

CDC Science Ambassador Workshop 2015 Lesson Plan

Lung Cancer at Peachstate Community Center

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Lung Cancer at Peachstate Community Center

Background

Noninfectious disease health events, such as cancers, may occur in a cluster. A cluster is an unusually high occurrence of a particular disease or disorder occurring in close proximity in terms of both time and geography. Concerns are common when illness clusters are reported in a community, but can also be raised when clusters occur among a group of workers. Cancer clusters related to a workplace exposure usually consist of the same cancer types. When cancer clusters occur in a specific workplace or among workers performing the same types of work, investigating the possibility of an occupational exposure is important. Source: <http://www.cdc.gov/niosh/topics/cancer/clusters.html>.

Cancer is a disease in which cells in the body grow out of control, often forming a solid mass or tumor. Two main classifications of tumors include benign and malignant. A benign tumor is a tumor that does not spread to the surrounding tissue or spread to other parts of the body. A malignant tumor is a tumor that can spread to the surrounding tissue or to other body parts. The type of cancer depends on where in the body it starts. For example, when cancer starts in the lungs, it is called lung cancer. Lung cancer can spread to lymph nodes or other organs in the body, such as the brain, liver, adrenal glands, bones and unaffected lung. Cancers starting in other organs such as the colon, breast or kidney often metastasize to the lungs. These are cases of colon, breast or kidney cancer, but not lung cancer.

Lung cancer* is the leading cause of cancer-related death in the United States, and it is estimated that only 17 of every 100 persons diagnosed with lung cancer will live more than five years after diagnosis. Cigarette smoking is the leading risk factor for lung cancers. Cigarette smoking is estimated to cause approximately 90% of lung cancers in the United States. Radon is the leading cause of lung cancer after tobacco smoke. Radon is estimated to cause approximately 21,000 lung cancer deaths each year. Smokers who are exposed to radon have a greater chance of developing lung cancer than persons who smoke and are not exposed to radon, or nonsmokers exposed to radon, because of the synergistic effects of radon and smoking. Using other tobacco products, such as cigars or pipes, also increases the risk for developing lung cancer. Smoke from other person's cigarettes, pipes, or cigars (secondhand smoke) also causes lung cancer. Other substances that increase the risk for lung cancer include asbestos, arsenic, diesel exhaust, and certain forms of silica and chromium. These substances can all be found in certain workplaces. Source: CDC http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm.

* Lung cancer is sometimes differentiated into cancer of the lung and bronchus. Because the bronchus is part of the lung, and the majority of tables of data concerning cancer of the lung and bronchus give one number for both as lung cancer, in the interest of simplicity and brevity, the term *lung cancer* will be used in this document.

Summary

This case-based lesson was developed for high school students. In this lesson, students use epidemiology to investigate a potential lung cancer cluster. Epidemiology is the study of the distribution and determinants of health conditions among populations and the application of that study to control health problems. Students apply descriptive epidemiology to describe the occurrence by person, place, time, and exposure to risk factors. Using data collected through in-person interviews of lung cancer patients, students then apply analytic epidemiology to evaluate the cluster using statistical approaches[†]. They use evidence to determine if there was an increase in cases compared to what was expected and how to establish a causal link between exposure and disease (i.e., that the exposure was the cause of the disease). Students will discover the importance of community relationships in making decisions and apply it by creating a multifaceted public service announcement (PSA).

Learning Outcomes

After completing this lesson, students should be able to

- describe data patterns;
- use evidence from designed scenarios to evaluate an association between radon exposure and lung cancer;
- analyze statistical data to evaluate whether this scenario would be considered a cancer cluster; and
- design a public health campaign that addresses radon concentrations in exceedance of the Environmental Protection Agency's (EPA) action limit.

Duration

This lesson can be conducted as one, 90-minute lesson, or divided into two, 45-minute lessons.

[†] For more information, see: <http://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson1/section7.html>

Procedures

Day 1: Radon and Lung Cancer by the Numbers (45 minutes)

Preparation

Before Day 1,

- Print copies of Worksheet 1A, one copy per student. Each part will be distributed separately; and
- Review Worksheet 1B, Teacher's Guide.

