

California Food Guide

Environmental Contaminants of Food

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Environmental contaminants are chemicals present in the environment that have a known or potential impact on human health. They may be present in food and water supplies yet nutrients and phytochemicals in food offer some protection against their toxicity. This chapter addresses dietary exposures to environmental chemical contaminants, such as lead, mercury, pesticides, phthalates, polyaromatic hydrocarbons (PAHs), and persistent organic pollutants (POPs) that include dioxins, polychlorinated biphenyls (PCBs), and polybrominated diphenyl ethers (PBDEs). A number of the objectives outlined in Healthy People 2010 aim to reduce human exposure to chemical contaminants.¹

What's New: Healthy People 2010 Objectives¹

#8-1 Increase the proportion of persons served by community water systems who receive a supply of drinking water that meets the regulations of the Safe Drinking Water Act.

#8-10 Reduce the potential human exposure to persistent chemicals by decreasing fish contaminant levels.

#8-11 Eliminate elevated blood lead levels in children.

#8-13 Reduce pesticide exposures that result in visits to a healthcare facility.

#8-14 Reduce the amount of toxic pollutants released, disposed of, treated, or used for energy recovery.

#8-25 Reduce exposure of the population to pesticides, heavy metals, and other toxic chemicals as measured by blood and urine concentrations of the substances or their metabolites.

#10-7 Reduce human exposure to organophosphate pesticides from food.



Public Health Implications

Human exposure to hazardous agents in our food and water contributes to illness, disability, and death. Poor environmental quality has its greatest impact on people whose health may already be at risk, notably pregnant women, young children, the elderly, and people with preexisting illnesses. National efforts to ensure clean and safe food and water supplies continue to contribute significantly to improvements in public health and prevention of disability.

Definition

The major categories of environmental contaminants in food and water include agricultural chemicals (pesticides), chemicals migrating from packaging materials or food service utensils, and industrial and environmental pollutants) that build up in the food chain. Table 1 gives examples of health hazards posed by environmental contaminants found in food and water.

Table 1: Environmental Contaminants of Public Health Concern

Contaminant	Biomarker	Health Effects	Potential Food Related Sources	References
Lead	Blood	<p>Learning and behavioral problems in children at low lead levels</p> <p>Seizures, coma, and death at levels of 70 micrograms/dL and above</p> <p>Hypertension and renal tubular dysfunction in adults with low-dose exposures</p> <p>Some evidence of early cognitive decline in the elderly, and increased risk of cataracts</p> <p>Lead in pregnant women is transmitted to the fetus and can affect nervous system development</p> <p>Good nutritional status, including high intakes of calcium, vitamin C, and iron can help reduce absorption of lead</p>	<p>Soil and dust on hands and in food</p> <p>Some herbal remedies such as greta or azarcon from Central America</p> <p>Food or beverages cooked, served or stored in glazed pottery from Mexico, Asia, or other countries</p> <p>Imported candies and candy wrappers, particularly those made with chili from Mexico</p> <p>Imported seasonings, especially from Mexico</p> <p>Mexican grasshopper treats (especially Oaxacan)</p> <p>Leaded glassware</p> <p>Food imported in lead-soldered cans</p> <p>Ayurvedic remedies (from South Asia)</p> <p>Sindoor, a South Asian cosmetic occasionally used as food coloring</p> <p>Water from faucets, pipes, and plumbing with lead or lead solder</p> <p>The major sources of</p>	2, 3, 4, 5, 6, 7, 8

