

1. PUBLIC HEALTH STATEMENT FOR DEET

This Public Health Statement summarizes the Agency for Toxic Substances and Disease Registry's (ATSDR) findings on DEET, including chemical characteristics, exposure risks, possible health effects from exposure, and ways to limit 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 targeted for long-term federal clean-up activities. U.S. EPA has found DEET in at least 2 of the 1,832 current or former NPL sites.

The total number of NPL sites evaluated for DEET is not known. But the possibility remains that as more sites are evaluated, the sites at which DEET is found may increase. This information is important because these future sites may be sources of exposure, and exposure to DEET may be harmful.

If you are exposed to DEET, many factors determine whether you'll be harmed. These include how much you are exposed to (dose), how long you are exposed (duration), how often you are exposed (frequency), 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 DEET?

DEET is the chemical N,N-diethyl-*meta*-toluamide. Technical DEET is a nearly colorless liquid with a faint characteristic odor. DEET is the active ingredient in some common repellents widely used to repel biting pests such as mosquitos and ticks. A significant benefit of DEET is protection against mosquito or tick borne illnesses. Examples of tick-borne illnesses include Lyme disease and Rocky Mountain Spotted Fever. Mosquito-borne illnesses may include those caused by West Nile Virus and Zika Virus.

DEET is the common name for an insect and acarid repellent used to repel, but not kill, biting insects, mites, and ticks. DEET formulations are typically used as sprays or mists, lotions and wipes. DEET formulations can be applied directly onto human skin or onto clothing. DEET has been formulated with sunscreen lotions for direct application to skin. DEET has also been infused into various products such as wrist bands, intended to be worn by the consumer while outdoors.

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DEET has been previously and is currently sold as an ingredient in several common repellent products, including Skeeter Skat[®], as well as various Off![®], Repel[®], and Old Time Woodsman[®] brand products and various Cutter brand products, such as Cutter All Family[®], Cutter Dry[®], and Cutter Backwoods[®].

WHAT HAPPENS TO DEET WHEN IT ENTERS THE ENVIRONMENT?

DEET can enter the air during spray applications. Approximately 9.6% of the DEET applied to human skin evaporates in 1 hour. DEET has occasionally been detected in air samples at low concentrations. If released to the atmosphere, DEET will exist solely as a vapor. Half of the amount of DEET in air will disappear in approximately 5 hours. DEET is not expected to persist or be transported long distances in the environment.

DEET can be released from common showering and laundering practices and eventually may enter waste water treatment facilities. DEET can also enter surface water from recreational activities such as swimming. DEET has been detected at low levels in streams, surface water, and groundwater systems, and sewage treatment plant effluents throughout the United States. If released to water, bioaccumulation of DEET in aquatic organisms is not expected. Volatilization from water surfaces is not expected. DEET may be biodegraded in water or undergo direct photolysis in sunlit waters; therefore, persistence in water systems is not expected.

Although DEET is registered by the EPA Office of Pesticides, it only acts as a repellent, not a pesticide. Therefore, applications to crops or agricultural products do not typically occur. DEET may enter soils as the result of overspray, disposal in landfills, or irrigation of soils with reclaimed water containing DEET. No data were located on the environmental concentrations of DEET in sediment or soil. If released to soils, volatilization is not expected and DEET will have moderate mobility. Data suggest that DEET would be biodegradable in soils under aerobic conditions and would biodegrade slowly under anaerobic conditions.

HOW MIGHT I BE EXPOSED TO DEET?

The most important route of exposure to the general population is through dermal contact from intentional application to human skin and clothing of consumer products containing DEET. It might also get into your eyes if sprayed improperly. DEET can be released into the air, water, and soil at places where it is produced or used. DEET is most often released into surface waters following its incomplete removal at waste water treatment facilities, and to a lesser extent released into the air when applying DEET-

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containing repellents. You will be exposed to DEET if you use water containing DEET for drinking or bathing. However, the levels of DEET detected in water and air are generally low.

HOW CAN DEET ENTER AND LEAVE MY BODY?