Materials

- Worksheet 1A: Lung Cancer at Peachstate Community Center, Part 1 and Part 2 (Appendix 1A).
- Worksheet 1B: Lung Cancer at Peachstate Community Center, Teacher's Guide (Appendix 1B).
- Electronic device with Internet access (optional).
Description: Computer, smart phone, tablet, or other to be used for accessing Internet databases.

Online Resources

- CDC's Guidelines for investigating clusters of health events
URL: <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001797.htm>.
- CDC's Lung Cancer Webpage
URL: http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm.
- Lung Cancer Incidence Rates
URL: <http://statecancerprofiles.cancer.gov/incidencerates/index.php>.
Description: Provides cancer incidence rates by county across the United States.
- ATSDR's Toxicological Profile for Radon
<http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=407&tid=71>
- ATSDR's Public Health Statement for Radon
<http://www.atsdr.cdc.gov/phs/phs.asp?id=405&tid=71>
- ATSDR's ToxFAQs™ for Radon
<http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=406&tid=71>
- ATSDR's ToxGuide™ for Radon
<http://www.atsdr.cdc.gov/toxguides/toxguide-145.pdf>
- A Citizen's Guide to Radon
URL: <http://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon>.
- A Consumer's Guide to Radon Reduction
URL: <http://www.epa.gov/radon/consumers-guide-radon-reduction-how-fix-your-home>.

Activity

1. Split students into small groups of 3 students. Each group member should be assigned a role: manager, note taker, and speaker. You can choose to have additional roles for larger groups.
2. Hand out Part 1 of Worksheet 1A. Ask for a volunteer to read the scenario. Direct students to work in groups to answer questions 1-2. After all groups have had time to discuss, review as a class by asking for feedback from each group.
3. Ask for a volunteer to read about survey design out loud, including the information in boxes: “What is demographic information?”, “What is a risk factor?”, and “What are risk factors for lung cancer?”. Direct students to work in groups to answer questions 3-5. After all groups have had time to discuss, review as a class by asking for feedback from each group.
4. Hand out Part 2 of Worksheet 1A. Explain to students that after Part 1 was completed, the team developed the survey, made initial contact with all patients, and notified the health department concerning the contact. Direct students to complete question 5-9 in groups. After all groups have had time to discuss, review as a class by asking for feedback from each group. Emphasize question 9 by having the speaker of each group present their hypothesis. As a class, agree on a hypothesis. Write the hypothesis on the board using the “if...then” format.
5. Ask for a volunteer to read about incidence rate. Read questions 10-14 out loud. Direct students to complete question 10-14 in groups. After all groups have had time to discuss, review as a class by asking for feedback from each group. Emphasize questions 13-14 by having the speaker of each group present their justification for whether there is a problem or not and suggestions for additional studies. On the board, create two headings “Problem”, “Not a Problem”, and “Studies” to map student answers. As a class, come to a consensus about whether there is a problem or not and additional studies that could be conducted.
3. For homework, have students read A Citizen’s Guide to Radon, available at: <http://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon> and A Consumer’s Guide to Radon Reduction, available at: <http://www.epa.gov/radon/consumers-guide-radon-reduction-how-fix-your-home>.

Day 2: Drawing Conclusions and Making Recommendations, 45 minutes

Preparation

Before Day 2,

- Read A Citizen's Guide to Radon and A Consumer's Guide to Radon Reduction; and
- Review Worksheet 1B, Teacher's Guide (Appendix 1B).

Materials

- Worksheet 1A: Lung Cancer at Peachstate Community Center, Part 3 and Part 4 (Appendix 1A).
- Worksheet 1B: Lung Cancer at Peachstate Community Center, Teacher's Guide (Appendix 1B).
- Electronic device with internet access.
Description: Computer, smart phone, tablet or other for accessing Internet databases.

