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Radon and Cancer

What is radon?

Radon is a colorless, odorless, radioactive gas. It forms naturally from the decay (breaking down) of radioactive elements, such as uranium, which are found in different amounts in soil and rock throughout the world. Radon gas in the soil and rock can move into the air and into underground water and surface water.

Radon is present outdoors and indoors. It is normally found at very low levels in outdoor air and in drinking water from rivers and lakes. It can be found at higher levels in the air in houses and other buildings, as well as in water from underground sources, such as well water.

Radon breaks down into solid radioactive elements called *radon progeny* (such as polonium-218, polonium-214, and lead-214). Radon progeny can attach to dust and other particles and can be breathed into the lungs. As radon and radon progeny in the air break down, they give off radiation that can damage the DNA inside the body's cells.

How are people exposed to radon?

At home and in other buildings

For both adults and children, most exposure to radon comes from being indoors in homes, offices, schools, and other buildings. The levels of radon in homes and other buildings depend on the characteristics of the rock and soil in the area. As a result, radon levels vary greatly in different parts of the United States, sometimes even within neighborhoods. Elevated radon levels have been found in every state.

Radon gas given off by soil or rock can enter buildings through cracks in floors or walls;

construction joints; or gaps in foundations around pipes, wires, or pumps. Radon levels are usually highest in the basement or crawl space. This level is closest to the soil or rock that is the source of the radon. Therefore, people who spend much of their time in basement rooms at home or at work have a greater risk for being exposed.

Small amounts of radon can also be released from the water supply into the air. As the radon moves from the water to air, it can be inhaled. Water that comes from deep, underground wells in rock may have higher levels of radon, whereas surface water (from lakes or rivers) usually has very low radon levels. For the most part, water does not contribute much to overall exposure to radon.

Radon exposure can also occur from some building materials if they are made from radon-containing substances. Almost any building material made from natural substances, including concrete and wallboard, may give off some level of radon. In most cases these levels are very low, but in a few instances these materials may contribute significantly to radon exposure.

Some granite countertops may expose people to different levels of radon. Most health and radiation experts agree that while a small portion of granite countertops might give off increased levels of radon, most countertops give off extremely low levels. According to the US Environmental Protection Agency (EPA), it's very unlikely that a granite countertop in a home would increase the radiation level above the normal, natural background level that comes from nearby soil and rocks. Still, people concerned about radon from countertops and from other household sources can test these levels using home detection kits or can hire a professional to do the testing (see the section "How can I avoid exposure to radon?").

According to the EPA, the average indoor radon level is about 1.3 picocuries per liter (pCi/L). People should take action to lower radon levels in the home if the level is 4.0 pCi/L or higher. The EPA estimates that nearly 1 out of every 15 homes in the United States has elevated radon levels.

Outdoors, radon generally disperses and does not reach high levels. Average levels of radon outdoors, according to the EPA, are about 0.4 pCi/L.

At certain jobs

In the workplace, people working underground, such as some types of miners, are among the most likely to be exposed to high levels of radon. High death rates from lung problems among miners in some parts of the world were first noted hundreds of years ago, long before people knew what radon was. Studies of radon-exposed miners during the 1950s and 1960s confirmed the link between radon exposure and lung cancer.

Higher levels of radon exposure are also more likely for people who work in uranium processing factories or who come in contact with phosphate fertilizers, which may have high levels of radium (an element that can break down into radon).

Does radon cause cancer?

Being exposed to radon for a long period of time can lead to [lung cancer](#)¹. Radon gas in the air breaks down into tiny radioactive elements (radon progeny) that can lodge in the lining of the lungs, where they can give off radiation. This radiation can damage lung cells and eventually lead to lung cancer.

[Cigarette smoking](#)² is by far the most common cause of lung cancer in the United States, but radon is the second leading cause. Scientists estimate that about 20,000 lung cancer deaths per year are related to radon.

Exposure to the combination of radon gas and cigarette smoke creates a greater risk for lung cancer than either factor alone. Most radon-related lung cancers develop in smokers. However, radon is also thought to cause a significant number of lung cancer deaths among non-smokers in the United States each year.

Some studies have suggested that radon exposure may be linked to other types of cancer as well, such as childhood leukemia. But the evidence for such links has been mixed and not nearly as strong as it is for lung cancer. Because radon and its progeny are absorbed mainly by inhaling, and because the radiation they give off travels only a short distance, it is unlikely that radon would affect other tissues in the body.

