Lesson 2: Why is radon a health problem?

Lesson overview
This lesson explains why radon is a serious public health concern.

Lesson objectives
By the end of this lesson, the learners will be able to:
- Recognize the importance of protecting people from exposure to high levels of radon
- Cite the number of deaths annually attributed to radon
- Describe the process by which radon exposure leads to lung cancer
- Identify the factors that affect the likelihood of developing radon-related lung cancer
- Identify the EPA action level for radon
- Explain the health effects of exposure to radon and its decay products in a hypothetical scenario with a client

Note: This lesson deals with lung cancer. Some learners may have had personal experience with this disease—either in their families or among their acquaintances—and may find the topic difficult to discuss.

In this lesson, we are going to talk about how radon affects human health.

See slide 2-1.

Radon is the largest source of radiation exposure and risk to the general public.

We said earlier that radon is harmful to human health. In fact, radon is the leading cause of lung cancer among nonsmokers. Overall, it is the second leading cause of lung cancer in the United States today. Only cigarette smoking causes more deaths from lung cancer than radon does. Radon causes more deaths than does secondhand smoke.

The EPA estimates that reducing radon in homes could reduce radon-related lung cancers by about one-third. Home inspectors can contribute by measuring radon levels accurately.
You may hear people minimize the effects of radon. You might hear something like:

“Oh, radon can’t really hurt you. The only problem is those government alarmists, who are always trying to scare us about some environmental hazard. There’s really nothing to worry about.”

How many of you have heard statements like this?

How many of you agree with this statement?

In fact, there’s a lot of scientific evidence to show that exposure to radon and its decay products can lead to lung cancer.

All major national and international organizations that have studied radon risks agree that it causes lung cancer. Many reputable agencies recognize radon as a serious public health problem, including:

- the American Lung Association
- the American Medical Association
- the American Public Health Association
- the National Academy of Sciences
- the U.S. Centers for Disease Control and Prevention
- the U.S. Environmental Protection Agency
- the World Health Organization

- Scientists agree that radon causes lung cancer in humans.
- We have solid evidence, from studies of underground miners, that radon causes lung cancer.
- A few small studies of radon and lung cancer in homes failed to show a relationship between relatively low radon levels in homes and lung cancer. However, national and international scientific organizations agree that these studies were too small to provide conclusive information about radon health risks.
- Two new studies, published in 2005, demonstrate a clear association between residential radon exposure and lung cancer. These studies confirm the radon health risks predicted by occupational studies of underground miners who breathed radon for long periods.
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 periods. This research confirms that breathing low levels of radon can lead to lung cancer.

See slide 2-4.

- How many people do you think die each year from lung cancer according to the most recent available national figures?
- How many people do you think die each year from radon-related lung cancer?
- On average, how many years of life are lost for radon-related lung cancer?

See slide 2-5 with the correct answers.

The Environmental Protection Agency (EPA) estimates that of 146,400 lung cancer deaths nationally in 1995, 21,000 (or 14%) were related to radon.

On average, radon-related lung cancer takes 17 years of life from its victims.

See slide 2-6.

Here’s how radon increases the risk of lung cancer:

When radon is inhaled, it is usually exhaled quickly. However, radon decay products, either attached to particles such as dust and smoke, or unattached, can become deeply lodged or trapped in the lungs. As these products decay in turn, they release radiation, especially alpha particles, which damage sensitive lung tissue and increase the risk of lung cancer.

Even very small exposures to radon can result in lung cancer. There is no known safe level of radon.

People may think that radon is harmless because there are no immediate symptoms from radon exposure. In fact, lung cancer usually occurs 5 to 25 years after exposure.

Once lung cancer develops, cancer cells can break away from the lungs and spread to other parts of the body. It often spreads in this way before it is found.

Explain.
Sadly, lung cancer is the most deadly form of cancer for both men and women. It kills more Americans than any other form of the disease.

- More people die of lung cancer than of colon, breast, and prostate cancers combined.
- About 60% of people with lung cancer die within 1 year of learning that they have lung cancer.
- Between 70 and 80% die within 2 years.

See slide 2-8.

We should note that there is no evidence that radon causes other respiratory diseases, such as asthma.

See slide 2-9.