			environmental lead are paint produced before 1978 and lead-contaminated soil and dust	
Methylmercury	Blood	Adverse developmental and cognitive effects in the fetus, infants, and children In adults: <ul style="list-style-type: none"> ➤ Paresthesia ➤ Fatigue ➤ Vision changes ➤ Cognitive disturbances 	Methylmercury, the organic form of mercury, is found in fish. The US Food and Drug Administration (US FDA) recommends that women of childbearing age, pregnant and breastfeeding women, and children avoid eating large predatory fish with the highest levels such as: <ul style="list-style-type: none"> ➤ Shark ➤ Swordfish ➤ Tilefish ➤ King mackerel <p>The U.S. FDA also recommends limiting albacore tuna and tuna steak consumption to 6 oz. per week</p> <p>Methylmercury levels in fish caught recreationally may be at levels that pose health concerns</p>	9, 10, 11, 12
Persistent Organic Pollutants (POPs) (e.g., polychlorinated biphenyls [PCBs], dioxins, polybrominated diphenyl ethers [PBDEs])	Blood Breast milk	Cancer Thyroid dysfunction Immunosuppression Hormone disruption Reproductive abnormalities Liver disorders Neurodevelopmental deficits	Fish and meats Animal fats Dairy products Eggs POPs enter the food chain and accumulate in the fatty tissues of animals and humans Highest levels are generally found in human breast milk	2, 13, 14, 15, 16, 17
Pesticides (chemicals used to control weeds, diseases, insects, fungi, or other pests on crops, landscape, or animals)	Urine, blood or breast milk depending on the chemical, e.g., cholinesterase levels in blood serve	Organophosphate pesticides are associated with neurological dysfunction resulting from inhibition of acetylcholine breakdown in neural tissue Other health effects related to pesticides include: Birth defects	Food, including fruit, vegetables, cereal and grain products, meats, and dairy products Water supplies	2, 18, 19, 20

	as a biological marker for organo-phosphate pesticides	Respiratory effects Immune system effects Reproductive dysfunction Low birthweight Subtle neurodevelopmental effects Endocrine disruption Cancer		
Polyaromatic hydrocarbons (PAHs) (a class of chemicals that result from incomplete burning of organic substances like meats, coal, oil, or gas)	Urine, blood	Cancer Low birthweight Decreased head circumference in newborns	Smoked, charcoal-broiled, and roasted foods At high heat, such as when grilling meats, heterocyclic amines can form	2, 21, 22
Phthalates (a group of chemicals used to soften and increase flexibility of plastics and vinyls)	Urine	Animal and human studies show different phthalate compounds exhibit developmental and reproductive toxicity at various levels Cancer	Upon contact with foods, phthalates found in plastics can leach and migrate into foods, especially those with high fat content, such as full-fat dairy products, meats, fish, and oils Polyvinyl chloride infusion lines for parenteral nutrition	2, 23, 24, 25, 26, 27

Burden

Federal, state, and local government programs are charged with the responsibility to maintain high food safety standards. Monitoring and enforcement help ensure that our food supply is among the safest and most abundant in the world. Nevertheless, improvements are still needed. In a survey about public perceptions of environmental health risks, about half of Californians surveyed ranked chemicals in food and water as serious factors in causing disease.²⁸ Potential health hazards are associated with environmental chemicals in foods. Acute poisonings related to accidental chemical releases into the food supply have been reported.²⁹ More difficult to quantify are health effects related to chronic exposures to chemicals that are found in low levels in food. Metals like lead and mercury are known neurotoxicants that may enter the food chain. Persistent organic pollutants (POPs) include chemicals such as polychlorinated biphenyls (PCBs), dioxins, polybrominated diphenyl ethers (PBDEs), and organochlorine insecticides, like dichlorodiphenyltrichloroethane (DDT). Although PCBs

and most organochlorine pesticides are now banned for use in the United States, PBDEs continue to be produced and widely used, due to their flame retardant properties; and dioxins are largely formed as byproducts of combustion and other industrial processes.^{13, 30} POPs are remarkably stable in the environment and can enter the food chain. They can be found in meat, dairy products, fish, and breast milk and, when eaten by humans, accumulate in our fatty tissues. A number of adverse health effects, such as immunosuppression, hormone disruption, reproductive abnormalities, neurodevelopmental disorders, and cancer, have been linked to long-term, low-dose exposures to POPs.¹³ Pesticides (chemicals used to control weeds, diseases, insects, fungi, or other pests on crops, landscape or animals) may be inhaled, absorbed through the skin, or through the digestive tract. Farmers, agricultural workers, pest-control workers, and their families are most likely to be exposed to doses high enough to have an effect on health.^{2, 20}

Human disease is multifactorial, involving environmental, lifestyle, socioeconomic, and genetic factors acting over a lifetime. Estimated total costs, including personal health care costs and lost productivity costs, for only nine environmentally related diseases in California amounted to more than ten billion dollars in 2000.³¹ Costs are likely much higher since these estimates only looked at costs related to five cancers (prostate, cervical, ovarian, uterine, and childhood cancers), child lead poisoning, childhood asthma, neurodevelopmental disorders, and birth defects.