Online Resources

- AirChek Radon Level Reports by United States, State, and County
URL: <http://www.radon.com/>.
Description: Reported radon readings by county for each state.
- A Citizen's Guide to Radon
URL: <http://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon>.
- A Consumer's Guide to Radon Reduction
URL: <http://www.epa.gov/radon/consumers-guide-radon-reduction-how-fix-your-home>.
- Public Health Public Service Announcement Examples
URL: <http://bangthetable.com/2015/07/15/public-health-social-media-campaigns/>.
<http://www.cdc.gov/healthcommunication/Campaigns/>.
<http://www.nwcphp.org/communications/news/five-tips-for-campaign-development>.
<http://www.cdc.gov/healthcommunication/audience/index.html>.
- A Recommended Standard for Occupational Exposure to Radon Progeny in Underground Mines
URL: <https://www.cdc.gov/niosh/docs/88-101/88-101.pdf>
Description: A helpful resource for students who choose to do their PSA on coal mine workers.

Activity

1. As a class, ask students to recap the scenario from Day 1.
2. Hand out Part 3 of Worksheet 1A. Explain that the team decided to collect environmental data concerning radon levels in and around the Peachstate Community Center. Part 3 refers to those test results.
3. Ask for a student volunteer to read Part 3 of the scenario. Review Table 2 and Figure 1 as a class.
4. Direct students to work in their groups from Day 1 to answer questions 15-21. After all groups have had time to discuss, review as a class by asking for feedback from each group. As a class, discuss whether student groups concluded an association existed between radon levels at Peachstate Community Center and the reported lung cancer cluster). Have student groups provide evidence that supports their decision (question 19). Write “Association”, “No Association”, and “Evidence” as headings on the board. As student groups present their answers, write their answers on the board. Then, ask students to provide short- and long-term recommendations for Peachstate Community Center and its employees (question 21).
5. Hand out Part 4 of Worksheet 1A. Ask for a volunteer to read Part 4 of the scenario. Explain to students that they will need to design a public service announcement (PSA) campaign for their audience. Show students a sample PSA from the online resources section. Projects will be graded by using the rubric provided. Emphasize that students should be creative in developing the campaigns and consider taking multiple approaches (e.g., radio, TV, or Internet). Students do not necessarily need to develop all of the materials for the campaign. They will design a proposal for each aspect of a campaign, including key messages, content, strategies to engage the audience, and steps to address or eliminate the issue.

Conclusions

The environment that we live, work, and play in affects our health. Radon is a radioactive naturally occurring gaseous element in the environment. Radon can seep from the ground and accumulate in homes and other buildings. Radon is a leading risk factor for lung cancer. The only way to know the radon level in a building is to test the building, but only a limited number of buildings ever are tested. Public awareness campaigns can help people understand the health effects of radon and encourage them to test (and fix, if necessary) their homes and other buildings. Through this lesson students will learn about radon, where exposure occurs, the potential implications of exposure to high levels of radon, and prevention methods for lung cancer associated with radon exposure.

Assessments

- Worksheet 1A: Lung Cancer at Peachstate Community Center, Part 1–3 (Appendix 1A)
Learning Outcome(s) Assessed
 - describe data patterns;
 - use evidence from a designed scenario to evaluate an association between radon exposure and lung cancer; and
 - analyze statistical data to evaluate.Description: Students will use data collected during a lung cancer cluster investigation to identify case patterns and lung cancer, smoking, and radon. Students will calculate rates and identify if an association between radon exposure and lung cancer exists.
- Worksheet 1A: Lung Cancer at Peachstate Community Center, Part 4 (Appendix 1A)
Learning Outcome(s) Assessed
 - design a public health campaign that addresses radon concentrations in exceedance of the Environmental Protection Agency’s (EPA) action limit.Description: Students will design a PSA campaign proposal for a specific target audience of their choice. The campaign proposal should include a definition of the target audience, key messages, type of information to be included, ways to make the target audience care about radon, and steps necessary to address or eliminate radon exposure. Projects will be graded by using the rubric provided.

Educational Standards

In this lesson, the following CDC Epidemiology and Public Health Science (EPHS) Core Competencies for High School Students¹, Next Generation Science Standards* (NGSS) Science & Engineering Practices², and NGSS Cross-cutting Concepts³ are addressed:

HS-EPHS1-2. Discuss how epidemiologic thinking and a public health approach is used to transform a narrative into an evidence based explanation.

