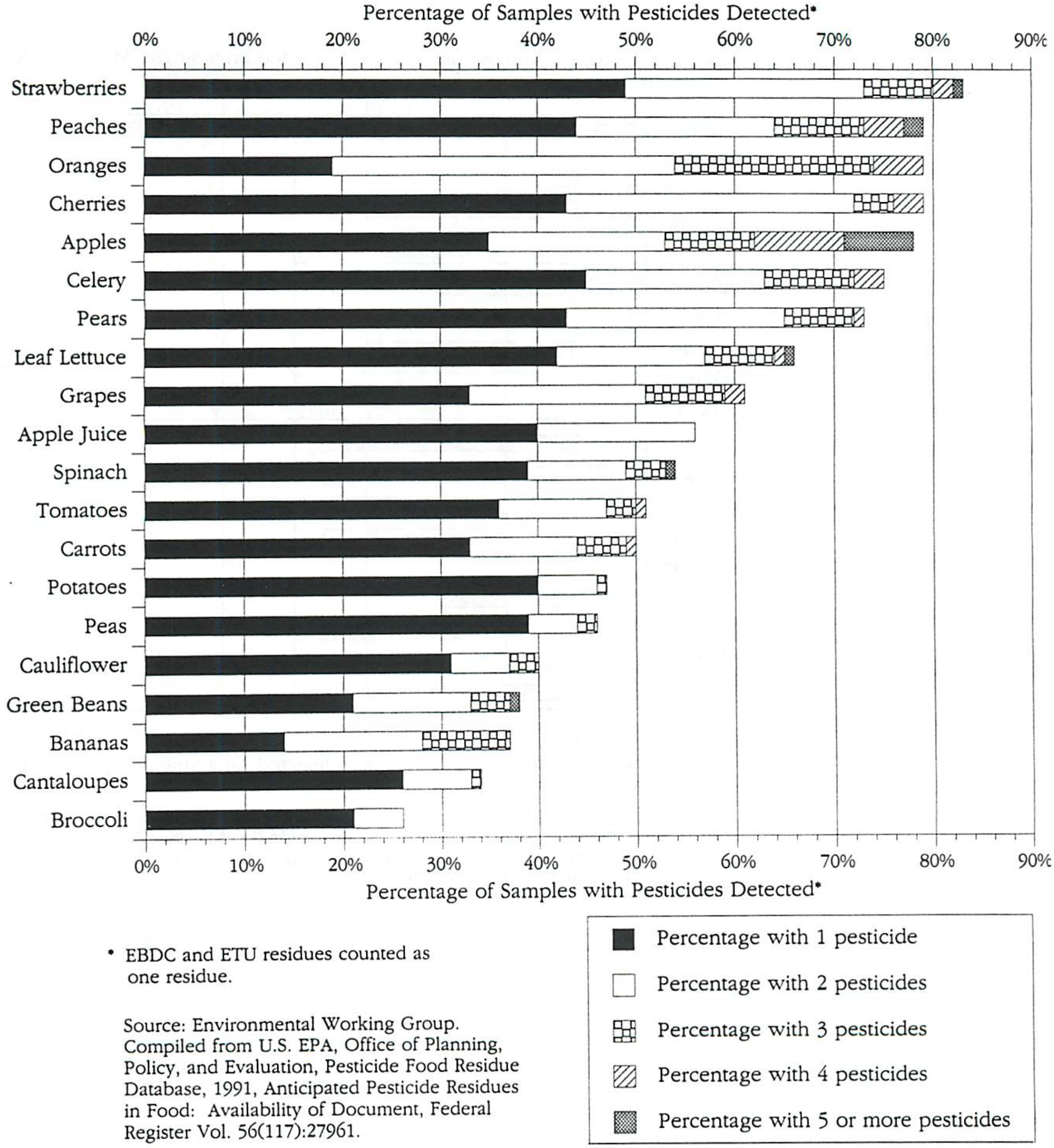
"Even if humans are exposed to no more than 100 potentially toxic agents, the possibility of unusual or unexpected combined effects is sizable. The matrix of only single-dose combinations of *two* of these agents at a time would contain 4,950 cells [different dose combinations]" (*NRC 1988, pp. 100*).

Pesticide residues are far more prevalent in fruits and vegetables than previously reported by the federal government. It is

Figure 6

Multiple Pesticide Residues on Foods Heavily Consumed by Young Children

Supermarket Warehouse Data 1990-1992



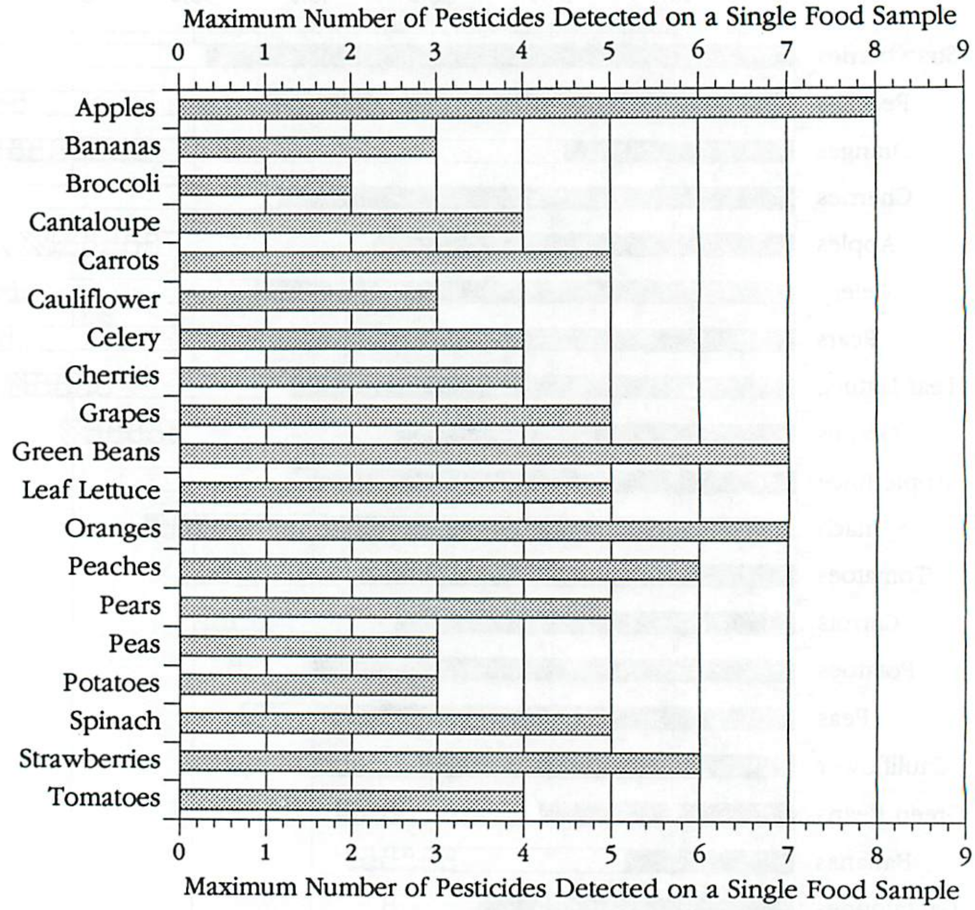
* EBDC and ETU residues counted as one residue.

Source: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961.

Figure 7

Maximum Number of Different Pesticides Detected in Single Samples of Fruits and Vegetables Heavily Consumed by Young Children

Supermarket Warehouse Data 1990-1992



Source: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961.

Table 9

Pesticides Detected in Five or More Foods Heavily Consumed by Young Children

Supermarket Warehouse Data 1990-1992

Pesticide	Number of crops with the pesticide
Endosulfan	15
Chlorpyrifos	13
Dimethoate	13
Diazinon	12
EBDCs	12
Benomyl	11
Dicloran	11
Parathion	11
Azinphosmethyl	10
Chlorothalonil	10
Acephate	9
Captan	9
Carbaryl	9
Methamidophos	9
Thiabendazole	9
Iprodione	8
Malathion	8
Dicofol	7
Methomyl	7
Permethrin	7
Dacthal	6
Mevinphos	6
Phosmet	6
DDT, DDE, DDD	5
Demeton	5
Dieldrin	5
Ethion	5
Metalaxyl	5
Metasystox R	5

Foods include (19): Apples, Bananas, Broccoli, Cantaloupes, Carrots, Cauliflower, Celery, Cherries, Grapes, Green Beans, Lettuce, Oranges, Peas, Peaches, Pears, Potatoes, Spinach, Strawberries, and Tomatoes.

Source: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, 1991, Anticipated Pesticide Residues in Food: Availablility of Document, Federal Register Vol. 56(117):27961.

not unusual, and for some crops it appears to be the norm, that a single piece of a fruit or vegetable will have residues of more than one pesticide. To date, the EPA has not considered multiple exposures when setting food tolerances for pesticides, in part because of the sheer impossibility of the task. If, as this analysis strongly indicates, multiple residues are the rule not the exception, then the EPA must act immediately to reduce these residues, particularly exposures to the combinations of pesticides routinely found in foods heavily consumed by young children.

End Notes

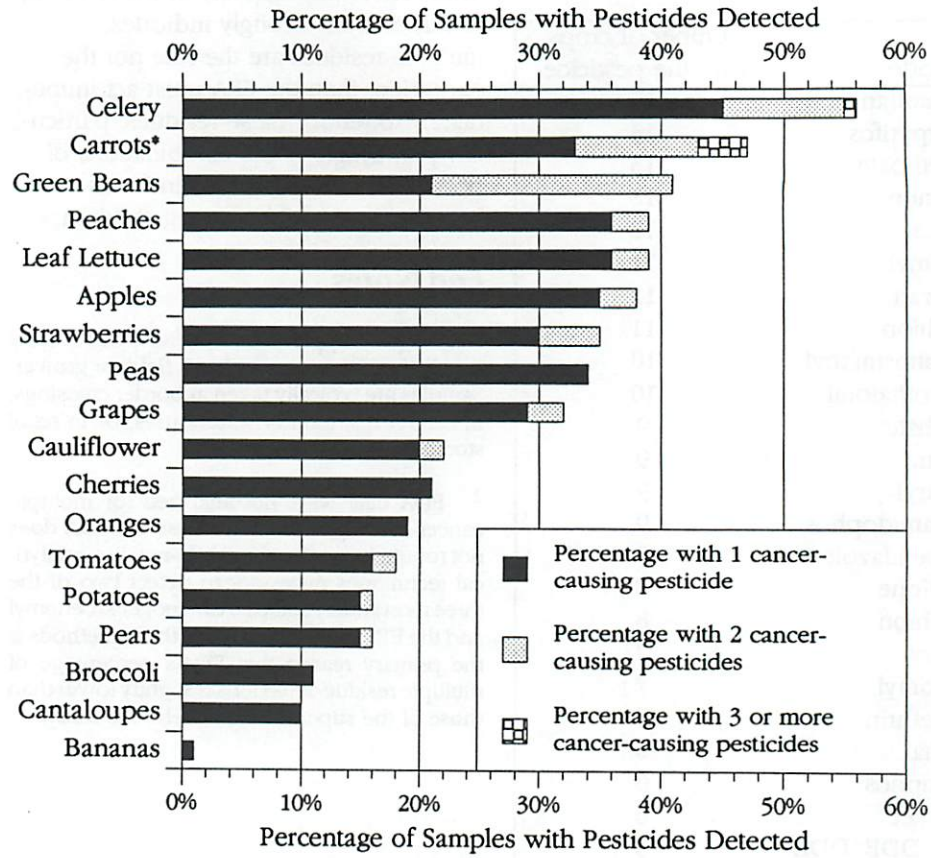
1 A sample is approximately a five-pound slurry usually from the same orchard, field, or grower. Samples are typically taken at border crossings, in central distribution warehouses, or in retail storage facilities.

2 FDA data were not analyzed for multiple cancer-causing residues because the FDA does not routinely employ the single-residue, analytical techniques necessary to detect two of the three most widely detected carcinogens: benomyl and the EBDCs. Failure to use these methods is the primary reason that FDA's percentage of multiple residue detections is slightly lower than those of the supermarket warehouse study.