Radon may also enter a home through the water supply. Swallowing water that contains radon carries some risk of stomach cancer or cancer of other internal organs. However, a much greater risk comes from breathing in radon and its decay products as they are released from the water—for example, when you shower or wash dishes.

The EPA estimates that radon in tap water causes about 168 cancer deaths per year. Of these,

- 89 percent are from lung cancer caused by breathing radon that is released from water
- 11 percent are from stomach cancer caused by drinking water that contains radon

See slide 2-10.

Let’s put radon risk in perspective.

Look at the chart. Each column represents the estimated deaths each year from one of the following causes:

- Drownings
- Drunk driving
- Falls in the home
- Home fires
- Radon

Which causes do you think go with which columns?

See slide 2-11 with correct answers.

The estimated deaths from radon are greater than the deaths from

- Drunk driving
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- Falls in the home
- Drownings
- Home fires

See slide 2-12.

The risk of developing lung cancer is directly proportional to both the duration of exposure to radon and the levels of radon.
- The longer the time of exposure, the greater the risk of lung cancer.
- The higher the radon concentration, the higher the risk of lung cancer.
- In addition, smoking in combination with radon exposure greatly increases the risk of lung cancer.

See slide 2-13.

Radon concentration in the air is usually measured in picocuries per liter (pCi/L) of air. We’ll talk in much more detail in the next lesson about measuring radon.

For now, we want to note that the EPA considers 4 pCi/L the action level for radon.
- It recommends fixing any home where the radon level is at or above 4pCi/L.
  The EPA action level of 4 pCi/L is based on what EPA believes is a level that can be achieved with existing technology for reducing radon levels. It is not a health-based standard. There is no known level of radon that is safe.
- The EPA also suggests that property owners consider fixing any home where the radon level is between 2 pCi/L and 4 pCi/L.

As a point of reference, the average radon concentration in the indoor air of America’s homes is about 1.3 pCi/L. The average concentration of radon in outdoor air is 0.4 pCi/L.

See slide 2-14.

The EPA estimates that 1 in 15 U.S. homes has a radon concentration at or above the action level of 4 pCi/L.

As I noted earlier, the EPA also estimates that reducing radon in homes could reduce radon-related lung cancers by about one-third.

See slide 2-15.
You can see the risk of developing lung cancer associated with radon for people who have never smoked. For example, with a radon level of 4 pCi/L (the EPA action level), we might expect 7 people among 1,000 nonsmokers to get lung cancer after lifetime exposure. (A lifetime exposure is considered about 75 years, with the assumption that a person spends about 70% of his or her time at home.)

The lung cancer risk is about equal to the risk of dying in a car crash.

As this slide shows, the greater the radon level (measured in pCi/L), the greater the risk of lung cancer.

See slide 2-16.

Radon alone is dangerous. As we noted earlier, radon in combination with cigarette smoking is more dangerous.

Many smokers who otherwise would not have gotten lung cancer will, if exposed to radon, get the disease. The combination of radon and cigarette smoking greatly increases the risk of lung cancer.

For example, with a radon level of 4 pCi/L, we might expect 62 people among 1,000 smokers to get lung cancer after lifetime exposure. The risk is five times the risk of dying in a car crash.

As for nonsmokers, the higher the concentration of radon, the greater the risk of lung cancer.

See slide 2-17.

You can compare the figures for smokers and nonsmokers.

Look again at our example of 4 pCi/L.

- Among nonsmokers, about 7 people in a 1,000 will die.
- Among smokers, about 62 people in a 1,000 will die of lung cancer.

See Handout 2-1.

Handout 2-1 summarizes the information we’ve just discussed.

See slide 2-18.

In January 2005, U.S. Surgeon General Richard H. Carmona issued a national health advisory about radon:
“Indoor radon is the second-leading cause of lung cancer in the United States and breathing it over prolonged periods can present a significant health risk to families all over the country. It’s important to know that this threat is completely preventable. Radon can be detected with a simple test and fixed through well-established venting techniques.”

See slide 2-19.

Work with a partner for a role-play. Decide which of you will play the role of a home inspector and which will play the role of a client.

Imagine that the inspector is trying to persuade a reluctant client to have a home tested for radon. Think about the health issues that we’ve discussed. Consider how you can persuade this client that radon testing is important to protect the health of the client and the client’s family.

