

Sources of Exposure

Toxicokinetics and Normal Human Levels

Biomarkers/Environmental Levels

ToxGuide™

for

1,4-Dioxane



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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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General Populations

- The general population may be exposed to 1,4-dioxane in contaminated air, water, food, and consumer products.
- Inhalation exposure to 1,4-dioxane in tap water may also occur during activities such as showering, bathing, and laundering. Exposure during these activities may be higher than exposure via ingestion of tap water.
- Dermal exposure may occur through bathing or showering in contaminated tap water or through the use of cosmetics, detergents, shampoos, and bubble baths containing 1,4-dioxane. Although FDA monitors 1,4-dioxane in raw materials used in the manufacture of cosmetic products, not all raw material producers are effectively controlling the levels.

Occupational Populations

- Facilities that produce or use solvents containing 1,4-dioxane.
- 1,4-Dioxane is also used as a laboratory reagent in chromatography and in plastic, rubber, insecticides, and herbicides.

Toxicokinetics

- 1,4-Dioxane is readily absorbed through the lungs and gastrointestinal system and poorly absorbed through the skin.
- At lower doses, 1,4-dioxane is rapidly metabolized to β -hydroxyethoxy acetic acid (HEAA).
- At higher doses, the metabolic process may become saturated resulting in 1,4-dioxane being excreted in exhaled air and urine.
- 1,4-Dioxane is rapidly eliminated from the body and does not accumulate.
- 1,4-Dioxane is primarily excreted as the metabolite HEAA in urine.

Normal Human Levels

- A 2007–2008 study from a U.S. population (≥ 12 years old) found no detectable concentration of 1,4-dioxane in 2,053 blood samples analyzed.

Biomarkers

- 1,4-Dioxane and HEAA in plasma and urine can be used as biomarkers of recent exposure in workers.

Environmental Levels

Air

- Levels in ambient air ranged from 0.028–0.11 ppb; mean concentration in indoor air was 1.03 ppb. These values are from the mid 1980s, more recent data are not available.

Sediment and Soil

- No data are available on actual measurements of 1,4-dioxane in soil.

Water

- Levels in municipal water were approximately 1 ppb in the 1970s; more recent data are not available.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological Profile for 1,4-Dioxane. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

Chemical and Physical Information

Routes of Exposure and 1,4-Dioxane in the Environment

Relevance to Public Health (Health Effects)

1,4-Dioxane is a Liquid

- 1,4-Dioxane is a clear liquid that dissolves in water.
- It is primarily used as a solvent for chemical processing (e.g., adhesives, cleaning and detergent preparations, cosmetics, deodorant fumigants, emulsions and polishing compositions, fat, lacquers, pulping of wood, varnishes, waxes).
- It is unintentionally formed as a contaminant during the manufacture of alkyl ether sulfates and other ethoxylated surfactants, which are used in consumer products such as cosmetics, detergents, and shampoos. Currently, manufacturers reduce 1,4-dioxane from ethoxylated surfactants to trace levels before these chemicals are made into consumer products.

Route of Exposure

- Inhalation** – Predominant route of exposure for the general population and workers. Inhalation exposure also occurs from 1,4-dioxane released from tap water during bathing and laundering.
- Oral** – Predominant route of exposure for the general population ingesting contaminated drinking water and from food.
- Dermal** – Use of contaminated consumer products such as cosmetics or shampoos.

1,4-Dioxane in the Environment

- 1,4-Dioxane can be released into the environment during its production, the processing of other chemicals, its use, and with its unintentional formation during the manufacture of ethoxylated surfactants.
- 1,4-Dioxane is expected to volatilize from the surfaces of water and soil at a moderate rate. In air, it is subject to photooxidation with an estimated half-life of 1–3 days.
- 1,4-Dioxane biodegrades very slowly in water and soils and is considered recalcitrant. It adsorbs weakly to soil and will move quickly into groundwater.
- Bioconcentration, bioaccumulation, and biomagnification are not considered important environmental fate processes for 1,4-dioxane.

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

Minimal Risk Levels (MRLs)

Inhalation

- An MRL of 2 ppm has been derived for acute-duration inhalation exposure (≤ 14 days).
- An MRL of 0.2 ppm has been derived for intermediate-duration inhalation exposure (15–364 days).
- An MRL of 0.03 ppm has been derived for chronic-duration inhalation exposure (≥ 1 year).

Oral

- An MRL of 5 mg/kg/day has been derived for acute-duration oral exposure (≤ 14 days).
- An MRL of 0.5 mg/kg/day has been derived for intermediate-duration oral exposure (15–364 days).
- An MRL of 0.1 mg/kg/day has been derived for chronic-duration oral exposure (≥ 1 year).

Health Effects

- The primary targets of 1,4-dioxane toxicity are the liver, kidneys, and nasal cavity (following inhalation exposure).
- Acute exposures to airborne 1,4-dioxane can also result in eye and nose irritation in humans.
- 1,4-Dioxane is likely to be carcinogenic to humans. Liver tumors have been observed in rats and mice following chronic drinking water exposure. Nasal tumors were also observed in rats following chronic inhalation or drinking water exposure.

Children's Health

- It is not known if children are more susceptible to 1,4-dioxane poisoning than adults.