Figure 8

Percentage of Fruits and Vegetables Heavily Consumed by Young Children With Residues of One or More Cancer-Causing Pesticides

Supermarket Warehouse Data 1990-1992



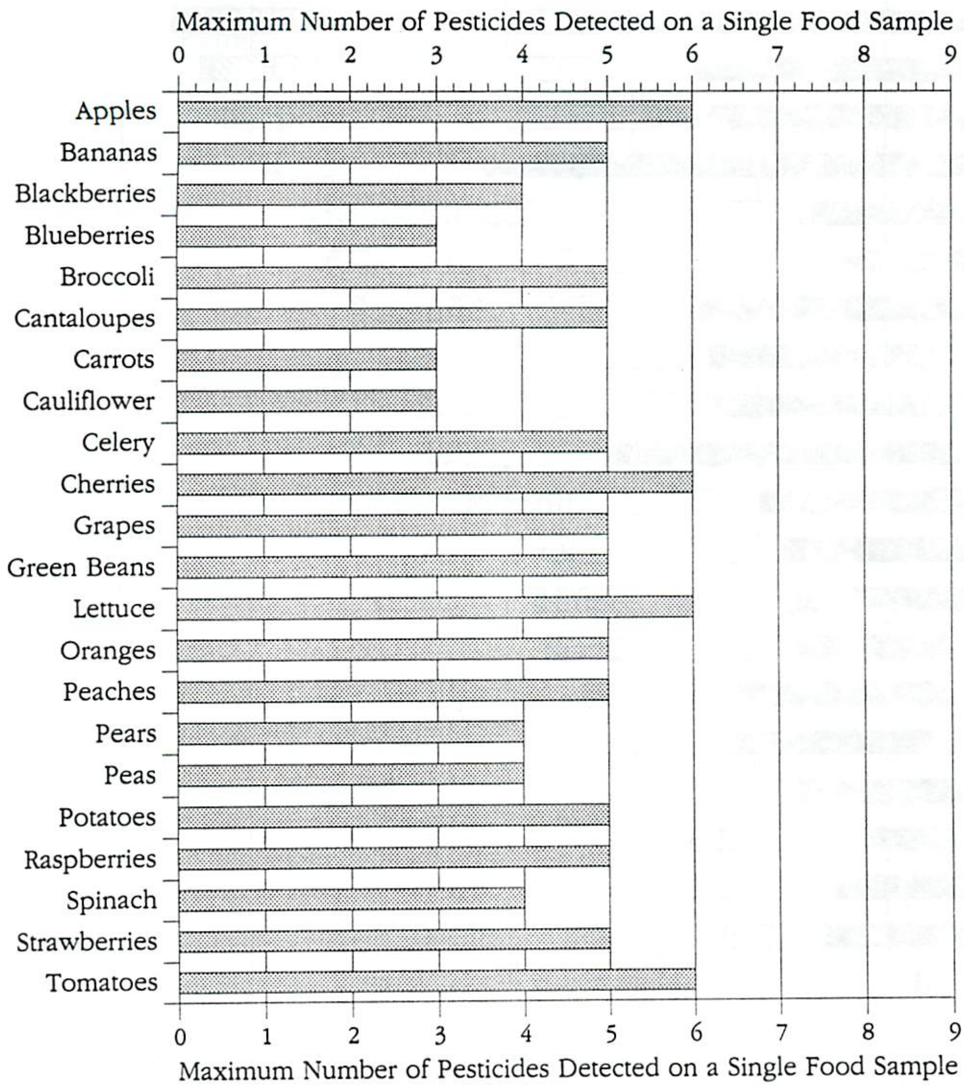
* Includes DDT, DDE, and DDD residues

Source: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961.

Figure 9

Maximum Number of Different Pesticides Detected in Single Samples of Fruits and Vegetables Heavily Consumed by Young Children

FDA 1990-1992*



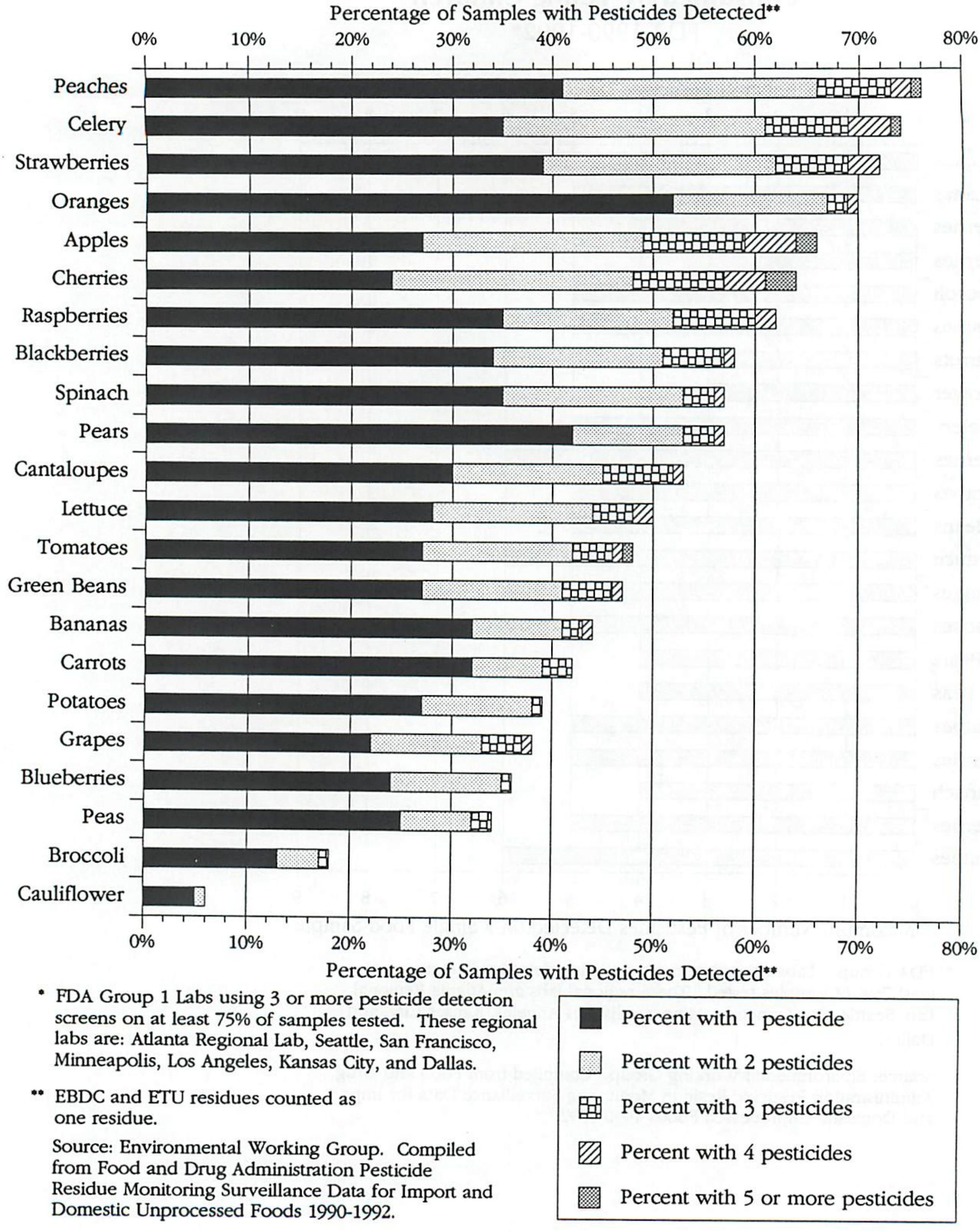
* FDA Group 1 Labs using 3 or more pesticide detection screens on at least 75% of samples tested. These regional labs are: Atlanta Regional Lab, Seattle, San Francisco, Minneapolis, Los Angeles, Kansas City, and Dallas.

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Figure 10

Multiple Pesticide Residues on Foods Heavily Consumed by Young Children

FDA 1990-1992*



* FDA Group 1 Labs using 3 or more pesticide detection screens on at least 75% of samples tested. These regional labs are: Atlanta Regional Lab, Seattle, San Francisco, Minneapolis, Los Angeles, Kansas City, and Dallas.

** EBDC and ETU residues counted as one residue.

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Chapter 4

Cancer Risks from Pesticides in Children's Diets

Young children, we have seen, are constantly exposed to low levels of different pesticide combinations in food. While the toxicity of these mixtures is not generally understood, it is possible to gain a better perspective on potential risks by aggregating exposure to pesticides with similar types of risks, such as carcinogens.

Risks from multiple carcinogens

The additivity of cancer risks from exposure to multiple carcinogens at low doses —such as pesticide residues in food—is generally accepted within the scientific community. The use of this methodology has been formally recommended by two National Academy of Sciences Committees: The Safe Drinking Water Committee, Subcommittee on Mixtures, and the Committee on Methods for the In Vivo Testing of Complex Mixtures (*NRC 1988, NRC 1989*).

Various types of dose-additive models also have been recommended by the American Council of Governmental and Industrial Hygienists (*ACGIH 1983*), the World Health Organization (*WHO 1981*), and the Occupational Safety and Health Administration (*OSHA 1983*).

When cancer risks from multiple exposures to carcinogens are *not* added, risk assessors assume that each chemical is acting in complete biological isolation, or that in total, the chemicals in combination negate one another's effects. To say the least, either of these assumptions is implausible, particularly for cancer-causing pesticides eaten in the same piece of fruit, during the same meal, or on the same day (*NRC 1989*). Yet cancer risks from carcinogenic pesticides are never added by EPA.

In concluding its analysis of complex chemical mixtures in drinking water, the National Academy of Sciences, Safe Drinking Water Committee, Subcommittee on Mixtures bluntly characterized approaches that consider only individual toxic agents as "inadequate" (*NRC 1989*).

There is no single, uniform cancer risk assessment method within the EPA (*EPA 1989a*). Different EPA programs (air, water, toxics, pesticides) treat similar compounds in very different ways. Some EPA programs add low-level carcinogenic risks from different pollutants to derive an overall cancer risk. For example, the Office of Air and Radiation adds cancer risks when assessing the hazards of exposure to some airborne carcinogens (*EPA 1990b*).[1]

The EPA has developed guidelines on the health risk assessment of chemical mixtures, which, as expected, support the concept of additivity.[2] As described in the National Research Council's

"In general, children can be seen as being more susceptible to toxins that require an extended latency time in order to express their effects, such as carcinogens."

— EPA Science Advisory Board, Report of the Human Health Subcommittee Relative Risk Reduction Project, 1990

Drinking Water and Health: Volume 9:

"In its approach to mixtures of carcinogens at doses associated with risks of less than 10-3 [one in one thousand], EPA assumes that the upper bound risk estimates for each of the carcinogenic chemicals can be added" (*NRC 1989, pp. 163*).

According to the EPA guidelines:

"For carcinogens, whenever linearity of dose-response curves has been assumed (usually restricted to low doses), the increased risk...for multiple com-pounds...may be generalized to:

$$P = \Sigma\, d1 \times B1$$

(Risk = the sum of exposure multiplied by potency).

This equation assumes independence of action by the several carcinogens and is equivalent to the assumption of dose addition as well as to response addition..."(*EPA 1985, pp. 8*).

The National Research Council, Committee on Methods for the In Vivo Toxicity Testing of Complex Mixtures concurs:

"When all environmental exposures are 3 to 4 or more orders of magnitude below that associated with observable effects in bioassays or in epidemiology studies, additivity assumptions can provide a reasonable approximation of the joint risk" (*NRC 1988, pp. 193*).

The committee also notes:

"Although a multiplicative exposure effect sometimes dominates at high doses, further exploration of this model indicates that the joint effect will be additive (that is, close to the sum of the individual effects) at sufficiently low doses. A newer model, that of Moolgavkar and Knudsen (*1981*), is more biologically specific and yields the same conclusion. (The conclusion depends of the assumption that the augmented risks of the chemical are small compared to the natural background rate of the tumor.) Additivity at low doses was also demonstrated under a general class of additive background models and under a multiplicative risk model when the relative risk for each component of the mixture is small" (*NRC 1988, pp. 200*).

Proponents of pesticide use, not surprisingly, argue vociferously against additivity. Generally these arguments cite the absence of firm proof of biological interaction, different tumor types produced by different pesticides in animal tests, the distinct chemistry and toxic properties of some individual carcinogenic pesticides, and the lack of a cause-and-effect relationship between dietary pesticide exposure and human cancer.

