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# ENVIRONMENTAL Fact Sheet

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## Manganese: Health Information Summary

### INTRODUCTION

Manganese is a common element in the earth's crust, water and particulate matter in the atmosphere. The principal sources of manganese in the atmosphere are natural processes including continental dust, volcanic gas and dust, and forest fires. Other sources are industrial emissions and combustion of fossil fuels. In water, manganese may undergo chemical reactions or may persist for up to several hundred years. This element is used in manufacturing steel, dry cell batteries, electrical coils, ceramics, matches, glass, fertilizers, fungicides and welding rods. Manganese may be used as an additive to animal food and in antiseptic solutions. It is also a constituent of a gasoline additive (MMT), primarily for fuel sold in Canada. MMT in US fuel supplies is currently at a very low 0.02%.

Manganese is an essential nutrient, present in all living organisms. While manganese is present in air and in most water supplies, the major portion of an individual's intake is derived from food. Drinking water usually comprises only a very small proportion of the total exposure. Historical data from NH public water systems found approximately 30% contained manganese at a concentration greater than 0.1 mg/L, and 12% had concentrations greater than 0.3 mg/L.

### MANGANESE NUTRITION

Because manganese is an essential nutrient, a certain amount must be ingested on a regular basis to maintain health. Although the precise requirement has not been determined, 2.5 to 5.0 milligrams per day (mg/day) has been estimated to constitute an adequate and safe intake. Typical daily intakes in the United States range between 1.0 and 6.4 mg/day for adults. Those who take supplements containing manganese may ingest an amount equal to the average intake from food. Foods that are high in manganese include nuts, beans, tea and whole grains, while there is relatively less manganese in meat, dairy and refined grains. Therefore, individuals eating plant-based diets are likely to have the highest intakes of manganese. However, because plants also contain substances such as fiber that interfere with the absorption of manganese, the body is not able to utilize all the extra manganese provided by vegetarian diets.

### HEALTH EFFECTS

#### Absorption

Limited data indicates that gastrointestinal absorption of manganese is low in older children and adults, averaging approximately 3%. The body has mechanisms that can usually control the total amount of internal manganese by increasing manganese elimination if excess levels are consumed. However, infants and small children do not eliminate manganese as efficiently as older children and adults. This results in higher exposure in formula-fed infants and small children. Because manganese and iron compete for gastrointestinal absorption, manganese uptake from the gut is likely to be increased in iron-deficient persons. Inhaled manganese may be absorbed in the lungs if the particles are small enough to enter

airways and reach the lungs. Absorption of manganese through the skin is expected to be very low at less than 1%.

### **Short-Term (acute) Effects**

Studies in animals and humans indicate that inorganic manganese has a very low acute toxicity by any route of exposure. However, acute inhalation exposure to high levels of manganese-containing dust can cause an inflammatory response in the lungs.

In a human study, adult women took daily manganese supplements of 15 mg for 90 days with no acutely toxic effects to the blood. Short term exposure to manganese above 100 µg/L in drinking water is considered a health risk to infants below 12 months old.

### **Long-Term (chronic) Effects**

Considerable evidence indicates that long-term overexposure to manganese can result in adverse health effects in miners and steel workers exposed by inhalation to manganese dusts. Clinicians refer to the multiple health effects of chronic manganese exposure as "manganism" or "manganese-induced Parkinsonism," because some of the symptoms and signs are similar to those seen in cases of Parkinson's disease. Signs and symptoms include muscle tremor, reduced motor skills, difficulty and slowing of walking, slurred speech and, sometimes, psychiatric disturbances.

There are a few reports in the literature examining the effects of excess oral exposure of humans to manganese, namely from drinking water. One report describes symptoms of lethargy, increased muscle tone, spasm, tremors and mental abnormalities in persons drinking water contaminated by manganese from dry cell batteries buried nearby. The actual length of time that people were drinking the water was not clear. The exposure time spanned a period of two to three weeks for some individuals and potentially much longer for other members who developed symptoms. When the water was tested, it contained manganese at a concentration of 14.3 milligrams per liter (mg/L; equivalent to parts per million or ppm). Those who studied this event believe it likely that other factors, possibly chemicals in the water beside manganese, contributed to the health effects.

