ENVIRONMENTAL EXPOSURES AND HEALTH RISKS

Developed by
The Environmental Health Sciences Research Center

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Introduction

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Iowa has the second-highest and fastest-growing rate of new cancer in the United States (1). In addition, Iowa has one of the greatest disparities in cancer mortality between Black and white populations (2). While many well-understood behavioral and genetic factors increase cancer risk, the role of chemical exposures in the environment in increasing cancer risk is not as well documented. A chemical exposure can occur when a person's body is exposed to a harmful substance in the air, water, or soil. These toxic substances, like nitrate, arsenic, and radon, have the potential to contribute to short-term and long-term illness in humans.

A combination of agricultural activity, geologic and glacial features, and changing environmental conditions make Iowa a hotspot for environmental exposure to cancer-causing agents. Iowa has the largest percentage of homes that test at or above the EPA action level, as well as the highest average groundwater nitrate pollution from fertilizer use in the country. These are two of the reasons exposure to environmental carcinogens is an important consideration when examining the elevated cancer rates in the state (3, 4, 5). Some sources of environmental risk will be further explored in the upcoming pages. However, it should also be noted that higher than average red meat consumption, lower levels of activity, high alcohol consumption, UV exposure, certain viruses, tobacco and nicotine exposure, lack of access to healthy fruits and vegetables, and more can further increase an individual's cancer risk, as highlighted by the Iowa Cancer Registry (1, 2). In line with priorities six and seven of Chapter 2 of the Iowa Cancer Plan, the goal of these fact sheets is to explain the current science about environmental contaminants and their relationship to cancer and other diseases to reduce the rates of potentially preventable diseases (6).

It is difficult to establish a causal relationship between one individual's exposure to an environmental carcinogen and cancer, so scientists use other ways to study these connections. In these fact sheets, risk, correlation, and association are all terms used to describe the relationship between an environmental contaminant and a health outcome (cancer, birth defects, etc.)

- Risk: explains the likelihood of an outcome in an exposed group compared to a lesser or unexposed group. A relative risk ratio of two indicates that the exposed group is two times more likely to experience the outcome than the comparison group.
- Correlation: measures the relationship between an exposure and a health outcome and how the two move together. A positive correlation indicates that when one variable increases, the other variable also increases. For example, when higher concentrations of radon are present in residential air, more people have lung cancer.
- Association: indicates there is a general relationship between an exposure and an outcome. A positive association means that an exposure is related to a higher probability of a health outcome.

In summary, relative risk ratio is the most specific indicator of a relationship, correlation shows a trend, and association is a more general relationship.

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Arsenic & Health Fact sheet

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Introduction

Inorganic arsenic is a toxic metalloid found naturally in Earth's crust. Arsenic can be detected in water, air, and soil globally and within the United States (1). While the metalloid can be found in many forms, inorganic arsenic is the environmental form that poses the greatest risk to public health (1). Arsenic is a colorless powder, with no smell or taste, making it imperceptible in water, food, air, and soil.

Exposure Sources

Exposure to inorganic arsenic is associated with mining and smelting, proximity to hazardous waste sites, and its use as a pesticide, wood preservative, and alloy in semiconductors and batteries (1,2). While some exposure is attributable to the consumption of rice, the primary route of exposure to arsenic in the US is through drinking water where high concentrations of inorganic arsenic are present in the groundwater. Concentrations of inorganic arsenic may be high in groundwater used as a source of drinking water (3). Wells deeper than 100 feet have the highest risk of inorganic arsenic contamination.

