Sources of Exposure

General Populations

- The general population may be exposed to nitrophenols through the inhalation of contaminated ambient air.
- Since nitrophenols are released from car exhaust, higher exposures could occur in populations living near heavy traffic or people who work with or around running gas- or diesel-powered motor vehicles, compared to the general population.
- 4-Nitrophenol is also a breakdown product of several pesticides; therefore, individuals living in agricultural areas that use methyl parathion and related pesticides for crop protection may be exposed to higher levels of nitrophenols than the general population.
- People living near landfill sites that contain nitrophenols may be exposed to higher levels of the compounds than the general population.

Occupational Populations

- Workers who manufacture or use nitrophenols and applicators of certain pesticides may be at higher risk of exposure to nitrophenols than the general population.
- People who work with or around running gasoline- or diesel-powered motor vehicles may also be at risk of higher exposures to nitrophenols.

Toxicokinetics and Biomonitoring

Toxicokinetics

- 4-Nitrophenol is rapidly absorbed through the gastrointestinal tract and skin. The reported rate of absorption in animals is 36% following oral exposure. The extent of dermal absorption is species-dependent, ranging from 11% in dogs to ~70% in rats and pigs. There are no data pertaining to inhalation absorption of nitrophenols.
- Absorbed 4-nitrophenol is widely distributed in the body after oral exposure, but the majority is distributed to the gastrointestinal tract. Levels steadily decrease in all tissues over a 24-hour period. Dermal application of 4-nitrophenol in animals results in very minimal body burden of 4-nitrophenol.
- 2-Nitrophenol and 4-nitrophenol undergo metabolic transformation by hepatic and extrahepatic phase I and phase II metabolism.
- Urine is the main route of excretion for nitrophenols. Small amounts are excreted in the feces.

NHANES Biomonitoring

- For survey years 2011–2012 and 2013–2014, the geometric mean of urinary 4-nitrophenol for the total U.S. population was 0.64 µg/L. These are the last annual intervals that NHANES reported information for any nitrophenols.

Biomarkers/Environmental Levels

Biomarkers

- 2-Nitrophenol and 4-nitrophenol break down into many metabolites that could be used to detect exposure, although none have been studied as such in the literature. The presence of 4-nitrophenol in urine may be associated with exposure to the chemical itself or to any of the chemicals for which it is a metabolite, such as methyl parathion or nitrobenzene.

Environmental Levels

Air

- There are no recent air monitoring data in the United States for nitrophenols.

Groundwater (2000–2022)

- 2-nitrophenol: <0.25–40 µg/L
- 4-nitrophenol: <0.2–250 µg/L

Surface water (2000–2022)

- 2-nitrophenol: <0.16–5.3 µg/L
- 4-nitrophenol: <0.28–27 µg/L

Soil and sediment (2000–2022)

- 2-nitrophenol: <0.3–19,000 µg/kg
- 3-nitrophenol: 200 µg/kg
- 4-nitrophenol: <10–34,000 µg/kg

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2023. Toxicological Profile for Nitrophenols. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Nitrophenols

$C_6H_5NO_3$

CAS# 88-75-5, 554-84-7, and 100-02-7

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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

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

2-Nitrophenol

- 2-Nitrophenol (also known as ortho- or o-nitrophenol) is a light yellow crystalline solid.
- 2-Nitrophenol is used to manufacture pesticides, fungicides, and other agricultural chemicals.
- 2-Nitrophenol has an aromatic odor.

3-Nitrophenol

- 3-Nitrophenol (also known as meta- or m-nitrophenol) is a colorless to pale yellow crystalline solid.
- 3-Nitrophenol is used as an indicator and to synthesize dyestuffs and drugs.
- 3-Nitrophenol has an odor between aromatic and sweet.

4-Nitrophenol

- 4-Nitrophenol (also known as para- or p-nitrophenol) is a colorless to slightly yellow solid.
- 4-Nitrophenol is used to darken leather, and to produce drugs, fungicides, methyl and ethyl parathion insecticides, and dyes.
- 4-Nitrophenol is odorless.
- Nitrophenols are manufactured or formed in vehicular exhaust and do not occur naturally in the environment.
- Nitrophenols are expected to be soluble in water and have low vapor pressures.

Routes of Exposure

- Inhalation – Inhalation exposure from nitrophenols released into the atmosphere may occur on or near agricultural land. Nitrophenols may also be released from vehicle exhausts. Inhalation is the primary route of exposure.
- Oral – Oral exposure may occur through contaminated drinking water, which may be a greater risk for those living or working near a farm, waste, or industry site that utilizes certain pesticides.
- Dermal – Dermal exposure may occur through contact with contaminated soil and/or water. This may also be a greater risk near a farm, waste, or industry site.

Nitrophenols in the Environment

- The primary source of anthropogenic nitrophenol release is traffic activity, although only a very small portion of released chemical is expected to be in ambient air due to photolysis and physical removal processes (atmospheric half-lives: 3–18 days).
- Nitrophenols can deposit in soil and degrade very slowly (4-nitrophenol half-lives: 1–14 days in topsoil, >40 days in subsoil).
- Photolysis and biodegradation break down nitrophenols in water (half-lives: 1–8 days in fresh water, 13–139 days in sea water). Nitrophenols bioaccumulate in edible aquatic species, although there is no current evidence indicating any transfer from plant to animal.

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- (≤14 days), intermediate- (>14 –364 days), or chronic-duration (≥365 days) inhalation MRLs were derived for 2-, 3-, or 4-nitrophenol.

Oral

- No acute-, intermediate-, or chronic-duration oral MRLs were derived for 2-, 3-, or 4-nitrophenol.

Health Effects

- No studies evaluating health effects in humans after inhalation, oral, or dermal exposure to nitrophenols were identified.
- Ocular effects are a suspected health effect of exposure to 4-nitrophenol via inhalation exposure. Findings include corneal opacity and cataract formation. Effects noted following inhalation exposure are likely due to direct ocular contact with dust particles, rather than a systemic effect. Direct ocular instillation with 4-nitrophenol in rabbits causes severe eye irritation, corneal cloudiness and neovascularization, inflammation, and visible damage to the iris.

Health Effects

- Some inhalation studies in rats report methemoglobinemia in rats following exposure to 4-nitrophenol, which lowers oxygen carrying and delivery capacity to tissues and can cause hypoxia, cyanosis, fatigue, weakness, dyspnea, headache, and dizziness. However, available data are inadequate to classify hematological effects as a health effect of 4-nitrophenol.
- Limited data suggest that decreased body weight occurs after oral exposure to 4-nitrophenol. However, available data are inadequate to classify decreased body weight as a health effect of 4-nitrophenol.
- The Integrated Risk Information System (IRIS) of the U.S. Environmental Protection Agency (EPA), the International Agency for Research on Cancer (IARC), and the Department of Health and Human Services (HHS) National Toxicology Program (NTP) have not evaluated the potential for nitrophenols to cause carcinogenicity in humans.

Children's Health

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