Yet, the scientific community is quite clear on the issue of additivity in just such cases as pesticides in food. While the similarity of tumor type or mechanism of action may increase the accuracy of risk assessments that combine the risk from several pesticides, the risk from carcinogenic contaminants can be added, simply on the basis of their carcinogenicity (*EPA 1985; NRC 1989, pp. 97, 104, 168; NRC 1988, pp. 102*).

And additivity alone may not be sufficient to characterize the true risk of low-dose pesticide mixtures. According to the Committee on Complex Mixtures:

"The excess cancer risk at low doses from an agent that acts on the same cell type in the same organ as another agent(s) to which exposure at high levels occurs could be seriously underestimated in an animal bioassay, because the bioassay ignores the effects of the other agent(s), such as cigarette smoke, on the estimated risk" (*NRC 1988, pp. 193*).

Cancer risk estimates

Cancer risk assessment is a complex blend of many sciences—toxicology, biostatistics, physiology, toxicokenetics, and computer modeling—to name just a few. As practiced by EPA, however, the basic concepts in cancer risk assessment are fairly straight forward. Cancer risk is based on the potency of a carcinogen and an individual's (or population's) exposure to it.

The following equation is used by EPA and in this report to calculate lifetime dietary risk from cancer-causing pesticides (*NRC 1987*):

risk = exposure (food consumption x residues) x cancer potency (Q^*)

Our study uses the EPA's standard risk assessment techniques to explore the distribution of risk throughout a lifetime and within the diets of infants and children. We used the most recent cancer potency estimates from the EPA, average food consumption estimates from the USDA for 20 fruits and vegetables for each year of life from birth through age 5, and pesticide residue data from the FDA and the private-sector, supermarket warehouse testing program for 1990 through 1992.

To estimate annual contributions to lifetime risk, cancer risk over a 70-year lifetime was calculated assuming average food consumption estimates for each year of life through age 5. A separate calculation was made for each year, assuming, for example, that food consumption levels of a one-year-old, were constant for 70 years. These estimates were then divided by 70, to produce the accumulation of risk that occurs during each of the first 6 years of life.

For example, the annual accumulation of cancer risk for the average one-year-old was estimated as follows. Average one-year-old food consumption values for each of the 20 fruits and vegetables used in our analysis were multiplied by the mean residue levels for each of eight carcinogens found on these same fruits and vegetables. After adjusting all units to mg/kg/body weight, this age group exposure level was then multiplied by the Q^* to produce a lifetime (70 year) estimate of risk. This lifetime risk estimate was then divided by 70 to produce the annual contribution to lifetime risk, accounted for by that year.

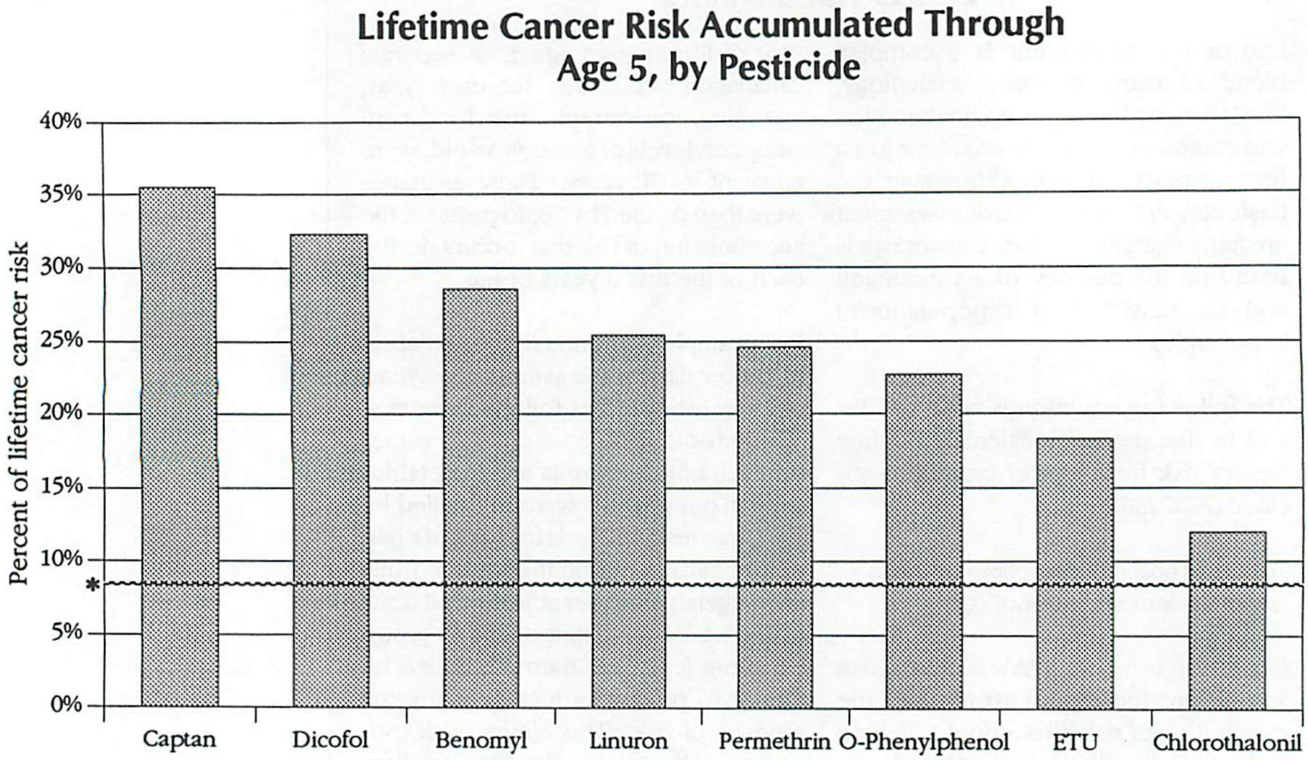
Mean (average) pesticide residue levels were calculated assuming that all samples with no detected residues were residue free, although it is probable that residues were present in some samples in amounts below the detection limit. When both FDA and the supermarket study provided data for the same pesticide on a given crop, we utilized the average residue from the single source with the largest sample size (*appendix table 36*).

Annual accumulation of cancer risk

As noted earlier, in assessing chronic risk, EPA estimates that exposure to pesticides in food is evenly accumulated over a lifetime (*Krewski 1991, Murdoch 1992*). Average food consumption estimates from the population are used, and average residues levels are assumed.

From a toxicological perspective this method assumes that only the lifetime dose produces a chronic effect. High exposures, sensitive phases of human development, exposure to carcinogens early in life, or any combination of these factors are presumed irrelevant by EPA in

Figure 11



*Percent of lifetime cancer risk accumulated by age five if cancer risk were accumulated evenly over lifetime.

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(127):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992. U.S. EPA, 1992, List of Chemicals Evaluated for Carcinogenic Potential, Memorandum to Health Effects Division Branch Chiefs, by Reto Engler, Office of Prevention, Pesticides, and Toxic Substances, October 14.

relation to lifetime risk. As a result, the EPA has yet to adjust a single food tolerance for a pesticide specifically to protect infants and children (*U.S. Congress 1991*).

In order to examine the significance of infant and child exposure to pesticides in the diet, we analyzed the rate, by year, at which the average child accumulates his or her lifetime cancer risk from specific foods and pesticides. The purpose of this analysis is to examine the degree to which specific carcinogenic pesticides are actually encountered early in life. Our analysis makes no adjustments in risk for the potential increased sensitivity of young children to pesticides.

Annual accumulation of cancer risk is a function of the foods with carcinogenic pesticide residues and the levels at which the foods are consumed. If a pesticide is present in significant amounts on foods heavily consumed by infants and children, then aggressive accumulation of health risk at a young age is likely to occur. If not, risk may be accumulated more evenly throughout a lifetime. For pesticides leaving residues on foods heavily consumed by infants and children, our analysis shows that the pattern of intensified risk is dramatic during preschool years.

Through age 5 (about 8 percent of the average life expectancy), the average child accumulates 35 percent of his or her lifetime cancer risk from the fungicide captan, 32 percent from the insecticide dicofol, nearly 29 percent from the fungicide benomyl, 25 percent of lifetime risk from the insecticide permethrin and the herbicide linuron, and slightly more than 23 percent from the fungicide O-phenylphenol (figure 11). Children who consume fruits and vegetables consistently above the age group average would receive a higher dose and accumulate cancer risks more quickly.

Accumulation of additive cancer risk

The EPA has identified about 70 carcinogenic pesticides currently registered for use on food. A subset of them, however, leave the vast majority of carcinogenic pesticide residues on foods that are heavily consumed by infants and children. These include, but are not limited to, benomyl, captan, the EBDCs, dicofol, O-phenylphenol, permethrin, chlorthalonil, and linuron.

Other carcinogenic compounds, such as the herbicides atrazine, cyanazine, alachlor, and metolachlor, can leave residues in animal feed that find their way into foods heavily consumed by infants and children, particularly milk. Milk was not included in our analysis, however, because of the inability of current analytical techniques to detect low-level residues of these compounds in milk. Risks from these herbicides in drinking water are discussed in the chapter 3. Even trace levels of these herbicides in milk and water may present substantial risks for the young.

The annual accumulation of cancer risk from birth through age 5 was calculated for the pesticides benomyl, captan, the EBDCs, dicofol, O-phenylphenol, permethrin, chlorthalonil, and linuron using actual residue data on just 20 fruits and vegetables. Captan, ETU, the carcinogenic metabolite of the EBDC fungicides, O-phenylphenol, and chlorthalonil are all considered *probable* human carcinogens by EPA. Benomyl, permethrin, linuron, and dicofol (the hydroxylated version of DDT) are considered *possible* human carcinogens, suitable for quantitative risk assessment.

The disproportionate accumulation of cancer risk from these pesticides is substantial, with more than 24 percent of lifetime cancer risk achieved through age 5. The level of risk itself, however, is more concerning. For just 8 pesticides on 20 crops, the average child exceeds the EPA lifetime one-in-one million standard of risk by his or her first birthday (table 10).

Herbicides in drinking water

Tap water comprises about 30 to 40 percent of the infant and child diet, by weight. Young children consume tap water as drinking water, in infant formula, and in reconstituted juices. More than 85 percent of infant formula sales are of concentrate or powder that is mixed with water in the home.

Most cities in the Midwest are located on major rivers, and their residents rely on these rivers for drinking water. According the the U.S. Geological Survey, about 18 million people in the Ohio, Missouri, and Mississippi river basins draw drinking water from surface water sources (*U.S. Geological Survey 1991*). Major cities dependent on surface water include Cincinnati, Ohio; Evansville, Indiana; Louisville, Kentucky; Omaha, Nebraska; Kansas City and St. Louis, Missouri; and Minneapolis/St. Paul, Minnesota.

Cancer Potency Estimates

Cancer potency estimates are commonly referred to as Q* (Q star) values. A Q* is a purely mathematical or quantitative expression of cancer potency that does not account for qualitative factors such as tumor type, occurrence of tumors in multiple species or in one or both sexes of test animals, or the structural or mechanistic similarity of the chemical in question to other known animal carcinogens.

The Q* represents the slope of the dose response curve from animals tests, where the slope measures the change in tumor incidence over the change in dose. This slope is typically calculated by extrapolating downward from doses received by test animals toward lower doses that humans might receive in food. A high Q* indicates strong potency, a low Q* indicates weak potency. The EPA calculates a Q* using a risk averse methodology that represents the 95 percent upper-confidence limit of tumor induction likely to occur from a given dose. EPA's most recent cancer potency estimates, or Q*s, were used in this study (*listed in the table at the right*).

For purposes of decision-making, however, the EPA does not rely exclusively on Q* values. Qualitative factors are also considered. These so-called "weight-of-the-evidence" factors are used to characterize a pesticide's likelihood of causing cancer in humans based on results in animal studies. The EPA's carcinogen classification scheme, based on a similar system develop by the International Agency for Research on Cancer, applies weight-of-the-evidence criteria to animal studies, including the presence of malignant vs. benign tumors, the number and rarity of tumor types and organs affected, the quality of the study, whether or not the compound is mutagenic, and the availability of valid human epidemiological data (*EPA 1986*).

Critics of Q*s claim they are crude measures that bear little relation to a chemical's actual cancer potency in humans.

It is noteworthy, however, that Q* values derived from animal studies correlate very well with the actual potency of chemical carcinogens in humans, when data are available from occupational exposures to permit such comparisons (*Pererra 1998, Allen 1988*). The vast majority of pesticides classified as carcinogenic are thought to be either probable or possible human carcinogens.