The evidence that radon causes lung cancer comes from studies in people and studies done in the lab.

Studies in people

Several types of studies in people have found that exposure to radon increases lung cancer risk:

- Studies of people working in underground mines with high levels of radon exposure
- Studies comparing radon levels in homes of people with lung cancer with the levels in homes of similar people without lung cancer
- Studies comparing lung cancer cases or deaths in areas with differing levels of radon exposure

These studies also show that the overall risk of lung cancer from radon is even higher in smokers and former smokers.

Some long term studies of uranium miners have found that they had higher risks of certain other cancers. But since the people with the higher risk weren't exposed to higher amounts of radon and radon progeny, it isn't clear that radon is the cause of those cancers. They may instead be linked to uranium dust or other exposures in the mines.

Studies done in the lab

Studies in lab animals have also shown an increased risk of lung cancer with exposure to radon. These studies revealed that breathing in radon and its progeny increases the risk of lung tumors. The risk is higher if the animal breathes in both cigarette smoke and radon. In some animals, the risk of certain other cancers was also increased.

In lab studies using human cells, radon and its progeny have also been shown to cause damage to chromosomes (packets of DNA) and other types of cellular damage. These types of changes are often seen in cancer cells.

What expert agencies say

Several national and international agencies study different substances in the environment to determine if they can cause cancer. (A substance that causes cancer or helps cancer grow is called a *carcinogen*.) The American Cancer Society looks to these organizations to evaluate the risks based on evidence from laboratory, animal, and human research studies.

Based on animal and human evidence, several expert agencies have evaluated the cancer-causing potential of radon.

The **International Agency for Research on Cancer (IARC)** is part of the World Health Organization (WHO). One of its goals is to identify causes of cancer. Based on sufficient evidence that radon and its progeny can cause lung cancer, IARC classifies them as "carcinogenic to humans."

The **National Toxicology Program (NTP)** is formed from parts of several different US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA). The NTP has classified radon as "known to be a human carcinogen."

The US **Environmental Protection Agency (EPA)** monitors the human health effects from exposure to various substances in the environment. The EPA lists radon as the second leading cause of lung cancer and the number one cause of lung cancer among non-smokers, estimating it is responsible for about 20,000 lung cancer deaths every year.

(For more information on the classification systems used by these agencies, see [Known and Probable Human Carcinogens³](#).)

Can I avoid being exposed to radon?

Radon is in the air we breathe, both indoors and out, so it isn't possible to avoid it completely. But there may be things you can do to lower your exposure.

In the home

For most people, the largest potential source of radon exposure is in their home. You can check radon levels in your home to determine if you need to take steps to lower them. Do-it-yourself radon detection kits can be ordered through the mail or bought in hardware or home supply stores. The kits are placed in the home for a period of time and then mailed to a lab for analysis.

Short-term kits are usually left in place for several days before being mailed. Long-term kits, which may give a more accurate assessment of average radon levels over the course of a year, are usually left in place for at least 3 months. The EPA recommends testing all homes below the 3rd floor, even new homes that were built “radon-resistant.”

You can also hire a professional to test radon levels in your home. Qualified contractors can be found through state radon offices, which are listed on the EPA website at www.epa.gov/radon/wherelive.html⁴.

The EPA recommends taking steps to lower radon levels if test results show levels of 4.0 pCi/L or higher. This value refers to the annual average. If you are using a do-it-yourself test, the EPA recommends using a short-term kit first. If the test result is 4.0 pCi/L or higher, do a follow-up test with either a long-term or short-term kit to be sure. If the result is still high, you should take steps to fix the problem.

A variety of methods can be used to reduce radon levels in your home, such as sealing cracks in floors and walls or increasing ventilation through “sub-slab depressurization” using pipes and fans. The EPA recommends that you have a qualified contractor fix your home because lowering high radon levels requires specific technical knowledge

and special skills.

Without the proper equipment or technical knowledge, you could actually increase your radon level or create other potential hazards and additional costs. Qualified contractors can be located through state radon offices, which are listed on the EPA website at www.epa.gov/radon/wherelive.html⁵. If you decide to do the work yourself, be sure you have the proper training and equipment.

Certain building materials may be more “radon tight” and may help reduce exposure in areas where radon levels are high. You can get more information from your state radon office or from qualified contractors.