See slide 2-20.

For the person who portrayed the inspector:
- What arguments did you use to convince your partner that radon has serious health effects and that the home should be tested?
- Could you have been more persuasive?
  o If so, how?

For the person who portrayed the client:
- Was your partner successful in convincing you to have your home tested?
  o Why or why not?
- Could this person have been more persuasive?
  o If so, how

See slide 2-21.

In summary, radon is known to cause lung cancer in humans. It is estimated to cause about 21,000 deaths each year. According to the Environmental Protection Agency, homes where radon levels are at or above 4 pCi/L should be repaired.

When people breathe in radon and its decay products, radioactive particles can get trapped in their lungs. As these particles decay, they damage lung tissue. Over long periods of exposure, this damage can increase the risk of lung cancer.
See slide 2-22.

The chances of developing lung cancer from radon depend on several factors:
- How much radon is in the home
- The amount of time the person spends in the home
- Whether the person smokes

Smoking, in combination with radon exposure, greatly increases a person’s risk of developing lung cancer.

See slide 2-23.

Do you have any questions about why radon is a health problem?

See slide 2-24.
See Handout 2-2A. This comprehension check is not graded.

Now you’re going to see whether you remember the main points that we’ve discussed in this lesson. Please answer the questions on handout 2-2A. When you all finish, we’ll review the answers together.

Review the answers. See Handout 2-2B, the answer key.
Resources


# Handout 2-1: Radon risks

## Radon risk for a person who has never smoked

<table>
<thead>
<tr>
<th>Radon level</th>
<th>If 1,000 nonsmokers were exposed to this level over a lifetime, the number who could get lung cancer is about</th>
<th>The risk of lung cancer from radon exposure equals (^*)</th>
<th>What to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 pCi/L</td>
<td>36</td>
<td>35 times the risk of dying by drowning</td>
<td>Fix the home</td>
</tr>
<tr>
<td>10 pCi/L</td>
<td>18</td>
<td>20 times the risk of dying in a home fire</td>
<td>Fix the home</td>
</tr>
<tr>
<td>8 pCi/L</td>
<td>15</td>
<td>4 times the risk of dying in a fall</td>
<td>Fix the home</td>
</tr>
<tr>
<td>4 pCi/L</td>
<td>7</td>
<td>The risk of dying in a car crash</td>
<td>Fix the home</td>
</tr>
<tr>
<td>2 pCi/L</td>
<td>4</td>
<td>The risk of dying from poison</td>
<td>Consider fixing the home if levels are between 2 and 4 pCi/L</td>
</tr>
<tr>
<td>1.3 pCi/L (average indoor radon level)</td>
<td>2</td>
<td></td>
<td>Reducing radon levels below 2 pCi/L is difficult.</td>
</tr>
<tr>
<td>0.4 pCi/L (average outdoor radon level)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: A former smoker may have a higher risk.

\(^*\) Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).

\(^\d\) Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.
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**Radon risk for a smoker**

<table>
<thead>
<tr>
<th>Radon level</th>
<th>If 1,000 smokers were exposed to this level over a lifetime, the number who could get lung cancer is about</th>
<th>The risk of lung cancer from radon exposure equals†</th>
<th>What to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 pCi/L</td>
<td>260</td>
<td>250 times the risk of dying by drowning</td>
<td>Stop smoking and fix the home</td>
</tr>
<tr>
<td>10 pCi/L</td>
<td>150</td>
<td>200 times the risk of dying in a home fire</td>
<td>Stop smoking and fix the home</td>
</tr>
<tr>
<td>8 pCi/L</td>
<td>120</td>
<td>30 times the risk of dying in a fall</td>
<td>Stop smoking and fix the home</td>
</tr>
<tr>
<td>4 pCi/L</td>
<td>62</td>
<td>5 times the risk of dying in a car crash</td>
<td>Stop smoking and fix the home</td>
</tr>
<tr>
<td>2 pCi/L</td>
<td>32</td>
<td>6 times the risk of dying from poison</td>
<td>Stop smoking and consider fixing the home if levels are between 2 and 4 pCi/L</td>
</tr>
<tr>
<td>1.3 pCi/L (average indoor radon level)</td>
<td>20</td>
<td></td>
<td>Reducing radon levels below 2 pCi/L is difficult.</td>
</tr>
<tr>
<td>0.4 pCi/L (average outdoor radon level)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: A former smoker may have a lower risk.*