NGSS Key Science & Engineering Practice²

Obtaining, Evaluating, and communicating information

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in text by paraphrasing them in simpler but still accurate terms

NGSS Key Crosscutting Concept³

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

HS-EPHS3-4. Make a claim about an association between an exposure and disease with consideration of a mathematical analysis of empirical data

NGSS Key Science & Engineering Practice²

Constructing explanations and designing solutions

Make a quantitative and/or qualitative claim regarding the relationship between an independent and dependent variable

NGSS Key Crosscutting Concept³

Scale, Proportion, and Quantity

Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another.

HS-EPHS4-2. Use a targeted health promotion and communication approach (taking into consideration scientific knowledge, the organization of systems and their patterns of performance, prioritized criteria, and tradeoff considerations) to design intervention strategies.

NGSS Key Science & Engineering Practice²

Engaging in argument from evidence

Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (economic, societal, ethical considerations).

NGSS Key Crosscutting Concept³

Cause and Effect

Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system

* Next Generation Science Standards is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, this product.

- ¹Centers for Disease Control and Prevention (CDC). Science Ambassador Workshop—Epidemiology and Public Health Science: Core Competencies for high school students. Atlanta, GA: US Department of Health and Human Services, CDC; 2015. Available at: <http://www.cdc.gov/careerpaths/k12teacherroadmap/pdfs/ephs-competencies.pdf>
- ²NGSS Lead States. Next Generation Science Standards: For States, By States (Appendix F—Science and Engineering Practices). Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. 2013. Available at: <http://www.nextgenscience.org/sites/ngss/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf>.
- ³NGSS Lead States. Next Generation Science Standards: For States, By States (Appendix G—Crosscutting Concepts). Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. 2013. Available at: <http://www.nextgenscience.org/sites/ngss/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf>.

Appendices: Supplementary Documents

Worksheet 1A

Lung Cancer at Peachstate Community Center Part 1

Name: _____

Date: _____

Directions: Read the information below concerning a lung cancer cluster and answer the questions using complete sentences.

Scenario, Part 1

During the last five years, four of 248 staff members of the Peachstate Community Center were diagnosed with lung cancer. Further inquiries led to the realization that another case of lung cancer in a previous employee was recently diagnosed. Based on Peachstate Community Center records, there have been 1395 employees from 1982 –2015.

The Peachstate Community Center has been a smoke-free environment since it opened. However, a smoke-free environment does not mean that smokers do not work there.

A request for an investigation was prompted by an increased concern among employees regarding the potential association between the workplace and cancer.

The health department asks you and your colleagues to consult on an investigation of the lung cancer cluster.

What is a cluster?

A cluster is an unusually high occurrence of a particular disease or disorder occurring in close proximity in terms of both time and geography. In this fictional scenario, the term “cluster” is used loosely in reference to a concentration of lung cancer cases in Peachstate Community Center. Although it may be initially thought to be a cluster, the majority of clusters in workplace scenarios have shown that a true cluster is not very likely.

1. Write down two places where you would look to find any additional cases of lung cancer in this workplace.

2. Where might you go to determine what is the expected number of lung cancer cases diagnosed in the area?

Survey Design

During the first step in the investigation, your team is asked to help design a survey to collect information from patients.

What is demographic information?

Demographic information includes personal characteristics of a person or group (e.g., age, sex, race/ethnicity, residence, and occupation). Demographic information is used in descriptive epidemiology to characterize patients or populations.

3. Write five questions that you would use to collect demographic information regarding patients?

What is a risk factor?

A risk factor is an aspect of personal behavior or lifestyle, environmental exposure, or hereditary characteristic that is associated with an increase in the occurrence of a particular disease, injury, or other health condition.

What are risk factors for lung cancer?

Cancer is a disease in which cells in the body grow out of control. When cancer starts in the lungs, it is called lung cancer. Lung cancer begins in the lungs and can spread to lymph nodes or other organs in the body, such as the brain. Research has reported multiple risk factors that can increase a person's chances of developing lung cancer.

