

Sources of Exposure

Toxicokinetics and Biomonitoring

Biomarkers/Environmental Levels

General Populations

- Everyone is exposed to cobalt daily in food, water, and air. In general, intake from food is higher than from drinking water or breathing air.
- The average daily cobalt intake in humans has been estimated to be 5–40 µg. Vitamin B₁₂ contains cobalt as an essential trace element important to health; it normally contributes a very small amount to total cobalt intake.
- Individuals may incidentally ingest or inhale cobalt powders or dusts that are found in products for consumer and commercial purchase, such as clothing, jewelry, furniture, cosmetics, and household cleaning items.
- Individuals, including children, living near industrial sites, hazardous waste sites, and agricultural areas using sewage sludge or cobalt containing fertilizers may be exposed to cobalt through dust inhalation or dermal contact with contaminated soil. There is no evidence that this would result in a higher than normal exposure.
- People who smoke, use cobalt and vitamin B₁₂ supplements, or have surgical implants may have higher cobalt exposures.

Occupational Populations

- Workers in the hard metal industry (tool production, grinding, etc.) and industries such as coal mining, metal mining, smelting, refining, cobalt dye painting, and cobalt chemical production are exposed to higher levels of cobalt via airborne dust and direct contact.

Toxicokinetics

- Absorption:** Submicron size inhaled particles of cobalt are absorbed through the respiratory tract, whereas larger particles are deposited in the respiratory tract and removed by mucociliary clearance and swallowed. Inhaled cobalt absorption ranges from 52-78%. The ingested cobalt absorption rates range from 5-97% based on solubility. Cobalt skin absorption varies with absorption through intact skin of <1%, and absorption through abraded skin of almost 80%.
- Distribution:** Cobalt is primarily distributed to the serum, whole blood, liver, kidneys, heart, and spleen, with lower amounts reported in the skeleton, hair, lymphatic circulation, and pancreas.
- Metabolism:** Cobalt is an element so it cannot be metabolized.
- Excretion:** Cobalt is excreted primarily in urine (for soluble forms) and feces (for insoluble forms) regardless of the route of exposure. The elimination of cobalt is often represented as a multi-compartmental model with compartments having half-lives of several hours to a week.

NHANES Biomonitoring

- The geometric mean urinary cobalt level for all adults in the 2017-2018 NHANES was 0.424 µg/L and 0.462 µg/g creatinine. The geometric mean blood level was 0.151 µg/L for all adults.

Biomarkers

Cobalt can be measured in blood, feces, and urine to indicate exposure. When elevated, these may indicate excess cobalt exposure. There are no effective biomarkers specific to cobalt toxicity.

Environmental Levels

Air

- Outdoor, mean range: 0.000025-0.0022 µg/m³

Water

- Drinking water range: <1–107 µg/L

Soil and Sediment

- Soils range: 7.2–12,700 mg/kg
- Sediment range: <20 mg/kg

Food

- Range: 0.01–0.86 mg/g

Reference

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

ToxGuide™

for

Cobalt

Co

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



Chemical and Physical Information

Routes of Exposure

Relevance to Public Health (Health Effects)

Cobalt is a gray metal and forms blue and red compounds

- Cobalt is a magnetic, brittle, hard, gray or silvery bluish-white metal. It is resistant to oxidation and can form alloys with other metals that are strong and heat-resistant.
- It occurs naturally in the Earth's crust and is a group 9 element (transition metal). It is also an essential trace element found in vitamin B₁₂.
- Cobalt is insoluble in water. Cobalt (II) chloride, cobalt (II) nitrate, and cobalt (II) sulfate are soluble in water.
- Cobalt (II) chloride is a blue solid with a slight, sharp odor. It is soluble in water, alcohols, acetone, ether, glycerol, and pyridine. It is a fire and explosion hazard as it reacts violently with alkali metals.
- Cobalt (II) nitrate is a pale red, odorless solid. It is soluble in water.
- Cobalt (II) sulfate is a red, odorless solid. It is soluble in water and methanol.

- **Inhalation** – The general public inhales cobalt in the atmosphere. Inhalation can occur in workers who handle cobalt or use cobalt-containing grinding or drilling tools. Communities living near facilities that process, mine, or use cobalt or items that contain cobalt (e.g., some sewage sludge, fertilizers, or amendments) can be exposed via inhalation.
- **Oral** – The general public is exposed daily to cobalt in water, food, and soil. Cobalt is primarily ingested via food.
- **Dermal** – Dermal contact is a potential route of exposure for workers. Dermal contact by the public may occur with jewelry, clothing, and cosmetics. Children may also be exposed if playing in contaminated soils.

Cobalt in the Environment

- Cobalt is released to the atmosphere in particulate form. It may settle to the ground by wet or dry deposition.
- Natural sources that release cobalt include wind-blown continental dust, seawater spray, volcanoes, forest fires, and continental and marine biogenic emissions. Anthropogenic sources include burning fossil fuels, using sewage sludge and phosphate fertilizers, mining and smelting cobalt-containing ores, processing cobalt-containing alloys, and industrial use of cobalt process compounds.
- Cobalt released to waterways can be transported with the water and air may settle onto and be incorporated into sediment, which can transport it.

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- (≤ 14 days) or intermediate-duration (15-364 days) inhalation MRLs were derived for cobalt.
- A provisional chronic-duration (≥ 365 days) inhalation MRL of 0.0001 mg Co/m³ was derived for cobalt

Oral

- A provisional acute-duration oral MRL of 0.03 mg Co/kg/day was derived for cobalt.
- A provisional intermediate-duration oral MRL of 0.03 mg Co/kg/day was derived for cobalt.
- No chronic-duration oral MRL was derived for cobalt.

Health Effects

- Studies in humans showed decreased lung function after occupational inhalation exposure to cobalt.
- Oral exposure to cobalt in humans caused an increase in red blood cell mass and erythrocytosis.
- Cobalt is a respiratory irritant. Workers who used cobalt dusts or sprays reported lung damage and nose and throat irritation.

Health Effects

- Skin discoloration and eye irritation were reported in workers who had dermal contact with cobalt dust.
- Intermediate-duration oral exposure studies in animals reported alterations in hematological parameters, neurological impairments, and damage to male and female reproductive organs.
- Offspring of animals orally exposed to cobalt during pregnancy showed delayed or altered development.
- *In vivo* studies suggested cobalt sulfate is genotoxic to mammalian cell lines.
- The Department of Health and Human Services (HHS) has classified cobalt and cobalt compounds that release ions inside the body as reasonably anticipated to be a human carcinogen based on evidence from human and animal studies
- The International Agency for Research on Cancer (IARC) has classified cobalt and cobalt compounds as “possibly” carcinogenic to humans (2B).
- The U.S. Environmental Protection Agency (EPA) has not classified cobalt for carcinogenicity.

Children's Health

- Children exposed to cobalt would be expected to experience effects similar to those expected in adults. It is unknown if developmental effects seen in animals are expected to be seen in humans.