

Ministry of the Environment programs and initiatives

Arsenic in the environment

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Arsenic occurs naturally and as a result of human activity. The most usual source of arsenic exposure is from food and drinking water, and small children sometimes ingest contaminated soil or dust. You can take steps to reduce your exposure to arsenic
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Arsenic is a naturally occurring element in the earth's crust, and is found throughout the environment. It is important to maintain a distinction between inorganic and organic arsenic, since the organic forms are usually less toxic than the inorganic forms.

Pure arsenic is a gray-colored metal, but this form is not common in the environment. Rather, arsenic is usually found combined with one or more other elements such as oxygen, chlorine or sulphur. Combined with these elements it is referred to as inorganic arsenic, whereas, combined with carbon and hydrogen, it is referred to as organic arsenic. Many arsenic-containing substances, both inorganic and organic, are naturally occurring, while others are man-made.

How much arsenic is there usually in our soil?

All soil contains some amount of arsenic. In Ontario, background arsenic concentrations in old urban parkland range up to 17 parts per million (ppm), while concentrations in rural parkland can reach 11 ppm.

Although significant amounts of arsenic can be released from natural ore bodies, human activity accounts for most arsenic contamination in soil. In Ontario, many gold, silver, nickel, copper and zinc ores are contaminated with arsenic. As a result, the areas of highest contamination are in the vicinity of mining and smelting operations. Arsenic concentrations in soils around mine sites have been reported as high as 4,700 ppm.

Historically, arsenic was used as an insecticide and a herbicide, which has resulted in the contamination of many agricultural soils,

particularly old orchards. Since arsenic is also a common contaminant in coal, localized contamination can occur around coal-burning facilities. In addition, soil may be contaminated within a few centimetres of structures made from pressure-treated wood.

Is arsenic harmful?

The effects of exposure to any hazardous substance depend on the dose, the duration of exposure, how you are exposed, personal traits and habits, and whether other chemicals are present.

Most arsenic that is absorbed into the body is converted by the liver to a less toxic form that is efficiently excreted in the urine. Consequently, arsenic does not have a strong tendency to accumulate in the body, except at high exposure levels.

Inorganic arsenic has been recognized as a human poison since ancient times, and very large doses can result in death. Lower levels of exposure may produce injury in a number of different body tissues or systems: these are called systemic effects. When taken by mouth, a common effect is irritation of the digestive tract, leading to pain, nausea, vomiting, and diarrhea. Other effects typical of exposure by mouth include decreased blood cells, abnormal heart function, blood vessel damage, liver and/or kidney injury, and impaired nerve function causing a pins-and-needles feeling in the feet and hands. There is also evidence from animal studies that high oral doses during pregnancy may damage the fetus, but this has not been demonstrated in humans.

Perhaps the single most characteristic systemic effect of oral exposure to inorganic

arsenic is a pattern of skin changes including the appearance of dark and light spots on the skin, and small “corns” on the palms, soles, and trunk. While these skin changes are not considered to be a health concern in their own right, some of the corns may ultimately progress to skin cancer. In addition, arsenic ingestion has been reported to increase the risk of internal cancer, especially in the liver, bladder, kidney, and lungs.

Inhalation of inorganic arsenic dusts or fumes sometimes produces the same types of systemic health effects produced by oral exposure. However, this is not common, and the effects are usually mild. Of much greater concern is the ability of inhaled arsenic to increase the risk of lung cancer. This has been observed mostly in humans exposed to high levels of airborne arsenic in or around operating smelters, but lower levels may increase lung cancer risk as well.

Direct contact with arsenic compounds, frequently from inorganic arsenic dusts, may result in mild to severe irritation of the skin.

There is some evidence that low levels of exposure may be beneficial. Animals kept on a diet with unusually low concentrations of arsenic did not gain weight normally, and they became pregnant less frequently than animals kept on a diet with a more normal (but low) concentration of arsenic. The offspring from these animals tended to be smaller than normal, and some died at an early age. The estimated daily dose of arsenic that is beneficial is quite small (about the same as normally supplied in the diet), and no cases of arsenic deficiency in humans have been found.

How does exposure to arsenic occur?

Because arsenic occurs naturally in the environment, everyone is exposed to low levels. The greatest, most common source of exposure to organic arsenic is from food, particularly shellfish, meat, poultry, grain and dairy products. Food and drinking water together account for 99 per cent of total

daily intake of arsenic through ingestion. The breakdown is roughly 84 per cent from food, 15 per cent from drinking water, less than one per cent from soil/dusts and a negligible amount from skin contact. Although most areas in Ontario have low levels of arsenic in drinking water supplies, there are places in Northern Ontario where arsenic concentrations in drinking water supplies are relatively high. People living near mining or smelting operations that have been historically contaminated with arsenic may be exposed to higher arsenic concentrations through ingestion of soil or through inhalation of arsenic-contaminated dust.