Cigarette smoking is the number one risk factor for lung cancer, and is associated with numerous other cancers. In the United States, approximately 90% of lung cancers are estimated to be caused by cigarette smoking. Using other combustible tobacco products, such as cigars or pipes, also increases the risk for developing lung cancer. Smoke from other person's cigarettes, pipes, or cigars (secondhand smoke) also causes lung cancer. There is no risk-free level of secondhand smoke exposure; even brief exposure can be harmful to health. In the United States, one out of four adults who do not smoke and two out of five children are exposed to secondhand smoke, and approximately 7,300 people who never smoked die from lung cancer caused by secondhand smoke every year.

Radon is the second leading risk factor for lung cancer. Radon is a naturally occurring, radioactive gas that comes from rocks and soil, and it can accumulate in homes and buildings. It cannot be seen, tasted, or smelled. According to the U.S. Environmental Protection Agency (EPA), radon causes approximately 21,000 deaths of lung cancer each year. Approximately one out of every 15 homes in the U.S. is suspected to have high radon levels; in certain states one out of every four homes can have high levels. EPA recommends testing every home for radon and using proven ways to lower high radon levels.

Other substances that increase risk for lung cancer include asbestos, arsenic, diesel exhaust, certain forms of silica dust, and chromium. These substances can be found in certain workplaces.

The risk of lung cancer can also be higher if parents, siblings, or children have had lung cancer. This might be because they also smoke, or they live or work in the same place where they are exposed to radon or other substances that can cause lung cancer. It may also be due to genetic susceptibility.

Source: CDC http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm.

4. Write at least five questions related to determining exposure to risk factors among patients.

Lung Cancer at Peachstate Community Center Part 2

Name: _____

Date: _____

Directions: Read the information below regarding the next steps in the lung cancer cluster investigation.

Your team presents the questions to the CDC investigation team. They develop the survey and use the survey to collect information from all current and former Peachstate Community Center employees (n=1395), including lung cancer patients (n=5).

Data for the lung cancer patients are presented to your team in Table 1. The CDC investigation team continues efforts to collect data from all current and previous employees of Peachstate Community Center. They notify the health department that initial contact has been made and ask for additional assistance.

Table 1. Demographic information from patients and initial data concerning lung cancer cases at Peachstate Community Center.

	Age	Sex	Race/ ethnicity	Occupation at Peachstate	Years at Peachstate	Average hours worked per week	Date of lung cancer diagnosis	Years smoked	Exposed to second- hand smoke?	Family history of lung cancer
1	61	M	White	Afterschool Director	23	40	02/2015	No	Wife smokes	No
2	50	M	White/Hi spanic	Janitor	26	40	04/2012	Yes, 10 years	No	Brother
3	63	F	Black	Activities Director	21	45	10/2011	No	No	No
4	58	M	White/Hi spanic	Gym Trainer	15	40	10/2014	No	No	No
5	72	F	Black	Front Desk Manager, retired	19	40	6/2010	No	No	No

*Note: These numbers are not based on a real scenario. In a more typical scenario, most of the observed cases would be smokers. This would not necessarily rule out an association with occupational exposure (e.g., radon), but present challenges in doing the investigation. For simplicity, it most of the observed cases in this scenario were non-smokers.

5. As a group, consider why the investigative team chose to look at each category, including age, sex, race/ethnicity, occupation, years working, average hours worked, date of lung cancer diagnosis, years smoked, exposure to secondhand smoke, and family history of lung cancer. Use CDC's website concerning lung cancer statistics, available at: <http://www.cdc.gov/cancer/lung/statistics/index.htm>, to support your reasoning.

Category	Rationale
Age	
Sex	
Race/ethnicity	
Occupation at Peachstate	
Years at Peachstate	
Average hours worked per week	

Category	Rationale
Date of lung cancer diagnosis	
Years smoked	
Exposed to secondhand smoke?	
Family history of lung cancer	

6. Describe any patterns in age, sex, or race/ethnicity among lung cancer patients based on the data presented in Table 1.