Exposures to many environmental contaminants are decreasing.^{2, 32} For example, in 1993, approximately 22 percent of U.S. children lived in an area served by a public water system that had at least one major monitoring and reporting violation. This figure decreased to about ten percent in 1999³² - the largest number of monitoring and reporting violations occurred for lead and copper. However, public and regulatory action is needed to reduce exposure to emerging chemicals of concern, such as PBDEs.^{30, 31}

Incidence and Prevalence

Data on the incidence and prevalence of health disorders related to chemical contaminants in food are not readily available. Acute episodes related to inadvertent or accidental contamination of foods with heavy metals or pesticides are more likely to be reported; however, no mandatory reporting system exists. The existence of pesticide residues and their metabolites in human breast milk and in children is of particular concern because children are more heavily exposed per kilogram of body weight and are more vulnerable than adults to the effects of pesticides.¹⁸

The Centers for Disease Control and Prevention's (CDC) National Report on Human Exposure to Environmental Chemicals is an ongoing assessment of the exposure of the general United States population to environmental chemicals present in air, water, food, soil, dust, or other environmental media, using biomonitoring.² Over 140 chemicals or their metabolites, including mercury, lead, pesticides, PAHs, and phthalates are measured in blood and urine samples taken from selected participants in the 1999-2000

and 2001-2002 National Health and Nutrition Examination Survey (NHANES). Exposure levels identified in the CDC reports are useful for establishing reference ranges to determine whether individuals or groups of people have an unusually high exposure or exceed currently defined levels of concern. CDC currently considers an elevated blood lead level as one greater than ten micrograms per deciliter or a blood mercury level greater than 5.8 micrograms per liter. However, separate epidemiological and animal research studies are needed to determine body burden levels of a chemical that may cause or contribute to a particular health effect or disease.

Trends/Contributing Factors

Selected findings from CDC's report on human exposures² include:

- **Lead:** NHANES data indicate that the prevalence of elevated blood lead levels among U.S. children aged 1-5 years dropped from 88 percent in the late 1970s to 4.4 percent in the early 1990s and 1.6 percent in 1999-2002. However, risk of elevated blood lead levels is disproportionately higher among children enrolled in Medicaid or the Women, Infants, and Children (WIC) Supplemental Nutrition Program, and children from low-income and uninsured families targeted by federal- and state-supported health center programs. In the early 1990s, the prevalence among these low-income children was 8.4 percent, or nearly five times the 1.7 percent prevalence among children not enrolled in these low-income programs. For children served by WIC in the 1990s, one in nine children, or 12 percent, had elevated blood lead levels.⁶ State data does not exist regarding prevalence of elevated blood lead levels among California children or adults. Analysis of California's Childhood Lead Poisoning Prevention Branch 2004-2005 data indicate that 4287 children were identified with elevated blood lead levels, or slightly under 1 percent of children tested. A few counties had two to four percent of tests with elevated blood lead levels. This reflects increased reporting following the universal laboratory reporting of blood lead tests in California that became effective in January, 2003, and is a decreased rate from previous years.³³
- **Mercury:** Based on 1999-2002 data from the National Health and Nutrition Examination Survey, about six percent of women aged 18-49 years had blood mercury levels higher than the U.S. Environmental Protection Agency's (U.S. EPA's) recommended reference dose (5.8 micrograms per liter), below which exposures are considered to be unlikely to cause adverse effects in the developing fetus. Mercury is a neurotoxicant that can cross the placenta and affect brain and central nervous system development in infants and young children. Based on the blood mercury levels found in women of childbearing age, the number of births in 2000, and recent data documenting a higher fetal cord blood to maternal blood methylmercury ratio, it is estimated that more than 400,000 newborns may have been exposed in utero to mercury concentrations that put them at increased risk for adverse neurodevelopmental effects.⁹⁻¹¹

