

1. PUBLIC HEALTH STATEMENT FOR ENDOSULFAN

This Public Health Statement summarizes the Division of Toxicology and Human Health Science's findings on endosulfan, tells you about it, the effects of exposure, and describes what you can do to limit that exposure.

The U.S. Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are sites targeted for long-term federal clean-up activities. U.S. EPA has found endosulfan in at least 176 of the 1,699 current or former NPL sites. The total number of NPL sites evaluated for endosulfan is not known. But the possibility remains that as more sites are evaluated, the sites at which endosulfan is found may increase. This information is important because exposure these future sites may be sources of exposure, and exposure to endosulfan may be harmful.

If you are exposed to endosulfan, many factors determine whether you'll be harmed. These include how much you are exposed to (dose), how long you are exposed (duration), and how you are exposed (route of exposure). You must also consider the other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

WHAT IS ENDOSULFAN?

Endosulfan is a restricted-use pesticide that is particularly effective against aphids, fruit worms, beetles, leafhoppers, moth larvae, and white flies on a wide variety of crops. It is not approved for residential use. It is sold as a mixture of two different forms of the same chemical (referred to as α - and β -endosulfan). It is a cream-to-brown-colored solid that may appear crystalline or in flakes. It has a distinct odor similar to turpentine. The use of endosulfan is being restricted to certain crops and is scheduled to be canceled for all uses by 2016.

Solid and liquid formulations are currently registered for active use in the United States. Dustable and wettable powders are recognized by the United Nations Food and Agriculture Organization (UN FAO), and may be available outside the United States. The restricted use classification requires that registered products may only be applied by a "certified pesticide applicator" or under the direct supervision of a certified pesticide applicator. Endosulfan is applied to crops by aerial or ground-level foliar spray.

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WHERE IS ENDOSULFAN FOUND?

Endosulfan can be released into the air, water, and soil in areas where it is applied as a pesticide.

Levels of endosulfan in air samples are highly variable depending on location. Remote Arctic air concentrations range from 3.3 to 8.3 picograms per cubic meter [pg/m³]. Rural areas tend to have higher reported concentrations (18–82 pg/m³), with spikes reported during growing seasons. In the air, α - and β -endosulfan may be broken down by chemical reactions, but are not expected to be broken down by direct sunlight. Endosulfan sulfate may be broken down by sunlight, but data are conflicting. Endosulfan can be transported long distances in the air to remote locations.

Levels of endosulfan in drinking water sources are regularly monitored through federal and state government programs. Endosulfan is not often detected in groundwater. Surface water concentrations are highly variable, but are generally highest in water bodies that drain areas of high agricultural use (0.21–54 nanograms/liter [ng/L] for α -endosulfan). α -Endosulfan and β -endosulfan will transform in water into the less toxic endosulfan diol. Endosulfan sulfate is more difficult to break down in water.

Endosulfan is applied directly to plants and soil during its use as pesticide. In soil, endosulfan attaches to soil particles and is not expected to move from soil to groundwater. α -Endosulfan and β -endosulfan are expected to break down in soil, but endosulfan sulfate is more resistant. Movement of α - and β -endosulfan from soil surfaces to air may be significant.

Endosulfan residues can be present in food; the highest concentrations reported were in fresh and frozen vegetables (0.011–0.037 parts per million [ppm]).

HOW MIGHT I BE EXPOSED TO ENDOSULFAN?

Dietary intake is expected to be the main source of endosulfan exposure to the general population. Exposure will also occur, although to a much lesser extent, by breathing contaminated air or drinking contaminated water or if you touch fruits or plants that have been sprayed with endosulfan. Farm workers are expected to be exposed to higher amounts of endosulfan compared to the general population. These exposures may occur through direct handling and application or through exposure in fields that were previously sprayed (occupational re-entry). In addition to individuals who are occupationally exposed to endosulfan, there are several groups within the general population that have potentially high exposures

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(higher than background levels). These populations include individuals living in the proximity of sites where endosulfan was produced or sites where endosulfan was disposed of.

HOW CAN ENDOSULFAN ENTER AND LEAVE MY BODY?

Endosulfan can enter your body from water, food, or soil. If you drink water containing endosulfan, some will be absorbed into your body through the digestive tract, but we do not know how much. If you eat food contaminated with endosulfan, most of it will probably rapidly be absorbed through the digestive tract. If you touch soil contaminated with endosulfan or fruits or plants that have been sprayed with it, some small amount of endosulfan may be absorbed through the skin.

Endosulfan has been detected in the urine of exposed people. In animals, endosulfan and breakdown products leave the body mainly in the feces within a few days or weeks.

HOW CAN ENDOSULFAN AFFECT MY HEALTH?

The health effects of endosulfan depend on how much endosulfan you are exposed to and the length of that exposure. Environmental monitoring data suggest that any endosulfan levels the public might encounter through direct contact or through water, soil, or food are generally low, much lower than animal study levels.

