Sources of Exposure

General Populations

- The general population is primarily exposed to mercury (Hg), as methylmercury (MeHg), through the ingestion of foods, specifically fish and seafood.
- The general population may also be exposed to Hg by inhalation of ambient air. However, for the general population, this is expected to be a minor source of exposure due low levels of Hg in ambient air.
- Elemental mercury (Hg^0) released from mercury amalgam dental restorations can also contribute to Hg exposure through inhalation and ingestion.
- Elemental mercury (Hg^0) released from breakage and/or spills of older items containing liquid mercury (e.g., thermometers) could result in Hg exposure through inhalation.

Occupational Populations

- Occupational exposure to Hg may occur through inhalation or dermal contact for persons working with Hg or Hg compounds, such as Hg recycling and reprocessing facilities or dental offices where Hg^0 is used in dental amalgams.

Toxicokinetics and Biomonitoring Levels

Toxicokinetics

- Hg^0 is well absorbed via the inhalation route. Small amounts can be absorbed through the skin and gastrointestinal tract. Absorbed Hg^0 is rapidly oxidized by catalase in blood and tissues to mercuric mercury (Hg^{2+}) in tissues.
- Inorganic Hg compounds can be absorbed to some extent via all routes. Hg^{2+} compounds are absorbed more readily than mercurous (Hg^+) compounds. The low pH and high chloride concentration of the gastric environment results in oxidation of ingested Hg^+ to Hg^{2+}.
- Absorption of MeHg through the gastrointestinal tract is nearly 100%. It is also absorbed through the skin. Once absorbed, some MeHg is demethylated to form Hg^{2+}.
- For all species, absorbed mercury is distributed throughout the body, with the highest concentrations in the kidney. All forms of Hg are distributed to the brain. Hg is found in human cord blood, placenta, and breast milk and is transferred to the fetus.
- The major routes of excretion for Hg are through exhaled air (Hg^0), urine and feces (Hg^{2+}), and hair (MeHg).

NHANES Biomonitoring

- NHANES 2015–2016 reported a geometric mean total blood Hg level of 0.810 µg/L in adults. The geometric mean MeHg level was 0.518 µg/L in adults. The median total urinary Hg level was 0.140 µg/L in adults.

Biomarkers/Environmental Levels

Biomarkers

- Hg levels can be measured in blood, urine, hair, and toenails.
- Biomarkers more strongly correlated to MeHg exposure include MeHg in whole blood or total mercury in red blood cells or hair.
- Biomarkers more strongly correlated to exposure to Hg^0 and inorganic mercury include Hg in blood (or plasma) and Hg or total Hg in urine.

Environmental Levels

Air

- The mean Hg levels in U.S. ambient air were 1.11–2.22 ng/m^3 in 2019.

Water

- There are no recent monitoring data for water levels of Hg in groundwater or surface water. U.S. drinking water generally contains <0.025 µg Hg/L.

Sediment and Soil

- There are no recent monitoring data for sediment and soil levels of Hg. Hg naturally occurs at a concentration of ~80 µg Hg/kg soil.

Reference

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

ToxGuide™ for Mercury

April 2022

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

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

Mercury

- Hg is a naturally occurring element.
- Hg compounds are classified into three general categories: (1) elemental mercury, Hg^0; (2) inorganic mercury compounds (e.g., mercuric chloride); and (3) organic mercury compounds (e.g., MeHg).
- Hg^0 exists as a gas, liquid, or solid. All Hg compounds are solid at room temperature except mercuric oxide, which is a gas.
- Hg and Hg compounds are odorless.
- Hg is primarily used in the manufacture of electronics, fluorescent-lighting, and the production of chlorine-caustic soda; it is also used in dental products (fillings), although use in dentistry is being phased out.
- Other historical uses of Hg^0 (alkaline batteries, electronic switches, and lighting applications, fungicides and pesticides, paints and pigments, and thermometers and other scientific and medical devices) have been eliminated or drastically reduced.

Routes of Exposure

- Inhalation – Likely route of exposure for occupational population (Hg^0). The general population may also be exposed via ambient air.
- Oral – Likely route of exposure for the general population through ingestion of contaminated foodstuffs and water. Exposure is predominantly to MeHg.
- Dermal – Likely route of exposure for occupational population (Hg^0).

Mercury in the Environment

- Hg may enter the environment from natural processes or through industrial waste discharge, leaching from landfills, and volatilization.
- Industries also release mercury to air and water. Releases to air have been steadily decreasing over the past few decades.
- Atmospheric Hg is primarily in the form of gaseous Hg^0 , which is subject to long-range transport. Therefore, Hg can be found in locations far removed from its release site.
- Hg in water can be methylated by anaerobic bacteria, producing a highly bioaccumulative form of organic mercury (MeHg) that biomagnifies in the aquatic food chain. For this reason, Hg can often be detected at high levels in fish and other aquatic organisms, rice, and other vegetation.

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 acute- or intermediate-duration inhalation MRLs were derived for elemental mercury (Hg^0), inorganic Hg compounds, or MeHg.
- A chronic-duration (≥365 days) inhalation provisional MRL of 0.3 µg Hg/m^3 was derived for **Hg^0**.

Oral

- An acute-duration (≤14 days) oral provisional MRL of 2 µg Hg/kg/day was derived for **inorganic mercury**.
- An intermediate-duration (15–364 days) oral provisional MRL of 0.01 µg Hg/kg/day was derived for **inorganic mercury**.
- A chronic-duration (≥365 days) oral provisional MRL of 0.1 µg Hg/kg/day was derived for **MeHg**.

Health Effects

Neurological effects (tremor, sensory and motor impairments, cognitive deficits, altered mood) have been seen in humans after inhalation exposure to Hg^0 or oral exposure to MeHg. Similar effects were observed in animals exposed to Hg^0, inorganic Hg, or organic Hg.

- Renal effects (impaired function, tubular injury) have been observed in workers exposed to Hg^0. Renal damage has consistently been observed in animals exposed to Hg^0 via inhalation and inorganic and organic mercury compounds via oral exposure.
- Impaired fertility has been observed in animals following oral exposure to inorganic or organic mercury compounds.
- High blood pressure and alterations in immune systems have been observed in humans and animals following oral exposure to inorganic or organic mercury.
- The U.S. Department of Health and Human Services has not evaluated the potential carcinogenicity of mercury or mercury compounds. Mercuric chloride and MeHg have been classified by the U.S. Environmental Protection Agency as possible human carcinogens; the carcinogenic potential of elemental mercury was not classified. MeHg has been classified by the International Agency for Research on Cancer as possibly carcinogenic to humans; the carcinogenic potential of Hg^0 or inorganic mercury was not classified.

Children's Health

- Cognitive, neuromotor, and neurosensory effects have been seen in humans with prenatal exposure to MeHg. Neurodevelopmental effects were also seen in animals orally exposed to inorganic or organic mercury compounds.
- Birth defects have occurred in humans with high dietary levels of MeHg.