7. Describe any patterns in occupation or years working at Peachstate Community Center among lung cancer patients.

8. Describe any patterns in date diagnosed with lung cancer among lung cancer patients.

9. On the basis of the data, what would you hypothesize regarding smoking, secondhand smoke, and family history of lung cancer among the lung cancer patients?

While the CDC investigation team continues efforts to collect data from the entire cohort, your team decides to look at lung cancer rates in Fulton County, where the Peachstate Community Center is located. This information can be used to determine if the number of lung cancer cases is abnormal in the larger community. For all races, sex, and persons aged >50 years, the team finds that the average incidence rate during 2008–2012 was 193.8/100,000 persons/year with a reported 404 cases. Source: <http://statecancerprofiles.cancer.gov/incidencerates/index.php>.

What is an incidence rate?

An incidence rate is the number of new cases of a disease among a given population in a specific period. In this scenario the incidence density would be used to standardize the rate. The incidence density requires the number of new cases of a disease among a given population (e.g., people who currently and previously worked at Peachstate Community Center, n=1395) and how many years each person was exposed (e.g., number of years worked at Peachstate Community Center).

Standardization to a rate/100,000 persons/year is common. Standardizing the incidence rate to the number of cases/100,000 persons/year allows you to compare regions with substantial populations to those with limited populations. It is calculated by dividing the number of new cases of disease or injury during a specified period by the total population during that period. In this case, it is the number of new cases of lung cancer from the most current period/100,000 population/year.

A team member notes that the majority of lung cancer cases in Fulton County are attributed to smoking. Although the majority of the persons in this investigation did not smoke, you need to identify the number of cases unlikely attributable to smoking.

10. How many cases of lung cancer [among people age >50 years] in Fulton County can likely be attributed to cigarette smoking? Hint: review the information from Part 1, What are the risks of lung cancer?
11. How many cases of lung cancer in Fulton County, Georgia, were unlikely attributable to cigarette smoking? What might these cases be associated with? Hint: review the information from the from Part 1, “What are the risks of lung cancer?”.
12. What percentage of cases [not attributable to smoking] in Fulton County, GA does this possible cluster represent?
13. Interpret your finding. As a team, decide if this could be a true cluster of lung cancer.
14. Based on your answer the question 13, determine what additional studies your team could conduct.

Lung Cancer at Peachstate Community Center

Part 3

Name: _____

Date: _____

Directions: Read the information below concerning the next steps in the lung cancer cluster investigation.

Prerequisite reading

Read A Citizen's Guide to Radon, available at: <http://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon> and A Consumer's Guide to Radon Reduction, available at: <http://www.epa.gov/radon/consumers-guide-radon-reduction-how-fix-your-home>.

Scenario, Part 3

You and your team recommend that the CDC investigation team collect environmental data regarding the radon levels in and around Peachstate Community Center. You also request testing for asbestos, arsenic, diesel exhaust, and certain forms of silica and chromium. You emphasize that testing should occur in different locations of the community center. You also request a historical report on smoking policies at Peachstate Community Center.

The CDC investigation team collected the data as requested. The majority of test results were <0.4 pCi/L (the lowest level detectable by using 3-day radon tests), but certain interesting test results for radon were noted. See Table 2. The historical report confirms that Peachstate Community Center has been a smoke-free environment since its opening with strict no-smoking policies on all of its facilities.

What is a picocurie?