In the past, household products such as paints, dyes, rat poisons, and medicines for diseases such as asthma and psoriasis contained inorganic arsenic. However, these products are no longer in general use, so exposure from them is now unlikely. There are other sources, such as some herbal teas, that may contain arsenic.

Arsenic is also present in cigarette smoke because it occurs in tobacco plants. As a result, people who smoke have slightly higher exposures to arsenic than non-smokers.

Can arsenic exposure occur through eating backyard vegetables?

Edible portions of plants seldom accumulate high concentrations of arsenic. This is because most backyard vegetable plants are sensitive to arsenic in soil and will either be killed or severely stunted long before the arsenic concentrations in their tissues reach concentrations that pose a health risk. The extent of arsenic uptake into plants not only depends on the degree of arsenic contamination in the soil but also on soil properties. In general, the sandier or wetter the soil, the greater the potential for arsenic toxicity. Toxicity symptoms in plants include stunted, blackened roots and blackened leaf margins.

The highest arsenic concentrations tend to be in root crops, particularly beets and radishes. Fruit crops, such as tomatoes,

berries and apples, present a much lower risk because they take up and store very little arsenic.

Green beans are good indicators of arsenic in soil, since bean plants are particularly sensitive to arsenic. If green beans grow well in a garden, it is unlikely that the uptake of arsenic into other vegetables will be high enough to pose a health risk.

Who is at risk?

Studies in humans indicate that there is considerable variation among different individuals. Sensitive individuals in exposed populations often begin to display one or more of the characteristic signs of arsenic toxicity at oral intakes of around 20 micrograms (μg) per kilogram of body weight per day (about 1000 to 1500 $\mu\text{g}/\text{day}$ for an adult – μg is one-millionth of a gram). While some humans can ingest over 150 $\mu\text{g}/\text{kg}/\text{day}$ without any apparent ill-effects.

There is no particular age group that is especially sensitive to arsenic, but children may have higher environmental exposure than adults because of their smaller body weight and because they play outside. Elevated levels of arsenic in soil (due either to natural mineral deposits or to contamination from human activities) can lead to some exposure from ingesting soil. This is a particular exposure pathway for small children who swallow small amounts of soil while playing.

Manufacturing (smelting) of copper and other metals often releases inorganic arsenic into the air. Thus, workers in metal smelters and nearby residents are exposed to elevated arsenic levels and may have increased risk.

There are also low levels of arsenic in cigarette smoke. Therefore people who smoke will have slightly higher risk than non-smokers to arsenic.

What can you do to reduce exposure to arsenic?

A person can take very simple steps to reduce their personal exposure to arsenic in soil or dusts, and because of arsenic's known toxicity, such measures are generally advised. These steps apply to reducing exposures to any metal in soil, in any location.

Contaminated soil can be removed, or exposure can be reduced by covering the soil with clean soil or sod. Soil can also be paved over or covered with paving stones or decking. Other things you can do:

- Wash your hands and face and those of your children after working or playing outdoors and before eating.
- Clean your home regularly using a damp mop or damp cloth. Vacuuming and sweeping can increase dust levels in the home. Use a phosphate cleaner at least once a week, especially near window sills and doors. Use rugs, curtains and slipcovers that can be cleaned easily.
- Avoid bringing outdoor dirt inside by removing outdoor shoes.
- Pets are known to carry contaminated dusts into houses. Brush pets often as their fur collects dust. Pet should be brushed outside if possible.
- Keep children's toys and play areas clean; discourage mouthing activities such as eating dirt or sucking on dirty objects.
- Before eating, thoroughly wash all vegetables and peel root crops. Washing has been shown to greatly reduce the levels of arsenic on vegetables.
- If you are digging or excavating soil around your home be sure to wear gloves and a protective mask to reduce contact, and to avoid inhaling arsenic in dusts. Do not put displaced soils into vegetable gardens.
- For smokers, reduce the amount you smoke.

How can you get more information?

If you live in the vicinity of a source of arsenic pollution and you suspect your soil may be contaminated, contact your local office of the Ministry of the Environment. You'll find the telephone number in the blue pages of your telephone directory.

Contact your local health unit or your medical doctor if you are concerned about being exposed to arsenic or have questions about health effects.