A study was conducted to evaluate populations in three areas of Greece, each containing different levels of manganese in their drinking water. Neurological examinations were conducted on individuals within each population. Significantly higher neurological scores indicating muscular disorders including weakness/fatigue, disturbance in walking and tremors were found in the area with the highest manganese levels (1.6 - 2.3 mg/L in water) compared with the area having the lowest. However, differences in each population that may not have been controlled for, such as age, occupational exposures or general health status make it difficult to be certain that manganese was the only causative factor.

Another study conducted in Germany comparing nervous system status between those exposed for many years to high (0.30 - 2.16 mg/L) and low (less than 0.05 mg/L) manganese levels in drinking water detected no difference between the two groups in nervous system functioning.

Animal data regarding toxic effects of oral manganese exposure are limited. A study conducted in monkeys receiving elevated oral doses for 18 months reported weakness and muscular rigidity. One animal study in which rats were exposed to 2,000 ppm of manganese in the diet failed to produce symptoms of central nervous system abnormalities.

Specific populations that may be more sensitive to manganese include infants, those with liver disease and the elderly. Evidence indicates that infants absorb more of the metal than adults and those with liver disease are more susceptible because manganese is removed from the blood by the liver for excretion. It is not known for certain why older populations appear to be more susceptible but possible explanations include normal declines in nervous system function with age or the accumulated effects of other environmental toxins make this group more vulnerable to manganese's effects.

### **Carcinogenic (cancer-causing) Effects**

Information regarding the carcinogenicity (ability to cause cancer) of manganese in humans or animals is not available. Therefore, the U.S. Environmental Protection Agency (EPA) has classified manganese as having "inadequate information to assess carcinogenic potential."

### **Developmental/Reproductive Effects**

There are a few reports associating intake of manganese with reproductive effects in humans. Impotency in males has been reported in association with occupational inhalation exposure to manganese. Another study found decreased levels of the male hormone testosterone without any decrease in reproduction in male rats fed diets containing 1,050 ppm of manganese.

Epidemiological studies suggest that excessive drinking water exposure to manganese can impair neurological development and learning in young children. This includes reductions in fine motors skills and IQ score based on certain cohorts from Canada and the United States. Due to the previously mentioned absorption issues in infants and small children, the risk of neurodevelopmental and cognitive effects is especially problematic for manganese. Short term exposure to manganese above 100 µg/L in drinking water is considered a health risk to infants below 12 months old.

Animal studies have found an association with very high levels in food and an increase in birth defects. Some animal studies indicate that excessive oral exposure to manganese can impair neurological and motor function development in rodents.

### **DRINKING WATER STANDARDS**

The EPA issued a lifetime health advisory (LHA) for manganese of 0.3 mg/L (300 µg/L). In addition to EPA's manganese LHA of 0.3 mg/L for infants, New Hampshire's ambient groundwater quality standard (AGQS) for manganese was revised from 0.84 mg/L to 0.3 mg/L in December 2020 (effective January 1, 2021).

The Secondary Maximum Contaminant Level (SMCL) for manganese is 0.05 mg/L (50 µg/L) based on aesthetic impacts. Manganese staining of fixtures usually produces a brownish-black color, compared to blue-green for copper and reddish-brown for iron.

### **FOR MORE INFORMATION**

For information on the drinking water regulations and testing, please contact the NHDES Drinking Water and Groundwater Bureau at [\(603\) 271-2513](tel:6032712513) or [dwgbinfo@des.nh.gov](mailto:dwgbinfo@des.nh.gov). For information on health effects please contact the NHDES Environmental Health Program (EHP) at [\(603\) 271-6802](tel:6032716802).

For a list of references please contact the EHP at [\(603\) 271-6802](tel:6032716802).

Note: This fact sheet is accurate as of May 2023, and scientific information available after this date may render this information inaccurate or incomplete.