Cancer Potency Factors*

Pesticide	Potency	Group
Alachlor	0.08	B2
Atrazine	0.22	C
Benomyl	0.0042	C
Captan	0.0036	B2
Chlorothalonil	0.011	B2
Cyanazine	0.84	C
Dicofol	0.031	C
ETU	0.11	B2
Linuron	0.18	B2/C
Metolachlor	0.002	C
Permethrin	0.018	C
o-Phenylphenol	0.0022	B2

B2 - Classified as a probable human carcinogen by the EPA

C - Classified as a possible human carcinogen by the EPA

* U.S. EPA, 1992. List of Chemicals Evaluated for Carcinogenic Potential. Memorandum to Health Effects Division Branch Chief by Reto Engler, Office of Prevention, Pesticides, and Toxic Substances, October 14. 9pp.

About 250 million pounds of herbicides are applied in the mid-continental corn belt each year. More than 150 million pounds of this total are comprised of the carcinogenic herbicides atrazine, cyanazine, alachlor, and metolachlor. Each year in the corn belt, between 60 and 65 million pounds of atrazine and 23 million pounds of cyanazine are applied to nearly 50 million and 15 million acres of corn, respectively; six million pounds of atrazine are also applied to sorghum. More than 50 million pounds of alachlor and metolachlor are applied annually to corn, sorghum, and soybeans (*USDA 1991, USDA 1992*).

Agricultural runoff, carrying pesticides and excess nutrients into surface water, is essentially exempt from regulation under the Clean Water Act. Amendments to the Act in 1987 require all states to develop nonpoint-source pollution control plans, but the law does not require states to implement these plans. A few states in the Midwestern corn belt (Iowa, Minnesota, and Nebraska) have begun to regulate specific herbicides on a limited case-by-case basis. These regulations, however, are generally unproven in terms of their ability to reduce runoff and leaching of extremely mobile herbicides, such as atrazine and cyanazine.

Table 10

Cancer Risk Accumulated in Childhood From Eight Pesticides on Twenty Different Fruits and Vegetables*

Age	Cumulative Risk	Percentage of Lifetime Risk
Birth through 12 months	9.8×10^{-7}	8.4%
Age 1	1.5×10^{-6}	13.2%
Age 2	1.9×10^{-6}	16.2%
Age 3	2.2×10^{-6}	19.2%
Age 4	2.5×10^{-6}	21.8%
Age 5	2.8×10^{-6}	24.3%
National Average Annual Risk†	1.7×10^{-7}	1.4%
Lifetime Cancer Risk* ††	1.2×10^{-5}	

* Foods include Apples, Bananas, Blackberries, Blueberries, Cantaloupes, Carrots, Celery, Cherries, Grapes, Green Beans, Lettuce, Oranges, Peas, Peaches, Pears, Potatoes, Spinach, Strawberries, Raspberries, and Tomatoes.

† Annual accumulation of risk assuming national average food consumption for each year of life.

†† Pesticides include Benomyl, Captan, Chlorthalonil, Dicofol, Linuron, O-Phenylphenol, Permethrin and ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register," Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992. Environmental Working Group. Compiled from U.S. EPA Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database,1991, Anticipated Pesticide Residues in Food: Availablility of Document, Federal Register Vol. 56(117):27961.

Once herbicides make their way into drinking water, they are regulated under the federal Safe Drinking Water Act as amended in 1986. For drinking water contaminants, the Act requires that the EPA first set a maximum contaminant level goal (MCLG), which is followed, usually several years later, by the setting of a maximum contaminant level (MCL). Only the MCL is legally binding and enforceable.

An MCLG is essentially a health-based standard. For contaminants that the EPA classifies as known and probable human carcinogens, also known as A, B1, and B2 carcinogens, the Agency routinely sets MCLGs at zero. Class C, or possible human carcinogens, however, are regulated by the EPA's Office of Drinking Water as non-carcinogenic contaminants. This is somewhat problematic because the Office of Pesticide Programs regulates most class C carcinogens, including atrazine, metolachlor, and cyanazine as carcinogens.[3]

MCLGs for non-carcinogenic contaminants are set by applying a 100- to 1,000-fold safety factor to the lowest dose that produces no observable adverse effect in a valid animal study. Calculations are based on a 70-kg adult who drinks two liters of water a day, assuming, in the absence of other data, that water accounts for only 20 percent of total exposure to the compound (*EPA 1989b*).

MCLs are health-based standards, although costs and the availability of practical technology can be considered in setting these standards. For non-carcinogenic compounds, nonetheless, MCLs are generally set at the MCLG. MCLs for carcinogens are generally set at a level that results in no greater then a one-in-one-million risk of cancer over a lifetime of exposure. As of May 1993,

Table 11

Maximum Contaminant Levels for Pesticides in Drinking Water

Pesticide	MCL (ppb)
Alachlor	2.00
Aldicarb	3.00
Atrazine	3.00
Carbofuran	40.00
Chlordane	2.00
Dalapon	200.00
Dinoseb	7.00
DBCP	0.20
Diquat	20.00
2,4-D	70.00
Endothall	100.00
Endrin	2.00
EDB	0.05
Glyphosate	700.00
Heptachlor	0.40
Heptachlor Epoxide	0.20
Lindane	0.20
Methoxychlor	40.00
Pentachlorophenol	1.00
Picloram	500.00
Simazine	4.00
Toxaphene	3.00
2,4,5-TP	50.00

Source: EPA list of contaminants regulated under the Safe Water Drinking Act, May 1993.

EPA set legally binding MCLs for 23 pesticides and their breakdown products (table 11).

In agricultural areas, particularly in the Midwest, a substantial percentage of the surface and groundwater is contaminated with herbicides as a result of normal agricultural use. The most prevalent compounds, atrazine, alachlor, cyanazine, and metolachlor, are classified by the EPA as probable or possible human carcinogens. Atrazine is by far the most persistent and prevalent of these chemicals in surface water; it is detected at the highest average and maximum levels (*EPA 1992a, Thurman 1991, Keck 1992, Illinois EPA 1990, Carney 1991, Baker 1989*). Cyanazine, alachlor, and metolachlor are also routinely detected above the MCL or health advisory level in surface water in the spring and early summer.[4]

Cyanazine and atrazine are closely related chemical compounds from the family of chlorinated triazines. Alachlor and metolachlor are also similar chemical formulations. Atrazine breaks down into several degradates in water, including desethyl-atrazine, desisopropyl-atrazine, and desalkyl-atrazine. Some herbicide metabolites are just as toxic as the parent compounds, yet extremely few monitoring programs to date have analyzed drinking water sources for any of these or other toxic metabolites. Failure to test for these metabolites may significantly understate health risks to children.

Pulses of relatively high herbicide levels in surface water frequently occur from April through July, when spring planting and herbicide applications are followed by rain (*Thurman 1991*). Levels as high as 108 parts per billion (ppb) have been detected in surface water, and levels as high as 17 ppb have been found in finished drinking water (*Taylor 1992*). In many areas atrazine is detected year round. Surface water recharge from groundwater contaminated with atrazine

Table 12

Cancer Risk Accumulated in Childhood From Herbicides in Drinking Water

Atrazine @ 3 ppb, Cyanazine @ 1 ppb

	One liter per day *		Average Tapwater Intake **		Tapwater at 90% Consumption	
	Cumulative Risk	Percentage of Lifetime Risk	Cumulative Risk	Percentage of Lifetime Risk	Cumulative Risk	Percentage of Lifetime Risk
Birth-6 Months	1.1×10^{-6}	2.5%	8.6×10^{-7}	2.5%	1.3×10^{-6}	2.1%
7-12 Months	2.1×10^{-6}	5.0%	1.5×10^{-6}	4.4%	2.1×10^{-6}	3.5%
Age 1	3.8×10^{-6}	8.7%	2.5×10^{-6}	7.4%	3.8×10^{-6}	6.5%
Age 2	5.4×10^{-6}	12.5%	3.5×10^{-6}	10.3%	5.6×10^{-6}	9.4%
Age 3	7.0×10^{-6}	16.2%	4.5×10^{-6}	13.3%	7.4×10^{-6}	12.3%
Age 4	8.0×10^{-6}	18.7%	5.3×10^{-6}	15.7%	8.9×10^{-6}	14.8%
Age 5	9.1×10^{-6}	21.2%	6.1×10^{-6}	18.1%	1.0×10^{-5}	17.3%
Age 6	1.0×10^{-5}	23.7%	6.9×10^{-6}	20.5%	1.2×10^{-5}	19.8%
Nat'l Avg. Annual Risk†	6.1×10^{-7}	1.4%	4.8×10^{-7}	1.4%	8.5×10^{-7}	1.4%
Lifetime Cancer Risk	4.3×10^{-5}		3.4×10^{-5}		6.0×10^{-5}	

* Water consumption was assumed to be one liter a day of water for an average 10kg child.
** Water consumption numbers for 0-6 and 7-12 months are based on tapwater consumption estimates from Ershow and Cantor of the National Cancer Institute (Ershow 1988) modified to reflect the increase since 1978 in powdered and concentrated infant formula mixed at home with tapwater. Calculations are based on 1978 tapwater and total water data and 1991 infant formula sales data indicating 80% of formula is reconstituted at home with tapwater.
† Annual accumulation of risk assuming national average water consumption for each year of life.

Source: Ershow, Abby and Cantor, "Total Water and Tapwater Intake in the United States: Population-Based Estimates of Quantities and Sources," Epidemiology and Biostatistics Program, National Cancer Institute, Bethesda, Maryland, May 1989.

is thought to be the source of much of the herbicide detected in surface water in the fall and winter (*Illinois EPA 1990, Goolsby 1991*). Atrazine contaminates the groundwater in 32 states (*EPA 1992b*).

None of these herbicides is removed from drinking water by conventional municipal drinking water treatment (*EPA 1992a*). When these herbicides contaminate drinking water, they are consumed by infants and young children through tap water, in juice concentrates, and in infant formula.

Herbicide contamination

No comprehensive source exists for data on pesticide contamination of drinking water. Various state and municipal water and natural resource agencies, however, have sampled drinking water sources for herbicides, particularly atrazine and alachlor. These findings have been summarized by the EPA, the American Water Works Association, and others. Some of the most significant reports are:

- Atrazine was detected in 80 percent of finished (treated) community water systems tested in Illinois in 1991, and in 55 percent of the systems tested in 1992. Three or more herbicides were detected in 53 percent of these finished water samples over two years. Atrazine levels exceeded the MCL in finished water from 17 percent of these systems in both 1991 and 1992 (*Taylor 1992*).

• Atrazine residues in eastern Kansas surface water used as public drinking water supplies from 1985 to 1990 averaged 3.27 ppb (the MCL is 3); 41 percent of samples exceeded the MCL (*Carney 1991*).

• Atrazine exceeded the MCL in 52 percent of 132 mid-continental stream sites sampled by the U.S. Geological Survey in the spring after crop planting in 1989 to 1990. Alachlor exceeded the MCL in 32 percent of sites; 23 percent of sites exceeded the MCL for two different herbicides (*Thurman 1991*).

• Atrazine was over the MCL in more than one-third of daily samples at St. Louis and Kansas City from May through July 1991. Average atrazine concentrations at St. Louis and Kansas City for the same period were 2.61 ppb and 2.15 ppb, respectively (*Keck 1992*).

• Seven years of year-round sampling in Ohio found average annual surface water levels of 2.97 ppb of atrazine, 1.3 ppb of alachlor, and 2.61 ppb of metolachlor. Seventeen percent of atrazine samples, 10 percent of alachlor samples, and 5 percent of metolachlor samples were above their respective MCLs (*Baker 1989*).

• Lakes and drinking water reservoirs that store spring runoff may harbor extremely high herbicide contamination levels. Atrazine surpassed the MCL in 12 of 14 raw and finished water samples taken from West Lake, near Osceola, Iowa, from April through December 1991. All 14 samples had detectable levels of three atrazine degradates. In addition, cyanazine exceeded the current EPA health advisory level of 10 ppb in all samples taken in July, August, and September of 1991 (*EPA 1992a*).

