

This fact sheet answers the most frequently asked health questions (FAQs) about nitrates and nitrites. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Nitrates and nitrites occur in soil, in water, and in some foods. They are naturally occurring inorganic nitrogen ions. Nitrates are a natural part of the human diet. When drinking water or eating food from areas containing nitrogen-based fertilizers, people could be exposed to high nitrate and nitrite levels. The most serious health condition caused by high nitrate or nitrite exposure is acute acquired methemoglobinemia. Infants younger than 4 months of age exposed to high levels of nitrates/nitrites are especially prone to acute acquired methemoglobinemia, which is described more fully in this fact sheet in the section entitled "How can nitrates and nitrites affect my health?"

What are nitrates and nitrites?

Nitrate (NO_3^-) and nitrite (NO_2^-) are inorganic ions that occur naturally and are part of the nitrogen cycle. Nitrates (e.g., potassium nitrate and ammonium nitrate) are common ingredients of fertilizer that contains nitrogen.

What happens to nitrates and nitrites when they enter the environment?

- Nitrite oxidizes easily into nitrate. Nitrate thus more frequently occurs in groundwater and surface water.
- Nitrate-containing compounds in the soil are generally soluble, which means they dissolve easily in water. Nitrates thus flow easily into groundwater.
- Nitrates and nitrites both occur in soil and water. Microbes break down animal and human organic wastes in soil and water. This breakdown process converts wastes into ammonia, which then oxidizes into nitrite and nitrate.

How might I be exposed to nitrates and nitrites?

- You might be exposed to nitrates and nitrites as normal parts of a human diet. Vegetables such as cauliflower, spinach, collard greens, broccoli, beets, and root vegetables have naturally greater nitrate content than do other plant foods.
- You may be exposed to high amounts of nitrates/nitrites from soil and water contaminated by runoff from nitrogen-containing fertilizers (e.g., potassium nitrate and ammonium nitrate).
- You may be exposed to nitrates/nitrites from contaminated foodstuffs, from certain medications, and from certain inhalants that give off nitrite fumes.

How can nitrates and nitrites affect my health?

Excessive nitrate or nitrite exposure can result in acute acquired methemoglobinemia, a serious health condition.

Hemoglobin in blood carries oxygen from the lungs to tissues and helps carry carbon dioxide back to the lungs.

Hemoglobin in blood contains iron normally found in the Fe^{2+} (ferrous) state. But excessive nitrates or nitrites can alter the iron in hemoglobin to the Fe^{3+} (ferric) state. This forms methemoglobin, an abnormal form of hemoglobin. As methemoglobin forms, the blood loses its ability to carry oxygen to tissues (anoxia).

Methemoglobinemia is actually an excess of methemoglobin in the blood. Methemoglobinemia can cause cyanosis (blue skin) of limbs/trunk, weakness, and rapid heart rate. If methemoglobinemia progresses in severity, central nervous system depression can occur, as can headache, dizziness, fatigue, difficulty in breathing, and nausea. Finally, severe methemoglobinemia can cause lethargy, brief loss of consciousness, irregular heartbeat, shock, convulsions, coma, and even death. In fact, methemoglobin levels greater than 50% are potentially fatal (Nathan et al. 1977).

Nitrate and nitrite medications may cause hypotension (low blood pressure). But ingestion of nitrates and nitrites in food and water does not commonly result in hypotension. Maternal exposure to environmental nitrates and nitrites may increase the risk of pregnancy complications such as anemia, abortion, premature labor, or preeclampsia.

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Methemoglobinemia can also occur from other causes. Exposure to oxidizing drugs or chemicals, systemic acidosis (a generalized, abnormal increase in body fluid acidity), diarrhea, or some genetic disorders such as infant cyanosis (bluish discoloration of skin and mucus membranes) shortly after birth can all result in methemoglobinemia.

How likely are nitrates and nitrites to cause cancer?

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the Environmental Protection Agency (EPA) have not classified nitrates and nitrites as to their human carcinogenicity.

Still, a metabolic pathway is available for nitrites to react with molecules in organisms to form N-nitroso compounds, some of which may cause cancer.

How can nitrates and nitrites affect children?

In some infants, fetal methemoglobinemia can be a significant problem. An infant's highly alkaline gastrointestinal system favors the growth of nitrate-reducing bacteria, particularly in the stomach and especially after ingestion of contaminated water. This can lead to conversion of nitrates into high levels of nitrites. These can change the hemoglobin in blood to methemoglobin. An adult stomach, however, is typically too acidic to allow for significant bacterial growth that would convert nitrates to nitrites.

Infants younger than 4 months of age are prone to nitrite exposure, especially infants who ingest formula diluted with water from nitrate-contaminated rural domestic wells. A portion of hemoglobin in young infants is still in the form of fetal hemoglobin. Nitrites can more readily generate methemoglobin from oxidized fetal hemoglobin than from adult hemoglobin. Thus, infants less than 4 months of age, and especially premature infants, are particularly susceptible to such exposure.

At or near the 30th week of pregnancy, an expectant mother and her fetus might be more sensitive to toxicity from nitrites or nitrates.

How can families reduce the risk of exposure to nitrates and nitrites?

You should avoid exposure to water, soil, or food contaminated with high levels of nitrates and nitrites.

If you have well water that comes from areas that contain large amounts of nitrogen-containing fertilizers, you should monitor the water closely.

Is there a medical test to determine whether I've been exposed to nitrates and nitrites?

No routine medical tests are available to determine nitrate and nitrite levels.

Routine blood tests are available to detect methemoglobinemia. But these tests cannot tell whether the high methemoglobin levels were caused by nitrates or nitrites.

Has the federal government made recommendations to protect human health?

The U.S. EPA has set an enforceable standard called a maximum contaminant level (MCL) for nitrates at 10 ppm and for nitrites at 1 ppm in drinking water. Public water supplies meeting certain criteria must follow these regulations.

The U.S. EPA has set a reference dose (RfD) for nitrate of 1.6 mg nitrate nitrogen/kg body weight per day (equivalent to about 7.0 mg nitrate ion/kg body weight per day).

The U.S. EPA has set an RfD of 0.1 mg nitrite nitrogen/kg body weight per day (equivalent to 0.33 mg nitrite ion/kg body weight per day).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Case Studies in Environmental Medicine, Nitrate/Nitrite Toxicity. Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Interaction Profile for: cyanide, fluoride, nitrate, and uranium. Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Nathan DM; Siegel AJ, Bunn HF. 1977. Acute methemoglobinemia and hemolytic anemia with phenazopyridine. Arch Intern Med;137(11):1636-1638.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-62, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is <http://www.atsdr.cdc.gov/toxfaq.html>. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

