Sources of Exposure

General Populations

- Thorium occurs naturally in the environment; therefore, background levels occur in air, water, and soil.
- The general population may be exposed to thorium from inhalation of air and ingestion of food and drinking water containing thorium.
- Concentrations of thorium in air, food, and drinking water are normally very low.

Occupational Populations

- Occupational exposures to higher levels of thorium isotopes occur primarily in uranium, thorium, tin, and phosphate mining, milling, and processing industries, radium dial workers, and gas lantern mantle workers.
- Higher levels of thorium and other radionuclides have been measured in exhaled breath and tissues of certain thorium industries workers.

Toxicokinetics and Biomonitoring

Toxicokinetics

- Thorium is not readily absorbed from the lungs or gastrointestinal tract; absorption depends on compound solubility and particle size.
- Elemental thorium cannot be metabolized.
- Thorium distributes primarily to lymph nodes and bone surface. It can be retained in the lungs following inhalation exposure.
- Most inhaled thorium is excreted in the feces following mucociliary clearance from the lungs to the gastrointestinal tract. Most ingested thorium is unabsorbed and excreted in the feces.

NHANES Biomonitoring

- There are no data regarding levels of thorium in the general population.

Biomarkers/Environmental Levels

Biomarkers

- Exposure to thorium can be determined by measurement of radioactive thorium and/or daughters (e.g., ^{220}Rn [thoron], ^{222}Rn [radon]) in feces, urine, and expired air.

Environmental Levels

Air

- There are no recent monitoring data for air levels of thorium. A study from 1979 showed mean ambient air level of 0.3 ng/m^3 from samples collected at 250 sites in the United States.

Water

- There are no recent monitoring data for water levels of thorium. Studies from the 1980s showed the average population-weighted concentration of ^{232}Th and ^{230}Th in U.S. community water supplies to be <0.01 and <0.04 pCi/L, respectively.

Sediment and Soil

- There are no monitoring data for levels of thorium in the sediment or soil in the United States.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2019. Toxicological Profile for Thorium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

ToxGuide™ for Thorium

Th

CAS # 7440-29-1

September 2019

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

Thorium

- Thorium is a radioactive element that occurs naturally in the environment.
- Thorium occurs in nature in four isotopic forms: ^{228}Th, ^{230}Th, ^{232}Th, and ^{234}Th. Of these, ^{228}Th is the decay product of naturally occurring ^{232}Th, and both ^{234}Th and ^{230}Th are decay products of natural ^{238}Uranium.
- Isotopes in the ^{232}Th series (^{228}Th, ^{232}Th) comprise 99.9% of the naturally occurring thorium in the environment; isotopes in the ^{238}U series (^{230}Th, ^{234}Th) comprise the remainder of naturally occurring thorium.
- All thorium isotopes emit alpha or beta particles with or without gamma radiation as they decay primarily toward isotopes of lead.
- Thorium is used to make ceramics, gas lantern mantles, and metals used in the aerospace industry and in nuclear reactions. Thorium can also be used as a fuel for generating nuclear energy.
- Medical thorium is a solution of thorium dioxide, known as Thorotrast. It was used world-wide from 1928 to 1955 as a radiocontrast agent in medical radiography.

Routes of Exposure

- Inhalation – Likely route of exposure for the general and occupational populations.
- Oral – Likely route of exposure for the general population through ingestion of contaminated food and water.
- Dermal – Not a likely route of exposure.

Thorium in the Environment

- Thorium occurs naturally in the earth's crust at an average lithospheric concentration of 8–12 µg/g (ppm).
- Of the naturally produced thorium isotopes, only ^{232}Th, ^{230}Th, and ^{228}Th have long enough half-lives to be environmentally significant.
- Data regarding the transport and partitioning of thorium in the atmosphere are limited. ^{228}Th may travel longer distances than both ^{230}Th and ^{232}Th due to its smaller aerodynamic diameter.
- In water, most of the thorium will be present in suspended matter or sediment. The concentration of soluble thorium in water will be low.
- In most soil, thorium is strongly adsorbed and the mobility will be very low; therefore, transport to groundwater will not occur in most soils.
- The transport of atmospherically deposited thorium from soil to plants is low. Lower bioconcentration factors in higher trophic animals indicate that thorium will not biomagnify in the aquatic environment.

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-, intermediate-, or chronic-duration inhalation MRLs were derived for thorium.

Oral

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

Health Effects

- It has not been determined whether the adverse health effects associated with exposure to thorium are the result of the ionizing radiation, the chemical toxicity of thorium, or a combination of radiation and chemical toxicity.
- Respiratory disease has been associated with occupational exposure to thorium, although workers were also exposed to other radioactive and nonradioactive compounds.
- Cancer of the lung and blood-producing tissues has been associated with occupational exposure to thorium and other radionuclides and non-radioactive substances.
- In animals, hematological effects (abnormal blood cells and decreased erythrocytes) and pulmonary effects (sclerosis and cancer of the lung) were observed following inhalation exposure to thorium.
- Adverse effects to the skin, testes, and sperm were reported in animals after thorium nitrate was applied on the scrotum or injected into the testes.
- No developmental toxicity studies were identified for thorium.
- The U.S. Department of Health and Human Services categorized thorium dioxide as reasonably anticipated to be a human carcinogen based on human and laboratory animal evidence following parenteral exposure to colloidal thorium dioxide (Thorotrast). The International Agency for Research on Cancer (IARC) also categorized ^{232}Th (as Thorotrast) as carcinogenic to humans (Group 1).

Children's Health

- It is not known if children are more sensitive to thorium exposure than adults, but neonatal animals have been found to absorb more thorium through the gastrointestinal tract than adult animals.