Cancer risks to young children

Infants, especially those drinking formula mixed with tap water, consume high amounts of water per unit of body weight and as a percentage of their diet. Surface water contaminated with carcinogenic herbicides presents a significant additional cancer risk to these young children. We noted earlier that, as a matter of practice, the EPA routinely separates drinking water from food when assessing dietary risk from a pesticide. The special review of the herbicide alachlor is perhaps the classic example. In this case, the EPA conducted a formal regulatory review of the risks and benefits of alachlor. Yet the Agency excluded the risks from exposure to alachlor in water in its final risk benefit analysis. The data available at the time indicated that the health risks from alachlor in water were equal to or greater than those from food (*EPA 1987*). Ultimately the EPA deferred all regulation of alachlor in water to state regulatory agenices.

The effect of this disaggregation of risk is to make the total dietary risk from a given pesticide (food and drinking water) appear smaller than it really is.

To create a more realistic picture of cancer risk to young children from pesticides, we calculated the annual accumulation of cancer risk from drinking water contaminated with atrazine, cyanazine, alachlor, and metolachlor. Cancer risk was calculated using two estimates of water consumption. First, we assumed a 10-kilogram infant consuming one liter per day, the standard EPA assumption for young children (*EPA 1989c*). The second assumption used data on water consumption from the 1977-1978 USDA National Food Consumption Survey as analyzed by Ershow and Cantor of the National Cancer Institute (*Ershow 1989*).

Six different scenarios were analyzed, using the two different water consumption levels from the EPA and the NCI, and assumptions about herbicide contamination levels based on the data

Table 13

Cancer Risk Accumulated in Childhood From Herbicides in Drinking Water

Atrazine @ 1 ppb, Alachlor @ 0.1 ppb, Cyanazine @ 1 ppb, Metalochlor @ 0.1 ppb

	One liter per day *		Average Tapwater Intake **		Tapwater at 90% Consumption	
	Cumulative Risk	Percentage of Lifetime Risk	Cumulative Risk	Percentage of Lifetime Risk	Cumulative Risk	Percentage of Lifetime Risk
Birth-6 Months	7.6×10^{-7}	2.5%	6.1×10^{-7}	2.5%	9.1×10^{-7}	2.1%
7-12 Months	1.5×10^{-6}	5.0%	1.1×10^{-6}	4.4%	1.5×10^{-6}	3.5%
Age 1	2.7×10^{-6}	8.7%	1.8×10^{-6}	7.4%	2.7×10^{-6}	6.5%
Age 2	3.8×10^{-6}	12.5%	2.5×10^{-6}	10.3%	4.0×10^{-6}	9.4%
Age 3	5.0×10^{-6}	16.2%	3.2×10^{-6}	13.3%	5.2×10^{-6}	12.3%
Age 4	5.7×10^{-6}	18.7%	3.8×10^{-6}	15.7%	6.3×10^{-6}	14.8%
Age 5	6.5×10^{-6}	21.2%	4.4×10^{-6}	18.1%	7.4×10^{-6}	17.3%
Age 6	7.2×10^{-6}	23.7%	4.9×10^{-6}	20.5%	8.4×10^{-6}	19.8%
Nat'l Avg. Annual Risk†	4.4×10^{-7}	1.4%	3.4×10^{-7}	1.4%	6.1×10^{-7}	1.4%
Lifetime Cancer Risk	3.1×10^{-5}		2.4×10^{-5}		4.3×10^{-5}	

* Water consumption was assumed to be one liter a day of water for an average 10kg child.
** Water consumption numbers for 0-6 and 7-12 months are based on tapwater consumption estimates from Ershow and Cantor of the National Cancer Institute (Ershow 1988) modified to reflect the increase since 1978 in powdered and concentrated infant formula mixed at home with tapwater. Calculations are based on 1978 tapwater and total water data and 1991 infant formula sales data indicating 80% of formula is reconstituted at home with tapwater.
† Annual accumulation of risk assuming national average water consumption for each year of life.

Source: Ershow, Abby and Cantor, "Total Water and Tapwater Intake in the United States: Population-Based Estimates of Quantities and Sources," Epidemiology and Biostatistics Program, National Cancer Institute, Bethesda, Maryland, May 1989.

previously summarized from Kansas, Ohio, Illinois, Missouri, Iowa, and the mid-continental region.

In all scenarios considered, by age one, the average child surpassed EPA's lifetime acceptable cancer risk standard of one-in-one-million additional cancer cases in the U.S. population (tables 12 and 13).

Scenarios one through three are based on an atrazine contamination level of 3 parts per billion (ppb) and a cyanazine level of 1 ppb.[5] Scenario one is based on one liter per day of water consumption; scenario two is based on the mean tap water consumption estimates from birth through age 6 from the NCI (*Ershow 1989*);[6] and scenario three is based on the 90th percentile of water consumption from the NCI data. The results are as follows (table 12):

Scenario one: By age 6, the average child accumulates 10 times the EPA's acceptable lifetime cancer risk of one-in-one-million cancers over a lifetime.

Scenario two: By age 6, the average child accumulates 7 times the EPA's acceptable lifetime cancer risk.

Scenario three: By age 6, the average child accumulates 12 times the EPA's acceptable lifetime cancer risk.

Atrazine and cyanazine are not the only herbicides routinely found in surface water. Scenarios four through six account for this fact and are based on exposure to atrazine at 1.0 ppb, cyanazine at 1.0 ppb, alachlor at 0.1 ppb, and metolachlor at 0.1 ppb. Scenario four is based on one liter of water consumption per day; scenario five is based on mean consumption data from NCI; and scenario six is based on the 90th percentile of consumption from the NCI as described above. The results are as follows (table 13):

Scenario four: By age 6, the average child accumulates more than 7 times the EPA's acceptable lifetime cancer risk.

Scenario five: By age 6, the average child accumulates nearly 5 times the EPA's acceptable lifetime cancer risk.

Scenario six: By age 6, the average child accumulates more than 8 times the EPA's acceptable lifetime cancer risk.

Our findings are based primarily on the distribution of risk by age as a function of exposure to pesticides in food and water. At the same time, we recognize the inherent uncertainty in all point estimates of risk. These uncertainties, however, do not significantly affect our results. Young children receive a disproportionately high dietary dose of all pesticides in food and water. In our view, the central issue is not the "accuracy" of risk assessment—that is, whether children exceed their lifetime safe dosage by age 1 or 6 or even 10. Our analysis simply indicates that cancer risk from pesticides in food is disproportionately accumulated in the early years of life. If young children are indeed more sensitive to carcinogens, they will face even greater risks. Policies must be enacted to correct this situation.

End Notes

1 The Office of Air and Radiation has yet to base regulations for individual airborne carcinogens based on their cumulative risks with other airborne carcinogens. On the other hand, the Air office has standards for complex mixtures of carcinogens, such as coke-oven emissions.

2 The guidelines do not recommend a specific additive model. The guidelines state, "Several studies have demonstrated that dose additive models often predict reasonably well the toxicity's of mixtures composed of a substantial variety of both similar and dissimilar compounds. Consequently, depending on the nature of the risk assessment and the available information on modes of action and patterns of joint action, the most reasonable additive model should be used."

3 The Office of Pesticide Programs divides class C carcinogens into two categories: Pesticides where the cancer risk is quantifiable (classified as Cq) and those where the data are too weak to support a quantitative risk assessment (classified as C). Pesticides classified as Cq carcinogens are typically regulated as carcinogens. Examples of widely used Cq pesticides regulated as carcinogens include the fungicide benomyl and the insecticide permethrin.

4 There is no MCL for cyanazine. The current federal health advisory level for cyanazine is 10 ppb; surface water is routinely contaminated with cyanazine levels above 10 ppb.

5 As noted, average annual atrazine levels of 3 ppb and above have been documented in surface water sources of drinking water in Kansas, Ohio, and Iowa. Maximum levels as high as 108 ppb have been recorded in the spring when application is immediately followed by heavy rain. The MCL for atrazine is 3 ppb. The health advisory level for cyanazine is 10 ppb. Both atrazine and cyanazine are closely related triazine herbicides; both are classified by the EPA Office of Pesticide Programs as quantifiable class C carcinogens suitable for cancer risk assessment (*see sidebar on Cancer Risk Estimates*); both are widely detected in surface waters. Both are considered to be endocrine mediated carcinogens, which may indicate a threshold for their carcinogenic effect. Such a threshold, however, has yet to be established.

6 According to the authors, "...it is likely that we have underestimated the fraction of tap water contained in (infant) formulas at the time of feeding and have also underestimated daily intake of tap water in infants." The calculations described in the table footnotes were made to improve the accuracy of these infant tap water consumption estimates based on 1992 infant formula sales data. It is likely that they remain underestimates.

Chapter 5

Conclusions and Recommendations

Pesticide policy must be fundamentally restructured to put the protection of human and environmental health first.

Young American children are continuously exposed to a complex, low-level mix of pesticides in food. The health effects of these exposures are not known, nor are they being investigated. Research has shown, however, that exposure to mixtures of other chemical toxins can cause unexpected, adverse effects. Our analysis shows that much of an individual's lifetime exposure to mixtures of pesticides in food occurs early in life. Nevertheless, the EPA evaluates pesticide safety as though people are exposed to them one at a time. EPA makes no explicit adjustments in food tolerances for pesticides to reflect the potential sensitivity or high pesticide exposure of infants and children.

Our study shows that low-levels of pesticides are pervasive in the food supply. Our analysis of more than 14,000 FDA food sample records found a total of 108 different pesticides on just 22 fruits and vegetables. Thirty eight (38) of the most common pesticides were found on five or more of those crops. Our analysis of comparable data from private-sector sources reveals 81 different pesticides on 19 fruits and vegetables, with 29 pesticides detected on five or more of those crops.

Our analysis of 4,500 fruit and vegetable samples taken from supermarket warehouses and tested by private-sector labs found that 62 percent of orange samples, 44 percent of apple samples, and between one-third and one-fourth of the samples of cherries, peaches, strawberries, celery, pears, grapes, and leaf lettuce had residues or *two or more* pesticides on them. Up to 56 percent of the samples of some foods had residues of cancer-causing pesticides; up to 20 percent of others had residues of two different carcinogens. Children occasionally eat common fruits or vegetables with up to 8 different pesticides on them. These findings were confirmed by pesticide residue test results we analyzed from the seven FDA labs that test most rigorously for pesticides.

Compounding this exposure in fruits and vegetables are pesticides in drinking water, an essential component of the diet that is consumed in relatively large amounts by infants and toddlers. High levels of the most commonly applied crop herbicides are routinely found in streams, lakes, and reservoirs and in municipal drinking water across the mid-continental corn belt. The most potent and prevalent of these herbicides are not removed by conventional public drinking water treatment.

Our analysis shows that, because of their physiology, the types and amounts of foods they eat, and patterns of pesticide residues that occur in or on those foods, American children, on average, accumulate between 25 and 35 percent of their

When cancer risks from just 8 pesticides in 20 fruits and vegetables are added, the average child exceeds the EPA lifetime one-in-one-million risk standard by his or her *first birthday.*

lifetime risk from several different carcinogenic pesticides by age 5. When cancer risks from just 8 pesticides in 20 fruits and vegetables are added, the average child exceeds the EPA lifetime one-in-one-million risk standard by his or her first birthday. By the time the average Midwestern child is old enough to walk, he or she may surpass EPA's benchmark lifetime acceptable cancer risk (one-in-one million) from herbicides in drinking water if the water is drawn from a surface water source. By age 6, these same children may exceed the EPA's lifetime risk standard by more than a factor of 10.

Although these results are disturbing, they should not be construed to advocate less consumption of fruits and vegetables. To the contrary, fruits and vegetables are essential to a healthful and balanced diet for people of all ages. We concur with the general view among nutrition experts that human health will benefit from increased fruit and vegetable consumption. This report does argue, however, that pesticides do pose risks in the food supply, particularly for infants and children. Those risks can and should be reduced or eliminated.

Reform federal pesticide policies

Federal policy for regulating pesticides is in need of fundamental reform. The current pesticide regulatory system is built on the notion of maximum acceptable risk. The effect of this system is not to produce abundant and affordable food using the least amount of pesticides possible. Rather, the systems sets and allows maximum "acceptable" levels of human and environmental exposure to hundreds of pesticides, in thousands of formulated pesticide products, applied to hundreds of food and feed crops. The foundation of this paradigm, which we consider highly implausible, is that scientists and regulators can accurately assess the risks from residues of 20,000 different formulated pesticide products many of which interact and accumulate in the environment and the human body. As this study shows, the pervasiveness of multiple pesticide mixtures in food alone overwhelms any conceivable agenda to study their combined effects.

The pervasiveness of multiple pesticide mixtures in food alone overwhelms any conceivable agenda to study their combined effects.