Scientists have not yet studied whether DEET in the air can be absorbed into your lungs after inhalation. It is absorbed through the skin and digestive tract, so it is likely that DEET can also be absorbed through the lungs and into the blood. DEET in the lungs can be coughed up and swallowed, if it is not absorbed first. DEET in water or food can be absorbed from the digestive tract; studies in animals suggest that most of the ingested DEET will be absorbed. Small quantities of DEET (less than 10–20% of the applied DEET) can be absorbed through your skin. In addition, if your skin contacts water with DEET in it, you may absorb some DEET through your skin.

Although rarely found in soil, if you accidentally eat soil contaminated with DEET, some of the DEET will enter your body through the digestive tract. In addition, if you touch soil contaminated with DEET, some of the DEET may enter your body through the skin.

In your body, most of the DEET is broken down into other substances (metabolites) in the liver, and both DEET and the metabolites distribute widely throughout your body. Studies have detected DEET or its metabolites in many organs of exposed animals, including the brain, liver, kidneys, lungs, spleen, fat, tears, and inside the nose. DEET does not appear to accumulate in any particular organ in the body.

Most of the DEET that is absorbed into your body is excreted quickly through your urine either unchanged or as a metabolite. A small proportion of the DEET that is taken in is excreted in the feces.

HOW CAN DEET AFFECT MY HEALTH?

The health effects of DEET depend on several factors including how much of this substance you are exposed, the route and length of that exposure, and how often you are exposed. Environmental monitoring data suggest that any DEET levels that the public might encounter in the environment are much lower than levels causing effects in animal studies, and at much lower levels than people are exposed to when using insect or acarid repellents. Considering the intentional extensive consumer use of products containing DEET on the skin, the risk of health effects due to exposure to DEET appears to be quite low.

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There have been sporadic reports over the last several decades of an association between excessive use of repellents containing DEET and adverse neurological effects including seizures, uncoordinated movements, agitation, aggressive behavior, low blood pressure, and skin irritation.

In a study of more than 9,000 exposures to DEET-containing repellents reported to Poison Control Centers between 1985 and 1989, most exposures (88%) did not produce symptoms that required treatment in a health care facility. In a similar study of more than 20,764 exposures to DEET-containing repellents reported to Poison Control Centers between 1993 and 1997, nearly 89% of the occurrences were managed at the exposure site; 11% of the cases were evaluated in a health care facility (80% of these subjects were treated and released). About half of the subjects were reported or judged to suffer no ill effects due to DEET exposure. A similar percentage was reported or judged to have a minor effect that were not bothersome, did not last long, and did not require treatment. Some of these included drowsiness, skin irritation, or temporary cough. Four percent experienced a moderate or greater effect or a potentially toxic exposure such as corneal abrasion, high fever, disorientation, or isolated brief seizures, and required treatment. In both reports, nearly 50% of cases were a result of DEET ingestion.

Workers at a national park who used insect repellents or lotions containing DEET repeatedly during the summer season complained more often of chest pain or wheezing, muscle cramping, skin rashes and blisters, dizziness, disorientation, and difficulty concentrating than workers who used the products less often or did not use them at all. Because exposure was inferred only from survey responses, these findings should be interpreted with caution.

A study of workers in Sweden found that those who used insect repellents for 115 days or longer had an increased risk of developing testicular cancer. However, because of deficiencies in the study, the results were not conclusive.

Long-term studies in which dogs, rats, and mice were given DEET orally or in which liquid DEET was applied to the skin of mice and rabbits did not find an increase in tumors in the animals.

The U.S. Department of Health and Human Services (DHHS) has not classified DEET as to its carcinogenicity. The U.S. EPA's Office of Pesticide Programs (OPP) has classified DEET as a Group D chemical, not classifiable as a human carcinogen. The International Agency for Research on Cancer (IARC) has not classified DEET as to its carcinogenicity.

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

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HOW CAN DEET AFFECT CHILDREN?

This section discusses potential health effects of DEET exposure in humans from when they're first conceived to 18 years of age.

Some children exposed to insect repellents or lotions containing DEET have experienced the same type of neurological effects observed in adults (i.e., agitation, hypertonia, seizures, ataxia, restlessness, and uncontrolled limb movements). In the specific case of seizures, it should be noted that because a relatively high percentage (23–29%) of children are exposed to DEET in the United States and because seizure disorders occur in approximately 3–5% of children from any cause, it might be possible, just by chance alone, to erroneously find an association.