People exposed to high levels of endosulfan, either intentionally or in contaminated food, or who were exposed during spraying fields, suffered tremors and seizures and some died.

The same types of effects have been observed in animals exposed briefly to high levels of endosulfan.

Two studies of environmental exposure of humans suggested that endosulfan may be associated with alterations in the levels of thyroid hormones and some sex hormones in the blood. However, participants in the study were also exposed to other pesticides and there was no evidence that the people had significant health problems due to their exposure to the pesticides. A study of people in India found that exposure to endosulfan was not associated with increased risk of Alzheimer's disease.

A study in rats suggested that endosulfan could impair the immune system of the animals, although this was not tested directly. In some studies in animals, endosulfan induced alterations in the testes and reduced the amount and quality of the sperm; it also has reduced the level of testosterone, a sex hormone,

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in the blood. Animal studies have shown that swallowing endosulfan in contaminated food over long periods affects mainly the kidneys.

Studies of occupational and environmental exposure of humans did not provide conclusive evidence that endosulfan can cause cancer. Endosulfan did not cause cancer in animal studies.

The U.S. Department of Health and Human Services (DHHS), the U.S. EPA, and the International Agency for Research on Cancer (IARC) have not classified endosulfan as to its ability to cause cancer.

See Chapters 2 and 3 for more information on endosulfan health effects.

HOW CAN ENDOSULFAN AFFECT CHILDREN?

This section discusses potential health effects of endosulfan exposure in humans from when they're first conceived to 18 years of age, and how you might protect against such effects.

Children who accidentally ate endosulfan or received applications of endosulfan onto the skin to remove lice developed seizures, the same effect seen in adults exposed to high amounts of endosulfan.

We do not know whether endosulfan can produce birth defects in children. Studies have examined possible associations between maternal exposure to endosulfan and autism, thyroid function, and development of the nervous system in newborn children. Studies also have examined potential associations between direct exposure of children to endosulfan and blood cancer and sexual maturation in males. In all cases, the results were suggestive but not conclusive due to study limitations. A study of Chinese people did not find an association between birth weight and exposure of the mothers to endosulfan.

Exposure of pregnant animals to endosulfan can produce abnormalities in the skeleton and organs in the offspring and reduced pup weight during lactation. This often occurred with doses that were also toxic to the mothers. Recent studies also have shown that exposure of rats and mice to endosulfan during pregnancy and lactation can alter the levels of some chemicals in the brain of their offspring. Proper levels of these chemicals are important for the normal functioning of the brain; however, these studies did not test the animals to determine whether their behavior or health was affected.

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Some studies showed that exposure of pregnant rats to endosulfan resulted in decrease in sperm in the male offspring when they reached adulthood. Other studies did not find this effect.

Endosulfan has been found in human breast milk, which means that mothers can transfer this chemical to their babies by nursing.

HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO ENDOSULFAN?

If your doctor finds that you have been exposed to significant amounts of endosulfan, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

To prevent exposure and risk to the general population, the EPA deemed endosulfan a restricted-use pesticide and it is also not allowed and should not be used for residential purposes. The use of endosulfan is scheduled to be canceled for all uses by 2016. Because of these actions and environmental degradation processes, it is likely that exposure to endosulfan to the general population and workers in the United States will decrease.

ARE THERE MEDICAL TESTS TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ENDOSULFAN?

Endosulfan and its breakdown products (metabolites) can be measured in blood, urine, fat tissue, and breast milk. However, the detection of endosulfan does not necessarily mean that you will suffer adverse health effects. Because endosulfan and its metabolites leave the body fairly rapidly (within days), the tests need to be conducted within a few days after exposure.

For more information on the different substances formed by endosulfan breakdown and on tests to detect these substances in the body, see Chapters 3 and 7.

WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect

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public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed as “not-to-exceed” levels; that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value usually based on levels that affect animals; levels are then adjusted to help protect humans. Sometimes these not-to-exceed levels differ among federal organizations. Different organizations use different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or emphasize some factors over others, depending on their mission.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that issued the regulation or recommendation.

The U.S. EPA recommends that the amount of endosulfan sulfate in lakes, rivers, and streams should not be more than 62 micrograms per liter ($\mu\text{g/L}$). This should prevent any harmful health effects from occurring in people who drink the water or eat fish or seafood that live in the water.

OSHA has not set a legal limit for endosulfan in workplace air.

NIOSH recommends a limit of 0.1 milligram per cubic meter (mg/m^3) for endosulfan in workplace air averaged over a 10-hour work day.

WHERE CAN I GET MORE INFORMATION?

If you have any questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below. ATSDR can also provide publically available information regarding medical specialists with expertise and experience recognizing, evaluating, treating, and managing patients exposed to hazardous substances.

- Call the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636) or

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- Write to:
Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences
1600 Clifton Road NE
Mailstop F-57
Atlanta, GA 30329-4027

Toxicological profiles and other information are available on ATSDR's web site:
<http://www.atsdr.cdc.gov>.