Pesticide policy must be restructured to put the protection of the human and environmental health first. As a guiding principle, regulatory decisions should be based on the public health rudiment of prevention. Childhood immunization, perhaps the classic preventative public health strategy, blocks disease at the source, reducing future health care costs and providing great public health benefits. A pollution prevention strategy for pesticides would aim to provide similar results. If successful, farmers would produce food with minimal pesticide use, reducing environmental and health costs in the process. To meet this goal, we recommend the following:

- The Administration should adopt a targeted pesticide risk reduction strategy that will gradually but completely phase out pesticides that present the greatest hazards to children. This phase-out should include, at a minimum, all pesticides classified by the EPA as known, probable, or possible human carcinogens, and any non-carcinogenic pesticides for which no threshold of toxicity has been identified.

As a part of this risk reduction strategy, the Administration should implement a national pesticide use reduction policy, directed at high-risk pesticide/crop combinations. The explicit and overriding goal should be to grow food with the least amount of pesticides possible, including, where appropriate, no synthetic chemical pesticides at all. The U.S. Department of Agriculture should consolidate existing research and demonstration on integrated pest management, biological pest control, organic food production, and sustainable agricultural systems into a single program. The purpose of this program should be to develop pest management and cropping system alternatives for farmers who are dependent on pesticides that would be phased out under a public-health-oriented pesticide policy.

• Reform legislation, introduced by Senator Edward Kennedy (D-MA) and Representative Henry Waxman (D-CA), would establish a strict health-based standard for pesticide residues in food. Such a standard would offer significant protection to infants and children against the types of risks identified in this report.

Develop market incentives

Consumers need to become more aware that there are pesticides in the food they feed their children, and that these pesticides pose a health risk. Consumers who want to reduce their children's exposure to pesticides need to demand organic or non-detected residue food from their grocers and from growers. Every day, the supply of organic and non-detected residue food increases. Consumer demand is the quickest route toward improving the supply and availability of safer food. To expand consumer access and farmer markets for foods with less pesticides on it, we recommend the following:

• The U.S. Department of Agriculture should expedite the promulgation of national standards for organically grown foods as authorized in the 1990 Farm Bill.

• The federal government should establish market incentives for farmers who use less pesticides. Specifically, the federal government should create a voluntary "no-detected" or "ultra-low" standard for pesticide residues in food, either through regulation or the Federal Food Drug and Cosmetic Act. Under such a program, farmers who keep records of pesticide applications, and certify that all pesticide residues are below the practical limit of detection, would be able to make a "no-detected residue" or "ultra-low residue" claim in the marketplace for any foods grown. Certification of these claims must be conducted in accordance with FDA-approved sampling and residue detection methods, and all certifying labs must be accredited by the FDA. Growers would be required to report to the appropriate state or federal agency, all pesticide applications to crops bearing a market claim of "no-detected" or "ultra-low" residues. Reports of pesticide applications and results of certification testing would be available to the public for inspection and use. We support full and mandatory recordkeeping for most types of pesticide usage, and full public access to those records.

Improve FDA's pesticide monitoring program

The FDA pesticide monitoring program does not adequately monitor pesticide residues in the food supply. Two basic problems compromise the program. First, many labs do not have or do not use a sufficient number of pesticide detection screens to find pesticides in the food supply. Until those labs improve their techniques, they will have little chance of detecting a representative number of pesticides in the food supply. Second, none of the FDA labs use a sufficient number of single-residue detection techniques to enable them to find some of the most widely used carcinogenic pesticides in food. To remedy this situation we recommend the following:

• The Food and Drug Administration (FDA) must improve and standardize pesticide testing procedures across all regional laboratories. All FDA labs must fully implement the Luke extraction method and all of its detection screens, and all FDA labs must increase their use of the single-residue detection methods.

The Administration should adopt a targeted pesticide risk reduction strategy that will gradually but completely phase out pesticides that present the greatest hazards to children.

Until the agency increases the use of single residue methods, it will continue to grossly under-report the presence of pesticides in food. The duplicative and costly Pesticide Data Program, administered by USDA's Agricultural Marketing Service, should be terminated immediately, and its funds reallocated to pay for these improvements and expansions of the FDA pesticide monitoring program.

- To improve the accuracy of FDA's testing, and to permit the efficient use of more expensive single-residue detection technologies, growers should be required to keep records of all pesticide applications and to make these records available to the appropriate state or federal officials. Without use reporting, even the most sophisticated pesticide monitoring program is nothing more than a well-informed guessing game. The government cannot afford to spend taxpayers' money to find pesticide residues in food without pesticide use information to guide the process.

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Appendix

Figure 12

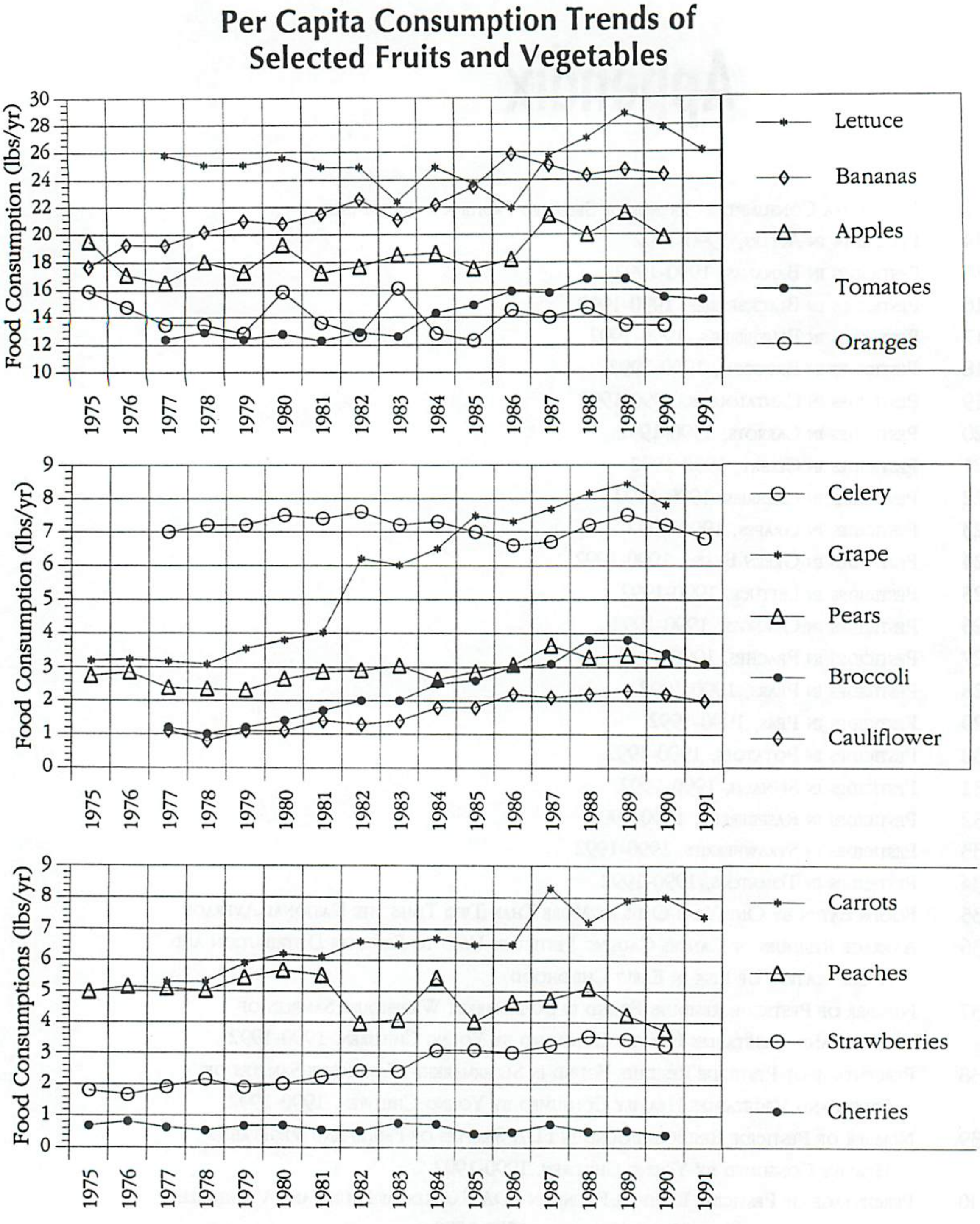

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Table 14

Pesticides in Apples 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
*Benomyl**	263	56%	0.1380	11	0%	0.0000
Diphenylamine	302	55%	0.4803	694	17%	0.4073
Captan	34	53%	0.0799	979	17%	0.0428
Azinphosmethyl	325	49%	0.0384	979	22%	0.0417
Thiabendazole	302	44%	0.2439	694	13%	0.2345
ETU †	131	24%	0.0032	17	53%	0.0448
Chlorpyrifos	348	21%	0.0090	979	16%	0.0074
Propargite	-	-	-	960	6%	0.0219
Phosmet	325	16%	0.0177	979	12%	0.0193
Carbaryl	302	14%	0.0238	740	7%	0.0149
Phosphamidon	325	12%	0.0034	979	6%	0.0038
Endosulfan	34	12%	0.0142	960	7%	0.0027
Dicofol	-	-	-	960	2%	0.0053
Dimethoate	-	-	-	979	3%	0.0035
Ethion	325	6%	0.0128	979	1%	0.0016
Diazinon	325	6%	0.0014	979	2%	0.0007
Parathion	325	5%	0.0021	979	7%	0.0049

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size

* Requires single-extraction residue detection method

† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 15

Pesticides in Bananas 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Chlorpyrifos	137	70%	0.0129	353	25%	0.0090
Thiabendazole	154	58%	0.2671	221	52%	0.3227
Imazalil	154	36%	0.0816	221	8%	0.0404
*Benomyl**	22	9%	0.0026	10	20%	0.0210

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size

* Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 16

Pesticides in Blackberries 1990-1992

	FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)
Iprodione	77	32%	0.0113
Captan	135	19%	0.2601
Carbaryl	80	11%	0.1089
Malathion	123	12%	0.0058

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size

* Requires single-extraction residue detection method

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 17 Pesticides in Blueberries 1990-1992

	FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)
Iprodione	187	11%	0.0824
Captan	251	17%	0.1035
Malathion	252	7%	0.0057

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
• Requires single-extraction residue detection method

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 18 Pesticides in Broccoli 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Methamidophos	-	-	-	641	4%	0.0012
Dacthal	-	-	-	641	7%	0.0032
Endosulfan	-	-	-	641	2%	0.0023
Permethrin	-	-	-	633	2%	0.0058
Chlorothalonil	-	-	-	633	3%	0.0039
Acephate	-	-	-	1,148	3%	0.0037

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
• Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 19

Pesticides in Cantaloupes
1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
*o-Phenylphenol**	36	47%	0.2425	-	-	-
Methamidophos	102	33%	0.0589	781	21%	0.0392
Endosulfan	40	30%	0.0283	765	24%	0.0375
Chlorthalonil	-	-	-	765	22%	0.0330
Diazinon	-	-	-	781	2%	0.0004
DCPA	-	-	-	781	1%	0.0007
Dimethoate	-	-	-	781	2%	0.0028
Acephate	102	1%	0.0001	781	1%	0.0018
ETU †*	-	-	-	49	4%	0.0081

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 20

Pesticides in Carrots
1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
ETU †*	61	23%	0.0067	2	0%	0.0000
DDT, DDE, DDD	208	16%	0.0078	321	19%	0.0121
Linuron	208	13%	0.0089	321	6%	0.0060

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 21

Pesticides in Celery
1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Acephate	29	55%	0.1149	387	25%	0.0563
Dicloran	67	51%	0.1739	387	27%	0.1149
Permethrin	64	38%	0.0863	387	14%	0.0307
*Benomyl**	60	32%	0.0494	18	0%	0.0000
Methamidophos	29	24%	0.0072	387	9%	0.0022
Chlorothalonil	64	19%	0.1573	387	30%	0.2058
Endosulfan	64	14%	0.0185	387	5%	0.0104
Diazinon	29	14%	0.0137	387	10%	0.0088
Parathion	29	14%	0.0187	387	2%	0.0000

