Sources of Exposure

General Populations

- Chlorinated dibenzo-*p*-dioxins (CDDs) are ubiquitous in the environment and low levels have been found in blood, adipose tissue, breast milk, and other tissues.
- The most important source of exposure to CDDs for the general population is food containing CDDs. The highest concentrations are found in meat, fish, and dairy products.
- Ambient air, drinking water, and consumer products are considered minor sources of CDD exposure.
- People living near incinerators or uncontrolled landfill sites may be exposed to higher levels of CDDs.
- Recreational or subsistence fishers may be exposed to higher levels of CDDs.

Occupational Populations

- Workers in industries that manufacture or use chemicals contaminated with CDDs may be exposed to higher levels.

Toxicokinetics and Biomonitoring Levels

Toxicokinetics

- Over 80% of ingested CDDs are absorbed. CDDs are also absorbed following inhalation or dermal exposure; however, the percent absorption of CDDs for these exposure routes has not been quantified.
- CDDs are lipid soluble and tend to accumulate in tissues with high lipid content. The highest amounts are found in the liver and adipose tissue.
- CDDs are very slowly metabolized by the cytochrome P450 enzyme system.
- The major pathway of excretion of CDDs is the feces.

NHANES Levels

- The weighted arithmetic mean of pooled blood samples (NHANES 2011–2012) were:

  0.54–2.93 pg/g lipid for 2,3,7,8-tetraCDD,
  0.74–8.50 pg/g lipid for 1,2,3,7,8-pentaCDD,
  1.09–7.23 pg/g lipid for 1,2,3,7,8,9-hexaCDD,
  6.46–49.1 pg/g lipid for 1,2,3,6,7,8-hexaCDD,
  0.74–6.44 pg/g lipid for 1,2,3,4,7,8-hexaCDD,
  13.1–50.9 pg/g lipid for 1,2,3,4,6,7,8-heptaCDD, and
  96.9–490 pg/g lipid for octaCDD.

Biomarkers/Environmental Levels

Biomarkers

- Levels of CDD congeners can be measured in blood, body fat, and breast milk. Levels of CDDs in serum and adipose tissue are believed to be representative of body burden.

Environmental Levels

Air

- Between 1998 and 2004, air levels were 0.6–7.3 fg/m^3 for 2,3,7,8-tetraCDD, 1,2,3,7,8-pentaCDD, 1,2,3,4,7,8-hexaCDD, 1,2,3,6,7,8-hexaCDD, and 1,2,3,7,8,9-hexaCDD; 102.3 fg/m^3 for 1,2,3,4,6,7,8-heptaCDD; and 352.8 fg/m^3 for octaCDD.

Water

- The concentrations of CDDs in most waters are below the detection limit unless there is a nearby emission source.

Sediment and Soil

- In general, 2,3,7,8-tetraCDD was detected infrequently and at very low concentrations in background soil samples taken at sites (urban and rural areas) that did not have previously known sources of 2,3,7,8-tetraCDD contamination.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2024. Toxicological Profile for Chlorinated Dibenzo-*p*-Dioxins (CDDs) (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Chlorinated Dibenzo-*p*-Dioxins (CDDs)

October 2024

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

CDDs are Solids.

- CDDs are a class of related chlorinated hydrocarbons comprised of two benzene rings joined via two oxygen bridges at adjacent carbons on each of the benzene rings. Based on the number of chlorine atoms (one to eight) on the parent chemical, dibenzo-*p*-dioxin, there are 75 possible types of CDDs, which are called congeners.
- CDDs are not manufactured commercially in the United States except on a small scale for use in research.
- CDDs are unintentionally produced during various uncontrolled chemical reactions involving chlorine and during combustion and incineration processes.
- In the past, CDDs were formed during the production of various pesticides and herbicides. Environmental contamination occurred due to the use of these pesticides and herbicides.

Routes of Exposure

- Inhalation – Minor route of exposure for the general population; possible major route in cases for occupational exposure and accidental exposure.
- Oral – Most likely route of exposure for the general population through ingestion of contaminated food.
- Dermal – Relevant route of exposure for the general and occupational populations.

CDDs in the Environment

- Biodegradation occurs slowly for higher chlorinated CDDs. They are considered to be persistent in the environment.
- CDDs have large soil adsorption coefficients and possess low mobility in soil surfaces.
- CDDs in water are predominantly adsorbed to suspended solids and sediment.
- The CDDs with more chlorine atoms are more likely to bioconcentrate in aquatic organisms.

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 CDDs.

Oral

- An acute-duration oral MRL (≤14 days) of $2x10^{-4}$ µg/kg/day was derived for 2,3,7,8-tetraCDD.
- No intermediate-duration oral MRL was derived for 2,3,7,8-tetraCDD.
- A chronic-duration (≥365 days) of $4x10^{-7}$ µg/kg/day was derived for 2,3,7,8-tetraCDD.
- No oral MRLs were derived for other CDD congeners.

Health Effects

- Exposure to CDDs can result in a wide range of adverse health outcomes in humans and animals.
- The toxicity of CDD congeners depends on the number and position of chlorine atoms. Congeners with chlorines in the 2,3,7,8- position are the most toxic. 2,3,7,8-tetraCDD, also referred to as 2,3,7,8-TCDD, is the most toxic congener.
- Effects observed in humans exposed to high levels of CDDs include chloracne, developmental effects, immunological effects, and reproductive effects.
- Effects observed in animal exposed to low doses of 2,3,7,8-tetraCDD include developmental effects, impaired immune system responses, reproductive effects, and liver effects.
- The developmental effects include increases in mortality, malformations, decreased birth weight and growth, impaired development of the immune system, and neurodevelopmental effects such as hyperactivity, altered social behaviors, and impaired learning.
- Reproductive effects include alterations in sperm, decreased female fertility, and altered nursing behavior.
- The Department of Health and Human Services (HHS) has categorized 2,3,7,8-tetraCDD as known to be a human carcinogen. The U.S. Environmental Protection Agency (EPA) has classified the mixture of 1,2,3,6,7,8-hexaCDD and 1,2,3,7,8,9-hexaCDD as a probable human carcinogen. The International Agency for Research on Cancer (IARC) concluded that 2,3,7,8-tetraCDD is carcinogenic to humans. IARC also concluded that other CDDs are not classifiable as to their carcinogenicity in humans.

Children's Health

- Children exposed to CDDs had similar effects as adults.
- It is not known if children are more sensitive to the toxicity of CDDs than adults.