

Sources of Exposure

Toxicokinetics and Biomonitoring

Biomarkers/Environmental Levels

General Populations

- The general population is exposed to trace amounts of beryllium by inhalation of contaminated air and ingestion of contaminated drinking water and food.
- The general population may be exposed to beryllium as a result of coal combustion and solid waste incineration.
- Exposure to beryllium occurs primarily in the workplace.
- Populations living near active beryllium industries have been found to have slightly elevated levels of beryllium dust.
- Populations living near some beryllium Superfund sites have contaminated groundwater.

Occupational Populations

- Workers in beryllium manufacturing, fabricating, or reclaiming are at higher risk for beryllium exposure.
- Occupational exposure is most likely to occur through inhalation or dermal contact.

Toxicokinetics

- Inhalation is the primary route of beryllium absorption in humans, but data on the rate and extent of absorption of inhaled beryllium in humans is limited.
- Absorbed beryllium is distributed throughout the body. Beryllium first accumulates in the liver, then the lymph nodes and bones.
- Beryllium and its compounds are not biotransformed, but soluble beryllium salts are partially converted to less soluble forms in the lung.
- Beryllium is slowly cleared from the lungs. Beryllium can be excreted via breast milk, feces, and urine.

NHANES Biomonitoring

- Urinary beryllium was measured for the National Health and Nutrition Examination Survey (NHANES) until 2010.
- In the 2009-2010 cycle of NHANES, all values of urinary beryllium that were not missing were below the lower detection limit of 0.072 µg/L.

Biomarkers

- Beryllium in blood, urine, hair, and tissue can be used as biomarkers of exposure.
- A Beryllium Lymphocyte Proliferation Test (BeLPT) draws blood to identify if an individual is sensitized to beryllium.

Environmental Levels

- Air:
 - Outdoor air range 0.0001-8.9 ng/m³
 - Indoor air ≤0.0045 ng/m³
- Water:
 - Surface water range 0-32.6 µg/L
 - Groundwater range <1-18 µg/L
 - Drinking water range <0.005-5.2 µg/L
- Soil:
 - Range 0.1-2.1 mg/kg
- Food:
 - ≤36 µg/kg fresh weight
- Effluent
 - Range 0-0.08 µg/L

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2022. Toxicological Profile for Beryllium (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Beryllium Be

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U.S. Department of Health and
Human Services
Public Health Service
Agency for Toxic Substances
and Disease Registry
www.atsdr.cdc.gov



Chemical and Physical Information

Routes of Exposure

Relevance to Public Health (Health Effects)

Beryllium is a gray solid.

- Beryllium naturally occurs in the earth's rocks.
- There are approximately 45 mineralized forms of beryllium. The two that are most frequently mined are beryl and bertrandite. Beryl is also well known as the gemstones emerald, aquamarine, and beryl.
- Beryllium exists as a solid and is part of the metal family.
- Beryllium is lightweight and strong, making it ideal for use in the defense, aerospace, energy, and electronics industries. It is also used in the medical and dental fields.
- Some beryllium compounds are soluble in water.

- Inhalation – Inhalation is a primary route of exposure for the general population and workers. Trace amounts of beryllium are present in outdoor air.
- Oral – A minor route of exposure may occur through ingestion of foods that contain beryllium, through ingestion of contaminated water, and through accidental ingestion of contaminated soil.
- Dermal – Dermal contact is a potential route of exposure for workers.

Beryllium in the Environment

- Beryllium is naturally present in rocks, coal, soil, and volcanic dust.
- Beryllium does not degrade in the environment, but it does change form.
- The transport of beryllium in the atmosphere to terrestrial and aquatic surfaces occurs through wet and dry deposition.
- Beryllium is carried to water bodies by the process of land erosion.
- Beryllium is more likely to be present in the sediment or suspended matter in water bodies than in the water.
- Beryllium in air is attached to particulate matter. The residence time depends on the particle size.
- Beryllium is not likely to bioaccumulate in the human food chain.

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- No acute-, or intermediate inhalation MRLs were derived for beryllium.
- A provisional chronic-duration (≥ 365 days) inhalation MRL of $0.001 \mu\text{g}/\text{m}^3$ was derived for beryllium.

Oral

- No acute-, intermediate-, or chronic duration oral MRLs were derived for beryllium.

Health Effects

- Exposure to beryllium can lead to beryllium sensitization, acute beryllium disease, and chronic beryllium disease in humans.
- Acute beryllium disease is characterized by inflammation of the respiratory tract tissues. Symptoms include nasopharyngitis, shortness of breath, labored breathing, and chemical pneumonitis.
- Chronic beryllium disease is an immune response to beryllium. Damage to the right heart ventricle, hepatic necrosis, kidney stones, and weight loss are effects that have been observed in individuals with chronic beryllium disease.

Health Effects

- Dermal contact with beryllium may cause skin granulomas or edema. Dermatitis has also been observed in workers exposed to airborne beryllium.
- Effects of oral exposure in humans are not well studied. In rats, effects of oral exposure appear to be associated with changes in enzyme levels in the brain and liver and decrease in body weight.
- The National Toxicology Program considers inhaled beryllium and beryllium compounds to be known human carcinogens.
- The U.S. Environmental Protection Agency (EPA) has classified beryllium as a probable human carcinogen to humans based on the inhalation exposure route. Based on the oral exposure route, there is inadequate information for EPA to classify carcinogenicity.
- The International Agency for Research on Cancer has classified beryllium as carcinogenic to humans based on sufficient evidence in both animals and humans.

Children's Health

- Children exposed to beryllium are expected to experience effects similar to those expected in adults.