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 22

Pesticides in Cherries 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Parathion	38	29%	0.0228	435	18%	0.0180
Azinphosmethyl	38	21%	0.0302	435	16%	0.0369
Malathion	38	18%	0.0453	435	27%	0.0136
Chlorpyrifos	-	-	-	435	6%	0.0009
Dicloran	72	17%	0.2080	435	6%	0.0858
Captan	72	6%	0.0070	435	7%	0.0471
Diazinon	-	-	-	435	5%	0.0011
*Benomyl**	-	-	-	14	29%	0.0839
Dimethoate	-	-	-	435	8%	0.0316
Iprodione	-	-	-	309	28%	0.3175
Parathion	-	-	-	309	6%	0.0027

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 23

Pesticides in Grapes 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Captan	178	44%	0.3127	927	19%	0.2664
Azinphosmethyl	-	-	-	928	3%	0.0061
Endosulfan	-	-	-	925	3%	0.0011
Iprodione	-	-	-	451	14%	0.0827
*Benomyl**	28	36%	0.0743	62	3%	0.0027
Vinclozolin	179	18%	0.0633	927	5%	0.0136
*ETU** †	53	17%	0.0038	-	-	-
Dimethoate	178	12%	0.0063	928	5%	0.0098

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 24

Pesticides in Green Beans 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
*Benomyl**	71	24%	0.0447	-	-	-
Endosulfan	131	24%	0.0385	362	19%	0.0358
Methamidophos	130	23%	0.0331	368	13%	0.0156
Acephate	130	22%	0.1219	368	10%	0.0375
*ETU** †	43	14%	0.0084	-	-	-
Vinclozolin	-	-	-	368	10%	0.0375
Dimethoate	130	11%	0.0231	368	5%	0.0124

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 25

Pesticides in Lettuce
1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Permethrin	137	43%	0.3363	2,378	23%	0.1827
Mevinphos	103	25%	0.0218	2,393	17%	0.0279
Methomyl	50	22%	0.0682	886	1%	0.0064
Dacthal	137	20%	0.0078	2,402	5%	0.0021
Chlorothalonil	-	-	-	2,378	1%	0.0011
DDT,DDE,DDD	-	-	-	2,378	2%	0.0006
ETU †*	-	-	-	51	10%	0.0062
Endosulfan	137	18%	0.0353	2,378	11%	0.0420
Iprodione	48	17%	0.5292	805	1%	0.0647
Acephate	103	13%	0.0853	2,393	3%	0.0059
Dimethoate	-	-	-	2,393	6%	0.0210

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 26

Pesticides in Oranges
1990-1992

Pesticide	Supermarket Warehouse Number of Samples	Supermarket Warehouse Percent Positive	Supermarket Warehouse Avg. Residue (ppm)	FDA Number of Samples	FDA Percent Positive	FDA Avg. Residue (ppm)
*o-Phenylphenol**	44	84%	0.7463	16	44%	0.5256
Thiabendazole	208	67%	0.9112	87	53%	1.7067
Imazalil	208	43%	0.4500	87	39%	0.7978
Methidathion	172	23%	0.0539	501	19%	0.0487
Chlorpyrifos	175	21%	0.0171	502	39%	0.1204
Ethion	172	13%	0.0189	501	9%	0.0122

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 27

Pesticides in Peaches
1990-1992

Pesticide	Supermarket Warehouse Number of Samples	Supermarket Warehouse Percent Positive	Supermarket Warehouse Avg. Residue (ppm)	FDA Number of Samples	FDA Percent Positive	FDA Avg. Residue (ppm)
Dicloran	172	58%	1.0101	493	29%	0.6114
*Benomyl**	127	54%	0.1964	-	-	-
Carbaryl	34	35%	0.8053	361	8%	0.1488
Parathion	105	17%	0.0132	513	14%	0.0132
Phosmet	105	13%	0.0876	513	11%	0.0957
Captan	172	8%	0.0395	493	15%	0.1664
Azinphosmethyl	-	-	-	513	9%	0.0193
Ipriodione	-	-	-	327	17%	0.3173
Chlorpyrifos	-	-	-	513	7%	0.0022

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 28

Pesticides in Pears
1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Azinphosmethyl	233	52%	0.0563	539	23%	0.0403
Thiabendazole	233	44%	0.1993	-	-	-
ETU †*	137	28%	0.0071	-	-	-
*o-Phenylphenol**	23	26%	0.0500	-	-	-
Phosmet	233	22%	0.0270	548	12%	0.0321
Dicofol	30	10%	0.0757	-	-	-
Diazinon	-	-	-	548	3%	0.0011
Parathion	-	-	-	548	7%	0.0085
Captan	-	-	-	549	9%	0.0646

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 29

Pesticides in Peas 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
ETU †*	162	40%	0.1185	128	35%	0.0767
Dimethoate	74	24%	0.0806	748	11%	0.1041
Captan	-	-	-	747	1%	0.0027
Chlorothalonil	-	-	-	709	2%	0.0097
Endosulfan	-	-	-	709	5%	0.0150
Acephate	-	-	-	-	-	-
Malathion	-	-	-	748	3%	0.0065

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 30

Pesticides in Potatoes 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Chlorpropham	135	51%	0.8858	550	33%	0.8131
ETU †*	103	38%	0.0166	4	0%	0.0000
Aldicarb	-	-	-	654	4%	0.0016
Thiabendazole	-	-	-	550	15%	0.1732

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 31

Pesticides in Raspberries 1990-1992

	FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)
Vinclozolin	301	25%	0.0999
Iprodione	221	16%	0.1288
Captan	301	35%	0.6443
Malathion	301	4%	0.0052

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 32

Pesticides in Spinach 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Permethrin	135	42%	0.5911	375	29%	0.3360
DDT,DDE,DDD	135	14%	0.0057	375	17%	0.0086
Endosulfan	-	-	-	375	9%	0.0967
Dimethoate	26	12%	0.0258	378	6%	0.0246

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 33

Pesticides in Strawberries 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
*Benomyl**	32	63%	0.2302	-	-	-
Iprodione	128	51%	0.5283	534	15%	0.2661
Malathion	28	39%	0.0274	987	14%	0.0180
Captan	121	36%	1.5113	986	23%	0.6620
ETU †*	-	-	-	36	31%	0.0354
Endosulfan	-	-	-	932	13%	0.0217
Vinclozolin	153	27%	0.1862	986	29%	0.1634
Carbaryl	128	7%	0.0183	585	4%	0.0505
Dicofol	-	-	-	932	1%	0.0042

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size

* Requires single-extraction residue detection method

† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 34 Pesticides in Tomatoes 1990-1992

	Supermarket Warehouse			FDA		
Pesticide	Number of Samples	Percent Positive	Avg. Residue (ppm)	Number of Samples	Percent Positive	Avg. Residue (ppm)
Methamidophos	292	46%	0.0376	1,148	24%	0.0159
ETU †*	125	28%	0.0035	32	13%	0.0051
Chlorothalonil	203	12%	0.0211	1,129	11%	0.0238
Endosulfan	-	-	-	1,129	9%	0.0088
Permethrin	-	-	-	1,129	4%	0.0037
Chlorpyrifos	332	5%	0.0029	1,148	6%	0.0035
Acephate	292	4%	0.0012	1,148	3%	0.0037

Pesticides listed met one of three criteria: At least 20 samples and 5 positive results or a percent positive of at least 10%; 200 or more samples and a percent positive of at least 5%; or at least 500 samples with 10 positive results.

Pesticides in italics are classified as probable or possible human carcinogens by the EPA.

- Insufficient Sample Size
* Requires single-extraction residue detection method
† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 35

Foods Eaten by One-Year-Olds at More Than Two Times the National Average
(Ranked by Multiple of the National Average)

Rank	Food	Multiple of the Natl. Avg.†	Percentage of Diet	Rank	Food	Multiple of the Natl. Avg.†	Percentage of Diet
1	Bananas-dried	23	0.02%	36	Cantaloupes	4	0.35%
2	Apple juice	21	9.85%	37	Wheat-rough	4	1.08%
3	Wheat germ	13	0.02%	38	Honey	4	0.11%
4	Raisins	12	0.43%	39	Corn sugar	3	0.68%
5	Turkey byproducts	12	0.01%	40	Pimientos	3	0.01%
6	Cottonseed meal	12	0.00%	41	Coconut-copra	3	0.01%
7	Pumpkin	11	0.10%	42	Pineapple juice	3	0.24%
8	Grape juice	11	2.07%	43	Potato-dry	3	0.01%
9	Cranberries	11	0.34%	44	Sweet potatoes	3	0.25%
10	Grapes	10	0.90%	45	Peaches-fresh	3	1.31%
11	Oats	8	1.28%	46	Carrots	3	1.05%
12	Bananas-fresh	7	3.41%	47	Olives	3	0.02%
13	Olive oil	7	0.08%	48	Beet sugar	3	1.96%
14	Sesame seeds	7	0.01%	49	Corn, endosperm	3	0.96%
15	Blueberries	7	0.12%	50	Soy flour, full fat	3	0.02%
16	Popcorn	6	0.08%	51	Cane sugar	3	4.15%
17	Apricots-fresh	6	0.41%	52	Rice-milled	3	0.87%
18	Chicken-w/o skin	6	0.71%	53	Eggs-whole	3	3.17%
19	Cherries-fresh	6	0.37%	54	Oranges-fresh	3	0.82%
20	Cocoa butter	5	0.06%	55	Walnuts	3	0.03%
21	Broccoli	5	0.55%	56	Wheat flour	3	6.81%
22	Strawberries	5	0.37%	57	Turkey w/o skin	3	0.04%
23	Peanuts	5	0.75%	58	Chocolate	3	0.19%
24	Tapioca	5	0.01%	59	Peas	2	0.88%
25	Cranberry juice	5	0.17%	60	Soy flour, defatted	2	0.06%
26	Tomato paste	5	0.37%	61	Shellfish	2	0.17%
27	Apples-fresh	4	4.21%	62	Palm oil	2	0.08%
28	Orange juice	4	10.08%	63	Tomatoes-whole	2	2.38%
29	Milk**	4	12.00%	64	Green beans	2	0.95%
30	Pears	4	1.07%	65	Parsley	2	0.02%
31	Dry beans	4	0.35%	66	Pecans	2	0.02%
32	Tomato catsup	4	0.36%	67	Soybean oil	2	1.39%
33	Plums-fresh	4	0.21%	68	Potato***	2	4.74%
34	Garlic	4	0.01%	69	Corn oil	2	0.10%
35	Egg whites	4	0.07%		Total		85.78%

† Based on consumption per unit of body weight
** Milk is a combination of Milk-non-fat solids, Milk-fat solids, and Milk-sugar
*** Potatoes are a combination of Potato-pulp, Potato-whole, and Potato-skin

Sources: 1977-78 USDA National Food Consumption Survey. 1985-86 USDA Nationwide Food Consumption Survey, Continuing Survey of Food Intakes by Individuals, Children 1-5.

Table 36

Average Residues of Cancer-Causing Pesticides Used to Estimate Distribution and Accumulation of Risk in Early Childhood

1990-1992

Pesticide	Food	Number of Samples	Percent Positive	Avg. Residue (ppm)	Source of Data
Captan	Apples	979	17%	0.0428	FDA
	Strawberries	986	23%	0.6620	FDA
	Pears	540	9%	0.0656	FDA
	Peaches	493	15%	0.1664	FDA
	Peas	747	1%	0.0027	FDA
	Blueberries	250	17%	0.1039	FDA
	Blackberries	134	19%	0.2621	FDA
	Raspberries	302	35%	0.6422	FDA
	Grapes	927	19%	0.2264	FDA
	Cherries	432	7%	0.0471	FDA
Benomyl	Apples	362	41%	0.1380	SW
	Green Beans	71	24%	0.0447	SW
	Peaches	127	54%	0.1964	SW
ETU†	Apples	115	27%	0.0037	SW
	Bananas	38	13%	0.0148	FDA
	Strawberries	36	31%	0.0354	FDA
	Carrots	61	21%	0.0067	SW
	Peas	162	40%	0.1185	SW
	Green Beans	43	14%	0.0084	SW
	Potatoes	103	38%	0.0166	SW
Chlorothalonil	Cantaloupes	765	22%	0.0330	FDA
	Celery	387	30%	0.2058	FDA
	Green Beans	362	4%	0.0055	FDA
	Peas	709	2%	0.0097	FDA
	Tomatoes	1128	11%	0.0238	FDA
Linuron	Carrots	321	6%	0.0060	FDA
Dicofol	Apples	960	2%	0.0051	FDA
	Strawberries	932	1%	0.0042	FDA
	Pears	30	10%	0.0757	SW
Permethrin	Leaf Lettuce	2378	23%	0.1827	FDA
	Celery	387	14%	0.0307	FDA
	Spinach	375	29%	0.3360	FDA
O-Phenylphenol	Orange	44	84%	0.7463	SW
	Cantaloupe	36	47%	0.2425	SW

† ETU (Converted from EBDCs at a rate of 7.5% as stated in "Ethylene Bisdithiocarbamates; Notice of Preliminary Determination to Cancel Certain Registrations, Notice of Availablity of Technical Support Document and Draft Notice of Intent to Cancel," The Federal Register, Part V Environmental Protection Agency, Vol. 54, No. 243, December 20, 1989).