Health Risks Associated with Arsenic

Cancer Health Risks	The U. S. Environmental Protection Agency (EPA) classifies inorganic arsenic compounds as carcinogenic to humans (4). Hundreds of epidemiological studies conducted worldwide have shown the exposure to arsenic causes cancers of the skin, bladder, and lung. There is also evidence of association with cancers of the kidney, nasal passages, liver, and prostate. Recent research in the U.S. has provided evidence of a significantly elevated risk at levels below the current drinking water standard of 10 micrograms per liter (7).
Non-Cancer Health Risks	The EPA has conducted risk assessment on non-cancer effects of long-term exposure to inorganic arsenic including ischemic heart disease (IHD), Type II diabetes, adverse pregnancy and birth outcomes, and neurodevelopmental effects (7). Evidence demonstrates risk levels for IHD and Type 2 diabetes as high as 180 per 10,000 people with lifetime drinking water exposure to inorganic arsenic at the 10 micrograms per liter maximum contaminant level (MCL) (7).

How is Arsenic regulated?

- The EPA established the MCL to be 10 micrograms per liter to protect against the cancer and non-cancer health effects listed above (5).
- Under the Safe Drinking Water Act, the EPA requires public water suppliers to test for inorganic arsenic on an ongoing basis(1,3).
- Private wells are unregulated for arsenic (1,3).
- The Food and Drug Administration (FDA) and Occupational Safety and Health Administration (OSHA) regulate dietary and occupational exposures, respectively (5).

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What can you do?

- If your water is supplied from a private well, you should get your water tested annually for arsenic by contacting your local health department.
- If you are on a public water supply, read your annual Consumer Confidence Report to see what levels of inorganic arsenic are in your drinking water. Arsenic is not reported if the concentration is below 5 micrograms per liter (3).
- Certain methods can be used to enhance the removal of arsenic from drinking water. These include anion exchange, reverse osmosis, activated alumina, pH adjustment, enhanced lime softening, and pre-oxidation (3,6).
- Using a Brita filter, refrigerator filter, and boiling water are not reliable methods of arsenic removal (6).
- Rice should be rinsed thoroughly prior to cooking.

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Nitrate & Health Fact sheet

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Introduction

Nitrate, a form of nitrogen, is a water-soluble chemical found at high concentrations in some Iowa waterways and private wells (1, 2, 3). Nitrate is colorless and has no smell, so it is unnoticeable in drinking water. Nitrate occurs naturally in the environment; however, applying nitrogen fertilizers to corn and other crop fields, and manure run-off from animal feeding operations can cause nitrate pollution in drinking water (2, 3). Nitrate can be reduced to nitrite and other compounds that have been shown to have negative health effects (1,5).

Exposure Sources

People are primarily exposed to nitrate through contaminated drinking water and by eating certain nitrate-containing foods, like processed meats (1, 4). Drinking water contaminated with nitrate is a public health concern in Iowa due to the amount of nitrogen fertilizer used in agriculture (1, 2, 3), with shallow wells being most at risk of high nitrate concentrations (3). Nitrate is the most common form of nitrogen entering Iowa streams because of its stability and water-solubility, potentially contributing to downstream contamination of drinking water.

Health Risks Associated with Nitrate

Cancer Health Risks	The International Agency for Research on Cancer (IARC) classifies nitrate in food and water as "probably carcinogenic to humans" (1, 5). Studies conducted in Iowa have shown a positive correlation between exposure to nitrate in the drinking water and some cancers (1). Some studies conducted in Iowa have analyzed cancer risk at or above levels one-half the maximimum contaminant level (MCL) over long periods of time. From these studies, consistent associations have been discovered for colorectal cancer. Cancers at other sites have been less studied, however, positive associations have been found at levels below the MCL for cancers of the thyroid, ovary, and kidney (6).
Non-Cancer Health Risks	Methemoglobinemia, or Blue Baby Syndrome, is a condition in which not enough oxygen is transported in the blood to the body's tissues (3). Blue Baby Syndrome can occur when infants are exposed to nitrate levels higher than 10 mg/L. Elevated prenatal nitrate exposure in Iowa has also been connected to increased risk of birth defects, including spina bifida, limb deficiencies, and cleft palate (7,8).

How is Nitrate regulated?