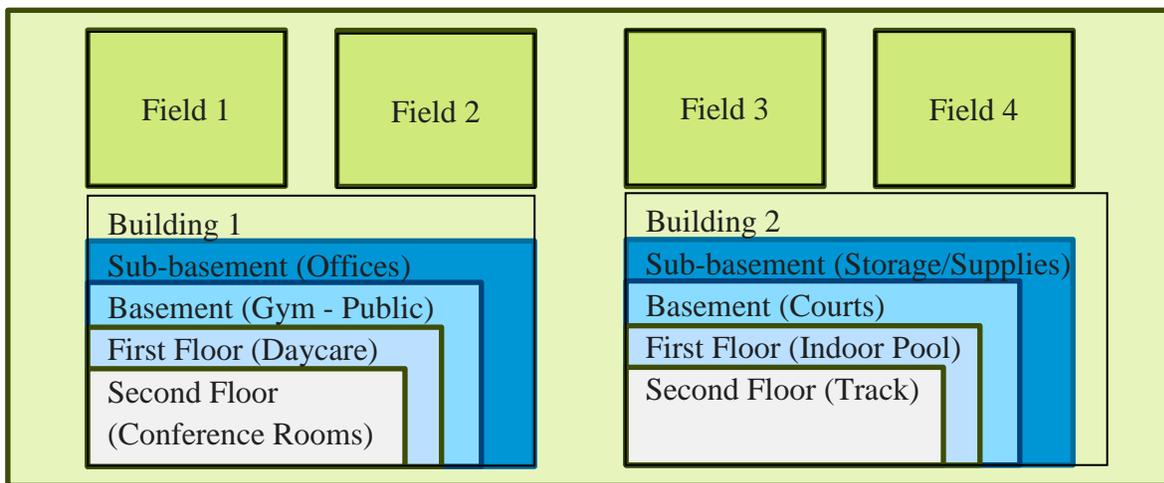
The curie (abbreviated Ci) is a measurement unit of radioactivity used in the US that is named after either Pierre Curie or Marie Curie, who discovered radioactivity. A curie is the amount of radiation released from one gram of radium in one minute (2.2×10^{22} disintegrations). A picocurie is one trillionth (1×10^{12}) of a curie and radon exposure is measured in picocuries per liter of air (pCi/L). This means that in a room with a measurement of 1 pCi/L approximately 2.2 disintegrations per minute are reported. By using pCi/L, scientists approximate the amount of radiation that a person is exposed to by breathing in that air (<http://www2.epa.gov/radiation/radiation-basics>).

Table 2: Radon levels in various locations of the Peachstate Community Center[‡].

Building 1	Radon Level	Building 2	Radon Level	Field #	Radon Level
Subbasement	9.6 pCi/L	Subbasement	9.4 pCi/L	1	0.3 pCi/L
Basement	9.2 pCi/L	Basement	9.1 pCi/L	2	0.2 pCi/L
First floor	4.6 pCi/L	First floor	3.6 pCi/L	3	0.3pCi/L
Second floor	2.9 pCi/L	Second floor	2.1 pCi/L	4	0.3pCi/L

*Note: These numbers are provided only for this scenario and would be unlikely to appear in a real scenario of a lung cancer cluster in the workplace. For simplicity, the numbers are provided to show actionable radon levels.

Figure 1. Map of locations in Peachstate Community Center tested for radon, including the types of activities that happen on each floor of the building.



15. Why did you and your team decide to test for radon in various locations of the Peachstate Community Center?

[‡] Radon levels normally drop as you go to higher floors, unless there is forced air heating, which is typical in north Georgia.

16. According to the EPA, the U.S. average indoor radon level is 1.3 pCi/L. Throughout the county, 16% of homes had radon levels ≥ 4 pCi/L; 28% of homes had radon levels ranging from 2.0 to 3.9 pCi/L and 57% had radon levels of < 2 pCi/L. As a group, construct at least two possible explanations for this pattern.

17. Describe any patterns among radon levels by location at Peachstate Community Center. Construct a scenario to explain these patterns in radon levels, according to location.

18. Review Table 1: Demographic information of patients and initial data regarding the lung cancer cluster. Describe any patterns in radon levels in different locations and occupation of each lung cancer case.

19. As a group, hypothesize if an association exists between radon levels at Peachstate Community Center and the potential lung cancer cluster. Provide at least three pieces of evidence to support your decision. Note: In order to identify if a true association exists, data from the cohort of all current and former employees is needed. Use the information your team has collected to make a hypothesis that you can test using the cohort data.

20. Design a study to test your hypothesis.

Drawing Conclusions

CDC has been asked to investigate numerous cancer clusters in workplaces and nearly all of them have shown that a “true” cluster is not very likely. This scenario would not be considered a cluster because it is a small number of cases (n=5) among a relatively small workforce (n=1395).