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961. Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 37

Number of Pesticide Residues Found in Supermarket Warehouse Samples of Fruits and Vegetables Heavily Consumed by Young Children 1990-1992

	Number of Samples	Number with zero Residues	Number with 1 Residue	Number with 2 Residues	Number with 3 Residues	Number with 4 Residues	Number with 5 Residues	Number with 6 Residues	Number with 7 Residues	Number with 8 Residues
Apples	542	117	187	98	50	51	23	11	3	2
Apple Juice	25	11	10	4	0	0	0	0	0	0
Bananas	368	234	50	52	32	0	0	0	0	0
Broccoli	63	47	13	3	0	0	0	0	0	0
Cantaloupe	225	147	58	16	3	1	0	0	0	0
Carrots	252	127	83	27	12	2	1	0	0	0
Cauliflower	65	39	20	4	2	0	0	0	0	0
Celery	114	29	51	21	10	3	0	0	0	0
Cherries	90	18	39	26	4	3	0	0	0	0
Grapes	313	121	104	55	26	6	1	0	0	0
Green Beans	249	154	52	30	9	1	2	0	1	0
Leaf Lettuce	201	65	85	30	15	3	3	0	0	0
Oranges	237	47	44	84	47	12	1	1	1	0
Peas	191	104	75	9	3	0	0	0	0	0
Peaches	246	52	108	49	22	11	2	2	0	0
Pears	328	88	142	71	23	3	1	0	0	0
Potatoes	258	138	102	16	2	0	0	0	0	0
Spinach	163	75	63	17	6	0	2	0	0	0
Strawberries	168	30	82	40	12	3	0	1	0	0
Tomatoes	395	192	144	44	12	3	0	0	0	0
Total	4,493	1,835	1,512	696	290	102	36	15	5	2

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961.

Table 38

Percentage of Pesticide Residues Found in Supermarket Warehouse Samples of Fruits and Vegetables Heavily Consumed by Young Children 1990-1992

	Number of Samples	Percent with zero Residues	Percent with 1 Residue	Percent with 2 Residues	Percent with 3 Residues	Percent with 4 Residues	Percent with 5 Residues	Percent with 6 Residues	Percent with 7 Residues	Percent with 8 Residues
Apples	542	21.6%	34.5%	18.1%	9.2%	9.4%	4.2%	2.0%	0.6%	0.4%
Apple Juice	25	44.0%	40.0%	16.0%	-	-	-	-	-	-
Bananas	368	63.6%	13.6%	14.1%	8.7%	-	-	-	-	-
Broccoli	63	74.6%	20.6%	4.8%	-	-	-	-	-	-
Cantaloupe	225	65.3%	25.8%	7.1%	1.3%	0.4%	-	-	-	-
Carrots	252	50.4%	32.9%	10.7%	4.8%	0.8%	0.4%	-	-	-
Cauliflower	65	60.0%	30.8%	6.2%	3.1%	-	-	-	-	-
Celery	114	25.4%	44.7%	18.4%	8.8%	2.6%	-	-	-	-
Cherries	90	20.0%	43.3%	28.9%	4.4%	3.3%	-	-	-	-
Grapes	313	38.7%	33.2%	17.6%	8.3%	1.9%	0.3%	-	-	-
Green Beans	249	61.8%	20.9%	12.0%	3.6%	0.4%	0.8%	-	0.4%	-
Leaf Lettuce	201	32.3%	42.3%	14.9%	7.5%	1.5%	1.5%	-	-	-
Oranges	237	19.8%	18.6%	35.4%	19.8%	5.1%	0.4%	0.4%	0.4%	-
Peas	191	54.5%	39.3%	4.7%	1.6%	-	-	-	-	-
Peaches	246	21.1%	43.9%	19.9%	8.9%	4.5%	0.8%	0.8%	-	-
Pears	328	26.8%	43.3%	21.6%	7.0%	0.9%	0.3%	-	-	-
Potatoes	258	53.5%	39.5%	6.2%	0.8%	-	-	-	-	-
Spinach	163	46.0%	38.7%	10.4%	3.7%	-	1.2%	-	-	-
Strawberries	168	17.9%	48.8%	23.8%	7.1%	1.8%	-	0.6%	-	-
Tomatoes	395	48.6%	36.5%	11.1%	3.0%	0.8%	-	-	-	-
Total	4493	40.8%	33.7%	15.5%	6.5%	2.3%	0.8%	0.3%	0.1%	0.0%

Sources: Environmental Working Group. Compiled from U.S. EPA, Office of Planning, Policy, and Evaluation, Pesticide Food Residue Database, 1991, Anticipated Pesticide Residues in Food: Availability of Document, Federal Register Vol. 56(117):27961.

Table 39

Number of Pesticide Residues Found in FDA Samples of Fruits and Vegetables Heavily Consumed by Young Children 1990-1992

	Number of Samples	Number with zero Residues	Number with 1 Residue	Number with 2 Residues	Number with 3 Residues	Number with 4 Residues	Number with 5 Residues	Number with 6 Residues
Apples	1,038	367	277	224	101	48	20	1
Bananas	478	268	153	41	11	4	1	0
Blackberries	136	57	46	23	8	2	0	0
Blueberries	252	163	60	27	2	0	0	0
Broccoli	641	523	81	25	9	1	2	0
Cantaloupe	781	367	236	119	51	6	2	0
Carrots	345	202	109	25	9	0	0	0
Cauliflower	419	390	22	6	1	0	0	0
Celery	393	103	138	101	33	15	3	0
Cherries	455	164	110	110	39	19	12	1
Grapes	970	609	212	106	35	7	1	0
Green Beans	368	191	101	52	18	5	1	0
Lettuce	2,402	1,198	679	374	108	37	5	1
Oranges	502	148	260	74	12	7	1	0
Peaches	513	124	209	127	38	12	3	0
Pears	550	239	235	57	16	3	0	0
Peas	752	503	185	51	12	1	0	0
Potatoes	765	458	207	87	9	3	1	0
Raspberries	301	113	104	51	25	7	1	0
Spinach	388	170	135	69	11	3	0	0
Strawberries	988	268	390	232	71	25	2	0
Tomatoes	1,164	621	311	175	41	10	5	1
Total	14,601	7,246	4,260	2,156	660	215	60	4

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 40

Percentage of Pesticide Residues Found in FDA Samples of Fruits and Vegetables Heavily Consumed by Young Children 1990-1992

	Number of Samples	Percent with zero Residues	Percent with 1 Residue	Percent with 2 Residues	Percent with 3 Residues	Percent with 4 Residues	Percent with 5 Residues	Percent with 6 Residues
Apples	1,038	35.4%	26.7%	21.6%	9.7%	4.6%	1.9%	0.1%
Bananas	478	56.1%	32.0%	8.6%	2.3%	0.8%	0.2%	-
Blackberries	136	41.9%	33.8%	16.9%	5.9%	1.5%	-	-
Blueberries	252	64.7%	23.8%	10.7%	0.8%	-	-	-
Broccoli	641	81.6%	12.6%	3.9%	1.4%	0.2%	0.3%	-
Cantaloupe	781	47.0%	30.2%	15.2%	6.5%	0.8%	0.3%	-
Carrots	345	58.6%	31.6%	7.2%	2.6%	-	-	-
Cauliflower	419	93.1%	5.3%	1.4%	0.2%	-	-	-
Celery	393	26.2%	35.1%	25.7%	8.4%	3.8%	0.8%	-
Cherries	455	36.0%	24.2%	24.2%	8.6%	4.2%	2.6%	0.2%
Grapes	970	62.8%	21.9%	10.9%	3.6%	0.7%	0.1%	-
Green Beans	368	51.9%	27.4%	14.1%	4.9%	1.4%	0.3%	-
Lettuce	2,402	49.9%	28.3%	15.6%	4.5%	1.5%	0.2%	-
Oranges	502	29.5%	51.8%	14.7%	2.4%	1.4%	0.2%	-
Peaches	513	24.2%	40.7%	24.8%	7.4%	2.3%	0.6%	-
Pears	550	43.5%	42.7%	10.4%	2.9%	0.5%	-	-
Peas	752	66.9%	24.6%	6.8%	1.6%	0.1%	-	-
Potatoes	765	59.9%	27.1%	11.4%	1.2%	0.4%	0.1%	-
Raspberries	301	37.5%	34.6%	16.9%	8.3%	2.3%	0.3%	-
Spinach	388	43.8%	34.8%	17.8%	2.8%	0.8%	-	-
Strawberries	988	27.1%	39.5%	23.5%	7.2%	2.5%	0.2%	-
Tomatoes	1,164	53.4%	26.7%	15.0%	3.5%	0.9%	0.4%	0.1%
Total	14,601	49.6%	29.2%	14.8%	4.5%	1.5%	0.4%	0.0%

Source: Environmental Working Group. Compiled from Food and Drug Administration Pesticide Residue Monitoring Surveillance Data for Import and Domestic Unprocessed Foods 1990-1992.

Table 41

Fungicide and Insecticide Application in Fruits and Vegetables Heavily Consumed by Young Children

Crop	Acres Planted	Active Ingredients (lbs per acre) Fungicide	Insecticide	Total
Pears	79,000	11.6	68.2	79.8
Peaches	207,000	43.0	16.7	59.7
Nectarines	29,162	18.7	32.4	51.1
Grapes	810,712	42.1	5.1	47.2
Apples	571,000	13.7	31.9	45.6
Citrus	1,084,000	6.1	26.7	32.8
Tomatoes	369,000	29.7	3.0	32.7
Strawberries	42,930	21.9	5.7	27.6
Cherries	128,000	13.0	9.5	22.5
Plums	148,614	4.1	17.1	21.2
Apricots	21,027	5.4	15.2	20.6
Melons	24,969	13.3	7.3	20.6
Blackberries	4,472	17.7	2.2	19.9
Raspberries	9,939	11.7	3.9	15.6
Celery	33,000	9.2	5.4	14.6
Brussel sprouts	4,197	2.6	8.2	10.8
Carrots	85,000	9.5	1.0	10.5
Blueberries	48,748	7.1	2.7	9.8
Cauliflower	52,716	1.0	5.4	6.4
Potatoes	1,302,000	3.2	2.9	6.1
Broccoli	96,214	2.0	4.0	6.0
Cantaloupes	113,000	4.4	1.1	5.5

Public Voice for Food and Heath Policy, May 1993. Agrichemicals in America: Farmers' Reliance on Pesticides and Fertilizers, A study of Trends Over 25 Years. Washington, D.C. p 89-92.

Table 42

Percentage of Fruits and Vegetables Heavily Consumed by Young Children Treated with Carcinogenic Fungicides

	Benomyl	Captan	Chlorothalonil	Mancozeb	Maneb	Metiram
Apples	14%	38%	-	43%	1%	10%
Blueberries	52%	66%	-	-	-	-
Broccoli	-	-	40%	-	49%	-
Cherries	10%	15%	31%	-	-	-
Grapes	12%	-	-	13%	2%	-
Green Beans	-	-	8%	-	-	-
Onions	-	-	-	56%	-	-
Peaches	25%	49%	34%	-	-	-
Peanuts	2%	-	89%	-	-	-
Pears	13%	1%	-	-	-	-
Potatoes	-	1%	22%	39%	24%	-
Raspberries	47%	51%	-	-	-	-
Strawberries	81%	79%	7%	-	-	-
Tomatoes	-	1%	54%	33%	19%	-

Source: Gianessi, L. P. and C. A. Puffer, "Fungicide Use in U.S. Crop Production," Resources for the Future, August 1992.

ENVIRONMENTAL WORKING GROUP

1718 CONNECTICUT AVE. NW, SUITE 600

WASHINGTON, D.C. 20009

TEL. (202)667-6982•FAX (202)232-2592

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