- **POPs:** Levels of such POPs as dioxins, furans, and PCBs with dioxin-like toxicity have been presented for the first time in the most recent CDC report.² It is estimated that serum lipid-based levels of dioxins and dibenzofurans decreased by more than 80 percent in the 1980s.² The newer data will allow improved risk assessments used to determine health risks from exposure to these chemicals.
- **DDT:** Compared with levels of DDT in several smaller exposure studies conducted before 1990, levels of DDT and its metabolite, dichlorodiphenyldichloroethylene (DDE), are lower but still detectable, even though DDT was banned for use in the United States in 1973. Continued exposure in the United States is likely due to persisting levels in the environment or DDT residues in food. Serum DDE levels are four times higher among Mexican Americans than among nonHispanic whites and two times higher than among nonHispanic blacks.² DDT is still used in Mexico for mosquito control.
- **Phthalates:** Urinary levels of monoester metabolites of various phthalates were measured in the 1999-2002 NHANES survey. People are exposed to phthalates through direct contact with products containing phthalates or through food that is in contact with packaging that contains phthalates. Measurable amounts were detected and provide a reference range that is useful for determining whether people are exposed to higher levels than those in the general population.²

Although PBDEs analyses were not included in NHANES 1999-2000, they were included in 2001-2002. Reporting of values found will be forthcoming from CDC in future reports. Other previous studies report body burden levels of PBDEs appear to be increasing worldwide, with some of the highest levels reported in California women.³⁴

Certain food processing methods also contribute to the presence of chemicals in foods that pose health concerns. For example, cooking meats by high-temperature cooking methods, such as grilling or sautéing, can lead to the formation of heterocyclic amines.²² Also, frying, roasting, or baking can lead to the formation of acrylamide in foods, especially high carbohydrate foods. In 2002, Swedish researchers found acrylamide in high carbohydrate foods cooked at high temperatures, such as french fries and potato chips. Acrylamide is a genotoxicant, and based on high-dose animal studies, it is a potential human carcinogen. The U.S. FDA is developing methods for acrylamide analysis to assess dietary exposure of consumers and the potential for health risks.^{35, 36}

Barriers to Implementation/Myths

Most health effects studies of environmental contaminants are conducted with animals. Many factors must be considered before extrapolating animal results to human health conditions, including route and timing of exposure, and endpoint of concern. Nevertheless, in keeping with the Precautionary Principle which advocates that society should not wait until it knows all of the answers before attempting to protect against significant harm, it is prudent to reduce our exposures to environmental contaminants.³⁷

Pregnant women, young children, the elderly, and people with preexisting illnesses are of special concern. Industry, government agencies, and consumers must work together to formulate and implement strategies to prevent or reduce exposures to environmental contaminants having a negative impact on humans and their environment.

Biomonitoring, or determining body levels of environmental contaminants, provides important information about exposure, but the presence of chemicals in our bodies does not by itself mean that the exposure causes disease. Learning more about body burden levels and exposures through scientifically sound biomonitoring studies will help facilitate the development of information about chemical exposures and their effects on human health.

Poisoning from lead, mercury, and other environmental contaminants are often, like hypertension, silent diseases. With some chemicals such as lead, unless levels are unusually high, there may be no symptoms. Developmental or neurologic effects may be subtle and require specific laboratory or clinical tests. Access to a laboratory or other facility capable of performing these tests, as well as the ability to pay for these tests, may be barriers for many families.

A number of environmental contaminants have been detected in breast milk.^{15, 38} Despite their presence, breast milk remains the best source of nutrition for infants.^{39, 40} Breast milk and breastfeeding provide multiple benefits for optimal infant growth, development and immunity, and for maternal health. Generally, the benefits of breastfeeding outweigh potential health risks from exposure to chemical contaminants in human milk. Continued efforts are needed to promote and support breastfeeding, and to reassure mothers who are concerned about environmental contaminants.⁴¹

Certified organically raised animals or produce have fewer environmental contaminants when compared to conventionally grown products; but, they do not differ in nutritive value. Recent evidence indicates that consumption of organic fruit, vegetables, and juice can reduce children's exposure levels from certain organophosphate pesticides to levels associated with negligible health risks, as estimated by the U.S. EPA.⁴²

Because information on chemical contaminants is increasing, with potential new hazards emerging, healthcare professionals must be alert to new evidence. Consumers will rely on healthcare professionals to separate scientifically sound evidence from common myths. A good source of information for both consumers and healthcare professionals is the U.S. FDA Center for Food Safety and Applied Nutrition, accessible at www.cfsan.fda.gov.

Common Concerns/Strategies

Eat a variety of foods to maintain optimal nutritional status and to reduce exposure and impact of environmental contaminants.

