

## Sources of Exposure

## Toxicokinetics and Biomonitoring Levels

## 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 B<sub>12</sub> 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. Small amounts of cobalt may be released into food or beverages stored in certain types of plastic containers containing cobalt.
- Individuals living near industrial sites, hazardous waste sites, or agricultural areas using sewage sludge or cobalt containing fertilizers may be exposed to cobalt through dust inhalation or dermal contact with contaminated soil.
- People who smoke, use cobalt and vitamin B<sub>12</sub> 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 to 78%. The ingested cobalt absorption rates range from 5 to 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 Levels

- The geometric mean urinary cobalt level for the U.S. population (≥3 years of age) in the 2017–2018 NHANES was 0.424 µg/L and 0.462 µg/g creatinine. The geometric mean blood level was 0.173 µg/L for the U.S. population.

### Biomarkers

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

### Environmental Levels

#### *Air*

- The average ambient air concentration across 464 U.S. locations in 2022 was 0.00040 µg/m<sup>3</sup>.

#### *Water*

- The average U.S. groundwater concentration in 2022 was 7.8 ppb (total cobalt) and 2.0 ppb (dissolved cobalt).
- The average U.S. surface water concentration in 2022 was 1.4 ppb (total cobalt) and 0.72 (dissolved cobalt).
- Reported U.S. drinking water level range: <1–10<sup>7</sup> µg/L

#### *Soil and Sediment*

- The average U.S. sediment concentration in 2022 was 22,240 ppb.
- The average U.S. soil concentration in 2022 was 7,340 ppb.

#### *Food*

- Range: <0.01–0.86 µg/g

### Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2024. Toxicological Profile for Cobalt. Atlanta, GA: U.S. Department of Health and Human Services.

ToxGuide™

for  
Cobalt  
Co

CAS#7440-48-4

October 2024

U.S. Department of Health and  
Human Services  
Agency for Toxic Substances  
and Disease Registry  
[www.atsdr.cdc.gov](http://www.atsdr.cdc.gov)



**ATSDR**  
AGENCY FOR TOXIC SUBSTANCES  
AND DISEASE REGISTRY

## 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).
- Cobalt is also an essential trace element found in vitamin B12. Therefore, it is found at trace levels in all humans.
- 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

- 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 is released to the atmosphere in particulate form. It may settle to the ground by wet or dry deposition.
- Cobalt released to waterways 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

- An acute-duration ( $\leq 14$  days) inhalation MRL of 0.0003 mg Co/m<sup>3</sup> was derived for cobalt.
- No intermediate-duration (15–364 days) inhalation MRL was derived for cobalt.
- A chronic-duration ( $\geq 365$  days) inhalation MRL of 0.0001 mg Co/m<sup>3</sup> was derived for cobalt.

#### Oral

- An acute-duration oral MRL of 0.03 mg Co/kg/day was derived for cobalt.
- An intermediate-duration oral MRL of 0.02 mg Co/kg/day was derived for cobalt.
- No chronic-duration oral MRL was derived for cobalt.

### Health Effects

- Inhalation exposure to cobalt in humans causes respiratory irritation and decreased lung function. Findings in animal inhalation studies confirm that the respiratory system is a sensitive target.
- Oral exposure to cobalt in humans caused an increase in red blood cell parameters. Findings in animal oral studies confirm these findings.

### Health Effects (*cont'd*)

- Thyroid effects were reported in some people after oral exposure to cobalt. Findings in animal oral studies for these endpoints are limited.
- Human data on reported gastrointestinal distress following oral exposure to cobalt are inadequate to determine an association with exposure.
- Skin discoloration and eye irritation were reported in workers who had dermal contact with cobalt dust.
- Effects noted at higher oral doses in animals include male reproductive effects and delayed or altered development following perinatal exposure.
- 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 metal and soluble cobalt salts as probably carcinogenic, cobalt oxide as possibly carcinogenic, and cobalt tetraoxide, cobalt sulfide, and other cobalt compounds as not classifiable as to their carcinogenicity to humans. The U.S. Environmental Protection Agency (EPA) is currently conducting a cancer risk assessment for cobalt.

### Children's Health

- It is not known if children are more sensitive to cobalt exposure than adults.