Sources of Exposure

General Populations

- The general population may be exposed to low environmental levels of selenium daily through food, water, and air.
- Selenium is an essential element needed by the body in small amounts.
- Ingestion of organic and inorganic forms of selenium from the diet is the primary exposure route for the general population.
- Organic forms of selenium found in grain, cereals, and forage crops constitute the greatest portion of dietary intake of selenium.
- Estimates of selenium intake by healthy adults in the U.S. range from 1–2 µg/kg/day.
- Non-occupational higher exposure to selenium may occur to people living in areas with naturally high levels of selenium in the soil.

Occupational Populations

- Workers in metal industries, selenium-recover processes, paint manufacturing, and special trades may be exposed to higher levels of selenium in the air.

Toxicokinetics and Normal Human Levels

Toxicokinetics

- Occupational studies indicate that elemental selenium dusts and other selenium compounds can be absorbed through the lungs.
- Many selenium compounds are readily absorbed through the gastrointestinal tract, often to >80% of the administered dose. In general, the degree of selenium absorption is independent of the exposure concentration. However, absorption efficiency can increase when there is selenium deficiency.
- Selenium distributes into many organs, but generally higher concentrations are found in the liver and kidneys.
- Selenium metabolism involves several steps that take inorganic selenium into selenoproteins or methylated metabolites of selenide.
- Selenium is eliminated primarily in the urine and feces. The distribution between the two routes vary with the level of exposure and time after exposure.

Normal Human Levels

- The geometric mean concentration of selenium in serum from U.S. residents of all ages determined in a national survey was approximately 0.125 mg/L.

Biomarkers/Environmental Levels

Biomarkers

- Tests for selenium in blood and urine are the most common methods used to detect recent exposures to high levels of selenium.
- Selenium can also be detected in the feces, hair, and nails.

Environmental Levels

Air

- Ambient background concentrations are low, generally <10 ng/m^3.

Sediment and Soil

- Concentrations in most soils have been estimated to range between 0.01 and 0.2 mg/kg. Western South Dakota and eastern Wyoming have much higher concentrations.

Water

- Selenium was detected in concentrations greater than the detection limit of 0.010 mg/L in only 2 of 535 samples from major watersheds in the United States.
- In the seleniferous area of South Dakota, 10 wells were found to have selenium concentrations ranging from 0.050 to 0.339 mg/L.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological Profile for Selenium (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

ToxGuide™ for Selenium

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CAS# 7782-49-2

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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

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ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

Selenium is a Non-metal Element

- Pure selenium exits as metallic grey to black hexagonal crystals. This form is often referred to as elemental selenium or selenium dust.
- In nature it is usually combined with sulfide minerals or with silver, copper, lead, and nickel.
- Natural sources of selenium include the weathering of selenium-containing rocks, and soils, and volcanic eruptions.
- Most processed selenium is used in the electronics industry because of its semiconductor and photoelectric properties.
- Selenium is also used in the glass industry; as a component of pigments in plastics, paints, enamels, ink, and rubber; in the preparation of pharmaceuticals; in pesticide formulations; as an ingredient in antidandruff shampoos; and as a constituent of fungicides.
- Selenium is additionally used as a human nutritional supplement and as a feed additive for poultry and livestock in areas with selenium-poor soils.

Routes of Exposure

- Inhalation (breathing) – Not a significant route of exposure for the general population. Primary route of exposure for selenium workers.
- Oral (mouth) – Primary route of exposure for the general population via ingestion of food.
- Dermal – Not a significant route of exposure to selenium.

Selenium in the Environment

- Selenium dust that enters the air from burning coal and oil will eventually settle over the land and water.
- The forms and fate of selenium in soils depend largely on the acidity of the surroundings and its interaction with oxygen.
- In soils, elemental selenium and inorganic selenium compounds, such as sodium selenite, can be methylated by microorganisms and subsequently volatized to the atmosphere.
- Some selenium that enters water from rocks and soil and from agricultural and industrial waste will dissolve in water; some will settle to the bottom as particles.
- Aquatic organisms can convert selenium to both inert and soluble forms.
- Selenium may accumulate up the food chain.

Relevance to Public Health (Health Effects)

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

Minimal Risk Levels (MRLs)

Inhalation

- No inhalation MRLs were derived for selenium.

Oral

- No MRL was derived for acute-duration exposure (≤14 days).
- No MRL was derived for intermediate-duration oral exposure (15–364 days).
- An MRL of 0.005 mg Se/kg/day was derived for chronic-duration oral exposure (≥1 year).

Health Effects

- Selenium is an essential nutrient for humans and other animals and is necessary for the function of enzymes involved in antioxidant defense, thyroid hormone metabolism, and redox control of intracellular reactions. However, according to the NAS Institute of Medicine, selenium deficiency in otherwise well-nourished individuals is not likely to cause overt symptoms.

Health Effects (continued)

- Short-term exposure to high levels of elemental selenium or selenium dioxide in the air can induce respiratory tract irritation, bronchitis, difficulty breathing, and stomach pain.
- Longer-term exposure to either of these forms can cause respiratory irritation, bronchial spasms, and coughing.
- Short-term oral exposure to high concentrations of selenium may cause nausea, vomiting, and diarrhea.
- Long-term oral exposure to high concentrations of selenium can cause selenosis, a disease characterized by hair loss, brittle nails; exposure of some animals to extremely high doses of selenium have caused neurological abnormalities ranging from unsteady gait to partial paralysis.

Children's Health

- It is not known if children are more susceptible to the effects of selenium than adults, but one study found that children may be less susceptible than adults.
- Selenium has been found in placental tissue, umbilical cord blood, fetal tissues, and breast milk.