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* Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003).
† Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.
## Comparison of radon risks

<table>
<thead>
<tr>
<th>Radon level</th>
<th>People who never smoked</th>
<th>People who smoked</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If 1,000 were exposed to this radon level over a lifetime, the number who could get lung cancer is about</td>
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<tr>
<td>1.3 pCi/L (average indoor radon level)</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>0.4 pCi/L (average outdoor radon level)</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Source: [http://www.epa.gov/radon/healthrisks.html](http://www.epa.gov/radon/healthrisks.html)
Handout 2-2A: Check your understanding

Select the best answer from the choices below. Circle the correct answer.

1. Radon is known to cause
   a. Asthma
   b. Lung cancer
   c. Skin cancer
   d. Emphysema

2. The estimated number of radon-related deaths each year is
   a. 41,200
   b. 146,000
   c. 14,000
   d. 21,000

3. According to the Environmental Protection Agency (EPA), reducing radon in homes could reduce radon-related lung cancers by about
   a. One-tenth
   b. One-third
   c. One-half
   d. One-twelfth

4. The EPA recommends that owners fix their homes if the radon level is at or above
   a. 0.4 pCi/L
   b. 1.4 pCi/L
   c. 4 pCi/L
   d. 10 pCi/L

5. According to the EPA, owners should consider fixing their homes if the radon level is between
   a. 0.2 and 0.4 pCi/L
   b. 0.4 and 1.3 pCi/L
   c. 2 and 4 pCi/L
   d. 10 and 20 pCi/L

6. Radon and its decay products are harmful mainly because
   a. Particles that people breathe in release radiation and damage lung tissue
   b. Particles that fall on the skin release radiation and cause internal damage
   c. Particles that are swallowed get into the bloodstream, travel to all parts of the body, and release radiation throughout the body
   d. Radioactive particles travel to the brain and damage the nervous system

7. Radon is particularly dangerous in combination with
   a. Drinking alcohol
   b. Showering
   c. Smoking
   d. Exercise

8. The main factors that affect a person’s chance of developing serious health effects from radon include
   a. Concentration of radon in the neighborhood, length of exposure to radon, and smoking
   b. Concentration of radon in the home, length of exposure to radon, and smoking
   c. Concentration of radon in the neighborhood and smoking
   d. Concentration of radon in the home and length of exposure to radon
Handout 2-2B: Check your understanding
Answer key

The correct answers are shown in bold.

1. Radon is known to cause
   a. Asthma
   b. **Lung cancer**
   c. Skin cancer
   d. Emphysema

2. The estimated number of radon-related deaths each year is
   a. 41,200
   b. 146,000
   c. 14,000
   d. **21,000**

3. According to the Environmental Protection Agency (EPA), reducing radon in homes could reduce radon-related lung cancers by about
   a. One-tenth
   b. **One-third**
   c. One-half
   d. One-twelfth

4. The EPA recommends that owners fix their homes if the radon level is at or above
   a. 0.4 pCi/L
   b. 1.4 pCi/L
   c. **4 pCi/L**
   d. 10 pCi/L

5. According to the EPA, owners should **consider** fixing their homes if the radon level is between
   a. 0.2 and 0.4 pCi/L
   b. 0.4 and 1.3 pCi/L
   c. **2 and 4 pCi/L**
   d. 10 and 20 pCi/L

6. Radon and its decay products are harmful mainly because
   a. **Particles that people breathe in release radiation and damage lung tissue**
   b. Particles that fall on the skin release radiation and cause internal damage
   c. Particles that are swallowed get into the bloodstream, travel to all parts of the body, and release radiation throughout the body
   d. Radioactive particles travel to the brain and damage the nervous system

7. Radon is particularly dangerous in combination with
   a. Drinking alcohol
   b. Showering
   c. **Smoking**
   d. Exercise

8. The main factors that affect a person’s chance of developing serious health effects from radon include
   a. Concentration of radon in the neighborhood, length of exposure to radon, and smoking
   b. **Concentration of radon in the home, length of exposure to radon, and smoking**
   c. Concentration of radon in the neighborhood and smoking
   d. Concentration of radon in the home and length of exposure to radon