To reduce exposure to lead in food:

- Eat a well-balanced diet with adequate amounts of iron, calcium, and vitamin C to minimize the absorption of lead from the digestive tract.
- Wash hands and faces of children frequently.
- Wash food before preparing it.
- Avoid imported canned products as the cans may have lead seams.
- Avoid preparing or storing foods or drinks in pottery ware with lead glaze or in leaded glassware.
- Avoid eating candy imported from Mexico as it may expose the person to lead.
- Do not use traditional remedies from other countries, particularly brightly colored remedies.
- Consider having your tap water tested for lead if your feeder line is old and may contain lead and if the water lines in your home may be soldered with lead.

To reduce exposure to mercury in fish and seafood:

- Women of childbearing age, pregnant and lactating women, and children should avoid shark, swordfish, tilefish, and king mackerel.
- If you eat canned tuna, eat chunk light tuna, which has less mercury than albacore (solid white or chunk white) tuna. If you eat albacore tuna or tuna steaks, limit consumption to six ounces per week and eat no other fish that week.
- Eat wild salmon, farmed catfish, shrimp, scallops, and pollock that have little or no mercury.
- Follow fish consumption advisories for areas where you fish. Contact the local health or environmental health department, or check the website for the California state agency that issues consumption advisories for sportfish: www.oehha.ca.gov/fish.html.
- For more detailed information about mercury in fish and seafood, check the websites for US FDA and US EPA listed below: (www.cfsan.fda.gov/seafood1.html and www.epa.gov/waterscience/fish/advisory.html)
- Check for multilingual educational materials available from the Environmental Health Investigations Branch, CA DHS, www.ehib.org

To reduce exposure to persistent organic pollutants in animal foods, fish, and shellfish:

- Decrease intake of animal fats;
 - Choose leaner cuts of meats and lower fat dairy foods.
 - Trim fat from meat and poultry.
 - Remove skin from poultry and fish.
 - Do not consume organ meats or guts of fish and shellfish.
 - Discard fats and oils in broths and pan drippings.

- Follow fish consumption advisories for areas where you fish (see above).

To reduce exposure to pesticide residues on produce:

- Select produce that is free of dirt, cuts, or other signs of spoilage.
- Wash produce in running water (do not use soap) to remove non-systemic pesticides.
- Scrub skin of produce or peel off outer leaves.
- Consider purchasing organic produce, if available and feasible.

To reduce exposure to phthalates in foods:

- Minimize storing and heating food in plastic packaging or containers. Consider using glass for storing and heating food.
- Reduce consumption of fatty foods like full-fat milk products, meat, fish, and oils.

To reduce exposure to PAHs and heterocyclic amines in foods:

- Avoid grilling foods when possible.
- Marinate foods before grilling.
- Before grilling, trim fat on meats; remove skin from poultry and fish, to have less fat drop into flames. Precook meats, fish, and poultry in oven or microwave and briefly grill for flavor.
- Flip food often when grilling.
- Remove all charred or burned portions of food before eating.

Opportunities for Improvement

- Promote the reduction/elimination of lead, mercury, persistent organic pollutants, pesticides, phthalates, and other contaminants from all food products and processing methods.
- Support legislation, policies, and procedures that reduce or eliminate environmental contaminants and promote pollution prevention/reduction measures.
- Circulate U.S. EPA and CDC reports on environmental contaminants via the internet and other public media.
- Educate healthcare and education professionals about the risks of environmental contaminants in our food supply and ways to reduce exposure.
- Develop and circulate low-literacy, illustrated materials in multiple languages on ways to reduce exposures to environmental contaminants in food.
- Develop media presentations in multiple languages to provide accurate information about environmental contaminants to the public.

- Continue to support and enhance national, state, and local systems to monitor existing and emerging environmental contaminants.

Clinical Implications

Sources of lead, mercury, persistent organic pollutants, toxic pesticides, and other environmental chemicals should be identified and measures taken to prevent or reduce human exposure to them. Women of childbearing age, pregnant and breastfeeding women, infants and children are particularly vulnerable. Clinicians can take an environmental exposure history to identify sources of exposure that include air, water, food, or direct contact, followed by appropriate biochemical and clinical tests as needed. Therapeutic measures will depend on the exposure and contaminant(s) of concern.^{43, 44} Guidelines for taking an exposure history can be found at: <http://www.atsdr.cdc.gov/HEC/CSEM/>.

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