- The EPA established the maximum contaminant level for nitrate to be 10 mg/L in drinking water, to protect infants against methemoglobinemia, or Blue Baby Syndrome (7, 9).
- Public water suppliers must test for nitrate and present results to consumers and the state through consumer confidence reports (3).
- Private wells are not required to be tested for nitrate, and those with water sourced from a shallow well, less than 50 feet, face a disproportionate risk of high nitrate exposure (3,10).

What can you do?

- Test well water for nitrate once a year if the well is privately-owned.
- Water purification methods that remove nitrate include reverse osmosis, ion exchange, and distillation. Using Brita filters, refrigerator filters, and boiling water are not effective at removing nitrate (7).
- Maintain a healthy diet rich in antioxidants and limited in processed, cured, and red meats (1).

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Radon & Health Fact sheet

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Introduction

Radon is a naturally occurring gas that originates from the breakdown of uranium and is present in air, water, and soil (1). It is odorless, colorless, tasteless, and imperceptible to the senses. Radon is radioactive, forming other radioactive products called decay products over time. Higher radon concentration in the ground in Iowa results from historical glacial activity that carried rock containing uranium to Iowa (2). The uranium in this rock naturally decays to form radon. Because the glaciers deposited this rock unevenly, uranium and, as a result, radon levels in the ground vary from site to site.

Exposure Sources

Unstable radon decays into radioactive products and emits alpha particle radiation (1). These radioactive products can be inhaled and damage lungs the DNA in our lung cells. This damage can lead to genetic mutations, which may eventually cause lung cancer. Many people are exposed to radon by breathing in indoor air. The amount of radon in the air is measured in pCi/L (picocuries per liter of air). Radon gas can infiltrate homes from soil through small cracks in the foundation or openings around pipes, sump pumps, crawl spaces, drains, and other structures (2). Building materials, water supply, and natural gas are also sources of radon in the home.

Radon levels will increase in homes with poor ventilation and lower floors near the foundation, such as a basement or ground floor. Indoor radon levels are often higher than outdoors levels (1). Because of its unique glacial rock deposits, Iowa has the highest average indoor radon levels in the nation (2,3). Radon levels can vary from home to home because of the uneven distribution of radon in the ground (2). Radon testing is the only way to determine indoor radon concentrations (1,2,3).

Health Risks Associated with Radon

Cancer Health Risks	Radon causes cancer in humans (4,5) and, after smoking, is the second leading cause of lung cancer in the nation (1). For example, the Iowa Radon Lung Cancer Study concluded that “cumulative radon exposure in the residential environment is significantly associated with lung cancer risk” (5). The chances of getting lung cancer from radon increase with the indoor level of radon and the time spent in the home. People who smoke that are exposed to radon are at a 10 to 20 times higher risk of developing lung cancer than non-smokers (1). Moreover, with their different lung shapes and sizes and higher breathing rates, children are exposed to higher radon doses than adults. No consistent relationship has been found between elevated radon exposure and cancer at other sites.
Non-Cancer Health Risks	Lung cancer is the only established adverse health effect associated with exposure to elevated radon levels (1). Some studies are being conducted in examination of a potential association between radon exposure and risk of stroke and clonal hematopoiesis of indeterminate potential (CHIP) (6).

How is Radon regulated?

- There are no enforceable federal regulations for acceptable radon levels in indoor environments, such as individual residences or schools (1).
- The EPA recommends taking action to reduce radon levels if they are at or above 4 pCi/L to limit the risk of developing lung cancer (1).
- Radon levels below 4 pCi/L still carry risk and, in many cases, should be further reduced, especially for inhabited or heavily used areas (1).

What can you do?

- Because the entire state of Iowa is at high risk of radon in homes and other buildings, the Iowa Department of Health and Human Services recommends testing every two years or after renovating your home (3). Radon testing is inexpensive and reliable.
- If the results from radon testing are greater than or equal to 2 pCi/L, installing a radon mitigation system can range from $800 to $2,500 (3).

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