Radon and Cancer

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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, and 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 inhaled 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 most people, 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 parts of 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 most people, water does not contribute much to overall exposure to radon.

People can also be exposed to radon from some building materials that are made from radon-containing substances. Almost any building material made from natural substances, including concrete and wallboard, might give off some level of radon. In most cases these levels are very low, but rarely these materials may contribute significantly to a person's 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 they can hire a professional to do the testing (see the section “Can I avoid or limit my 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 be breathed in and 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 in the US 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 people who smoke. However, radon is also thought to cause a significant number of lung cancer deaths each year among people who don't smoke.

Some studies, including studies by American Cancer Society researchers, have suggested that radon exposure might also be linked to some other types of cancer, including adult and childhood leukemia. But the evidence from studies done so far has been mixed and not nearly as strong as it is for lung cancer, so more research is needed to explore these possible links. Because radon and its progeny are absorbed mainly by inhaling, and because the radiation they give off travels only a short distance, other tissues in the body would be expected to get smaller amounts of radiation.

The evidence that radon causes cancer (mainly lung cancer) comes from both 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 people who smoke or used to smoke.

Some studies are now looking at whether some people are more or less likely to get cancer from radon because of genetic traits they inherit from their parents.

Studies done in the lab

Studies in lab animals have also found an increased risk of lung cancer with exposure to radon. These studies have shown that breathing in radon and its progeny increases the risk of lung tumors. The risk was higher if the animal breathed 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 the available evidence.**

Based on studies in people and studies done in the lab, 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 elat10c.t84 Tm /F2 12 Tf 0584 Tm /F2 12 Tf 0584 Tm /F2 12 Tf

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 people who don't smoke.

(For more information on the classification systems used by these agencies, see Known and Probable Human Carcinogens[3].)

Can I avoid or limit my exposure 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 on the EPA website[4].

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. 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 exposure 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 smoking and radon exposure raise the risk of

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.html[7] or by calling 1-800-729-7327 (1-800-729-RECP).

Hyperlinks

1. www.cancer.org/cancer/types/lung-cancer.html
2. www.cancer.org/cancer/risk-prevention/tobacco.html
3. www.cancer.org/cancer/risk-prevention/understanding-cancer-risk/known-and-probable-human-carcinogens.html
4. www.epa.gov/radon/epa-map-radon-zones-and-supplemental-information
5. www.cancer.org/cancer/types/lung-cancer/detection-diagnosis-staging/detection.html
6. www.cancer.org/cancer/types/lung-cancer/detection-diagnosis-staging/signs-symptoms.html
7. www.justice.gov/civil/common/reca.html

References

Agency for Toxic Substances and Disease Registry. ToxFAQs for Radon. 2014. Accessed at https://wwwn.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=406&toxid=71 on October 31, 2022.

Darby S, Whitley E, Howe GR, et al. Radon exposure and cancers other than lung cancer in underground miners: A collaborative analysis of 11 studies. *J Natl Cancer Inst*. 1995;87:378384.

Environmental Protection Agency. A Citizen's Guide to Radon. 2016. Accessed at https://www.epa.gov/sites/default/files/2016-12/documents/2016_a_citizens_guide_to_radon.pdf on October 31, 2022.

Environmental Protection Agency. Consumer's Guide to Radon Reduction. 2016. Accessed at https://www.epa.gov/sites/default/files/2016-12/documents/2016_consumers_guide_to_radon_reduction.pdf on October 31, 2022.

Environmental Protection Agency. Granite Countertops and Radiation. 2021. Accessed at https://www.epa.gov/radiation/granite-countertops-and-radiation on October 31, 2022.

Field RW, Steck DJ, Smith BJ, et al. The Iowa Radon Lung Cancer Study--phase I: Residential radon gas exposure and lung cancer. *Sci Total Environ*. 2001;272:6772.

Hauri D, Spycher B, Huss A, et al; Swiss Paediatric Oncology Group (SPOG). Domestic radon exposure and risk of childhood cancer: A prospective census-based cohort study. *Environ Health Perspect*. 2013;121:12391244.

Hornung RW. Health effects in underground uranium miners. *Occup Med*. 2001;16:331344.

International Agency for Research on Cancer (IARC). *IARC monographs on the evaluation of carcinogenic risks to humans. Vol. 100D: Radiation*. 2012. Accessed at https://publications.iarc.fr/121 on October 31, 2022.

Keller G, Hoffmann B, Feigenspan T. Radon permeability and radon exhalation of building materials. *Sci Total Environ*. 2001;272:8589.

Lagarde F, Axelsson G, Damber L, et al. Residential radon and lung cancer among never-smokers in Sweden. *Epidemiology*. 2001;12:396404.

Lubin JH, Boice JD Jr. Lung cancer risk from residential radon: Meta-analysis of eight epidemiologic studies. *J Natl Cancer Inst*. 1997;89:4957.

Lubin JH, Linet MS, Boice JD Jr, et al. Case-control study of childhood acute lymphoblastic leukemia and residential radon exposure. *J Natl Cancer Inst*. 1998;90:294300.

Moon J, Yoo H. Residential radon exposure and leukemia: A meta-analysis and dose-response meta-analyses for ecological, case-control, and cohort studies. *Environ Res*. 2021 Nov;202:111714.

Mozzoni P, Pinelli S, Corradi M, et al. Environmental/occupational exposure to radon and non-pulmonary neoplasm risk: A review of epidemiologic evidence. *Int J Environ Res Public Health*. 2021 Oct 5;18(19):10466.

National Cancer Institute. Radon and Cancer. 2011. Accessed at https://www.cancer.gov/about-cancer/causes-prevention/risk/substances/radon/radon-fact-sheet on October 31, 2022.

National Research Council (NRC), Committee on the Biological Effects of Ionizing Radiation. Health Effects on Exposure to Low Levels of Radon: BEIR VI. Washington,

DC: National Academy Press; 1998.

National Toxicology Program. *Report on Carcinogens, Fifteenth Edition: Ionizing Radiation*. 2021. Research Triangle Park, NC: US Department of Health and Human Services, Public Health Service. Accessed at http://ntp.niehs.nih.gov/ntp/roc/content/profiles/ionizingradiation.pdf on October 31, 2022.

Pisa FE, Barbone F, Betta A, et al. Residential radon and risk of lung cancer in an Italian alpine area. *Arch Environ Health*. 2001;56:208215.

Schubauer-Berigan MK, Daniels RD, Pinkerton LE. Radon exposure and mortality among white and American Indian uranium miners: An update of the Colorado Plateau cohort. *Am J Epidemiol*. 2009;169:718730.

Stidley CA, Samet JM. A review of ecological studies of lung cancer and indoor radon. *Health Phys*. 1993;65:234251.

Teras LR, Diver WR, Turner MC, et al. Residential radon exposure and risk of incident hematologic malignancies in the Cancer Prevention Study-II Nutrition Cohort. *Environ Res*. 2016 Jul;148:46-54.

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