A study of more than 9,000 human exposures involving insect repellents containing DEET reported to Poison Control Centers did not find evidence that children are more likely to develop adverse health effects than adults if exposed to DEET. As mentioned earlier, considering the extensive use of products containing DEET and limited reports of significant health effects, the risk of serious health effects from exposure to DEET may be quite low.

Two studies of women who used insect repellents containing DEET during pregnancy did not find abnormalities in the babies at birth that were attributable to exposure to DEET.

Studies in rats and rabbits administered DEET in their food during pregnancy did not find birth defects or other abnormalities in the offspring.

HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO DEET?

If your doctor finds that you have been exposed to significant amounts of DEET, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate. You may also contact the state or local health department with health concerns.

It is possible to transfer DEET from your hands onto food. Encourage good hygiene practices (e.g., hand-washing) to minimize this possible route of exposure and be careful not to overspray and contaminate foods, utensils, etc. when applying DEET-containing products from aerosol dispensers. The American Association of Pediatrics (AAP) recommends that products containing DEET should not be applied to

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young children's hands or around the mouth, or to infants below the age of 2 months. The Centers for Disease Control and Prevention (CDC) supports these restrictions. Children under 10 years of age should not apply DEET by themselves. Do not re-use DEET product containers, especially for storing food and water.

Many consumer repellents contain DEET as an active ingredient. Check the label of these products and follow the instructions listed below regarding the proper use, disposal, and application of DEET. In general, do not apply DEET near your mouth or eyes and do not apply over cuts or irritated skin. Do not apply it under clothing, and wash clothing that has been sprayed with DEET before wearing it again. When applying DEET to the facial area, first apply to your hands, then rub the product onto your face, and then wash your hands. Avoid direct spraying to the face as this could cause the product to get into your eyes, mouth, or lungs. To avoid overexposure, be sure to remove DEET containing products from your body before going to bed (shower or use a wash cloth to remove from skin).

The U.S. EPA requires the following statements on all DEET product labels:

1. Read and follow all directions and precautions on this product label.
2. Do not apply over cuts, wounds, or irritated skin.
3. Do not apply near eyes and mouth. Apply sparingly around ears.
4. Do not apply to children's hands.
5. Do not allow children to handle this product.
6. When using on children, apply to your own hands and then put it on the child.
7. Use just enough repellent to cover exposed skin and/or clothing.
8. Do not use under clothing.
9. Avoid over-application of this product.
10. After returning indoors, wash treated skin with soap and water.
11. Wash treated clothing before wearing it again.
12. Use of this product may cause skin reactions in rare cases.
13. If you suspect a reaction to this product, discontinue use, wash treated skin, and call your local poison control center.
14. If you go to a doctor, take this product with you.
15. ACTIVE INGREDIENTS: DEET.....XX.XX%
16. A toll-free telephone number for consumers to call for additional product information and to report incidents.

The EPA does not require an expiration date on the label of DEET products manufactured in the United States.

Animal research indicates that drinking less alcohol might reduce how much DEET passes into the body through the skin.

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

DEET and its breakdown products (metabolites) can be measured in blood and urine. However, the detection of DEET or its metabolites cannot predict whether or not health effects might develop from that exposure. Because DEET and its metabolites leave the body fairly rapidly, such tests need to be conducted within hours after exposure.

For more information on the different substances formed by DEET 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 public health but are not enforceable 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 (e.g., 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.

In order to protect against vector-borne illnesses such as Lyme Disease or those caused, for example, by West Nile Virus or Zika Virus, the Centers for Disease Control and Prevention (CDC), the EPA, and the World Health Organization (WHO) all recommend and/or endorse the use of DEET-containing products.

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CDC specifically recommends using products with at least 20% DEET on exposed skin to reduce biting by ticks or mosquitos that may spread disease. The concentration of DEET in a product can be selected to meet the type and duration of protection. The manufacturer's directions on the label should be followed for applying and reapplying the product; excessive reapplication is not useful and should be avoided.

The EPA has not recommended drinking water guidelines for DEET. OSHA has not set a legal limit for DEET in air. NIOSH has not set a recommended limit for DEET in air.

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. You may also contact your doctor if experiencing adverse health effects or for medical concerns or questions. ATSDR can also provide publicly 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
- 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>.