In the workplace

Federal agencies, such as the Nuclear Regulatory Commission (NRC) and the Occupational Safety and Health Administration (OSHA) set limits on exposure to radon (and radon progeny) in the workplace. Because radon is known to be a health hazard, underground mines now have features to lower levels.

For people who may be exposed to radon in the workplace, it’s important to follow recommended safety procedures. If you are concerned that your exposure might be above the allowed limits, contact your workplace safety officer or these agencies.

What should I do if I’ve been exposed to radon?

There are no widely available medical tests to measure whether you have been exposed to radon.

If you smoke and have been exposed to higher levels of radon, it’s very important to try to quit smoking. The combined effects of cigarette smoking and radon exposure raise the risk of lung cancer much more than either exposure alone.

If you think you might have been exposed to high levels of radon over long periods of time, talk with your doctor about whether you should get regular health checkups and tests to look for possible signs of lung cancer. Be aware of possible symptoms of lung cancer, such as shortness of breath, a new or worsening cough, pain or tightness in the chest, hoarseness, or trouble swallowing, and tell your doctor if you start to have any of these symptoms.

For uranium miners, millers, and transporters who have certain health problems as a result of exposure to radon, the United States government has established the

Radiation Exposure Compensation Program. The program offers a lump sum payment to people with lung cancer and selected non-cancerous lung diseases, if certain criteria are met. Information about the program is available at www.justice.gov/civil/common/reca.html⁶ or by calling 1-800-729-7327 (1-800-729-RECP).

Hyperlinks

1. www.cancer.org/cancer/lung-cancer.html
2. www.cancer.org/cancer/cancer-causes/tobacco-and-cancer.html
3. www.cancer.org/cancer/cancer-causes/general-info/known-and-probable-human-carcinogens.html
4. <https://www.epa.gov/radon/whereyoulive.html>
5. <https://www.epa.gov/radon/whereyoulive.html>
6. <https://www.justice.gov/civil/common/reca.html>
7. <http://www.atsdr.cdc.gov/>
8. <http://www.atsdr.cdc.gov/toxfaqs/tfacts145.pdf>
9. <https://www.justice.gov/civil/common/reca.html>
10. <https://www.epa.gov/>
11. <https://www.epa.gov/radon/index.html>
12. <https://www.epa.gov/radon/pubs/citguide.html>
13. <https://www.epa.gov/radon/pubs/consguid.html>
14. <http://www.cancer.gov/>
15. <http://www.cancer.gov/about-cancer/causes-prevention/risk/substances/radon/radon-fact-sheet>

Additional resources

Along with the American Cancer Society, other sources of information and support include*:

Agency for Toxic Substances and Disease Registry (ATSDR) Toll-free number: 1-888-422-8737 (1-888-42-ATSDR) Website: www.atsdr.cdc.gov

[\(http://www.atsdr.cdc.gov/\)](http://www.atsdr.cdc.gov/)⁷ ToxFAQs for

Radon: www.atsdr.cdc.gov/toxfaqs/tfacts145.pdf

<http://www.atsdr.cdc.gov/toxfaqs/tfacts145.pdf>⁸

Department of Justice Radiation Exposure Compensation Program Toll-free

number: 1-800-729-7327 (1-800-729-RECP)
Website: www.justice.gov/civil/common/reca.html
(www.justice.gov/civil/common/reca.html)⁹

Environmental Protection Agency (EPA) National Radon Hotline: 1-800-767-7236 (1-800-SOSRADON) Website: www.epa.gov (www.epa.gov)¹⁰ Radon home page: www.epa.gov/radon/index.html (www.epa.gov/radon/index.html)¹¹

A Citizen's Guide to Radon: www.epa.gov/radon/pubs/citguide.html
(www.epa.gov/radon/pubs/citguide.html)¹²

Consumer's Guide to Radon Reduction: www.epa.gov/radon/pubs/consguid.html
(www.epa.gov/radon/pubs/consguid.html)¹³

National Cancer Institute Toll-free number: 1-800-422-6237 (1-800-4-CANCER)
Website: www.cancer.gov (<http://www.cancer.gov>)¹⁴

Radon and Cancer: www.cancer.gov/about-cancer/causes-prevention/risk/substances/radon/radon-fact-sheet (<http://www.cancer.gov/about-cancer/causes-prevention/risk/substances/radon/radon-fact-sheet>)¹⁵

**Inclusion on this list does not imply endorsement by the American Cancer Society*

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