Occupational levels of radon exposure in indoor buildings are unlikely to produce a detectable excess risk of lung cancer in a small cluster investigation. In this scenario, no conclusions could be drawn about an association between radon exposure and lung cancer. Even with the cohort data, this investigation would likely be considered inconclusive. Lung cancer takes years to develop following exposure to an occupational or environmental carcinogen. It is also highly associated with smoking, which makes it difficult to provide evidence for an alternative exposure, especially when the anticipated excess attributable risk of lung cancer from typical indoor radon exposure levels is very low.

Regardless of inconclusive findings, radon levels presented in this scenario are actionable.

21. Write three short-term and two long-term recommendations for Peachstate Community Center and its employees.

Lung Cancer at Peachstate Community Center

Part 4

Name: _____

Date: _____

Directions: Read the information below regarding the next steps in the lung cancer cluster investigation.

Scenario, Part 4

Peachstate Community Center is grateful to you, the state, and the CDC investigation teams for identifying a potential cause of the lung cancer among their employees. In addition to hiring a contractor to install a radon mitigation system, the management team has offered your team funding to develop and implement a multifaceted public service announcement campaign concerning radon for all of Georgia, including Fulton County. Your team accepts the grant and begins the development process.

Your team quickly realizes the need to target multiple audiences, which will require different approaches. You decide to break it down into the following categories

Homeowners

Business owners

School community

Administrators/teachers

Students

PTA?

Specialty workers

Medical workers

Coal-fired power plant workers

Coal mine workers

Other

In groups, you will develop a public awareness campaign concerning radon for your target audience. Be creative in developing your campaign and consider taking multiple approaches. For example, in addition to creating a flyer, you would also develop a 1-hour education session regarding radon held at the community center. Note that you do not need to develop the materials for your campaign, but you will need to design a proposal for each aspect of it, including key messages for your audience, what type of information should be included, ways to make you audience care about radon, and steps to address or eliminate the issue. Consider scientific, social, economic, environmental, cultural, and political impacts of how you present your message.

Use the rubric to help guide you.

Rubric

	1	2	3	4
Is the audience considered in campaign messages?	Audience is not clear or all messages are not audience-appropriate.	Audience is named and certain messages are not audience-appropriate.	Audience is clear and the majority of messages are audience-appropriate.	Audience is clear; all messages are audience-appropriate.
Do messages and strategies appeal to the audience?	Messages do not appeal to the audience.	Certain messages appeal to the audience.	The majority of messages appeal to the audience.	All messages appeal to the audience.
Does the campaign address reasons why the audience should care about radon exposure?	The reason proposed is unclear.	The reason proposed is stated, but does not provide any convincing evidence.	The reason proposed is stated and provides certain convincing evidence.	The reason proposed is stated and provides convincing evidence.
Does the campaign provide clear steps to address or eliminate the issue?	The steps are unclear.	The steps are stated clearly, but description of each step is unclear.	The steps are stated clearly, and description of each step is somewhat clear.	The steps are stated clearly, and the description of each step is clear.
Will the campaign make the audience feel informed and confident to take the necessary steps?	The audience will feel scared or overwhelmed.	The audience will feel overwhelmed and will unlikely be able to take the necessary steps.	The audience will feel hesitant, but informed enough to take the necessary steps.	The audience will feel informed and confident to take the necessary steps.

Worksheet 1B

Lung Cancer at Peachstate Community Center, Teacher's Guide Part 1

Directions: Split students into small groups of 3 students. Each group member should be assigned a role: manager, note taker, and speaker. You can choose to have additional roles for larger groups. Consider having students read CDC's Guidelines for Investigating Clusters of Health Events prior to Part 1. Available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001797.htm>.

Student Directions: Read the information below concerning a lung cancer cluster and answer the questions using complete sentences.

Scenario, Part 1

Note: Ask for a volunteer to read the scenario. Direct students to work in groups to answer questions 1-2. After all groups have had time to discuss, review as a class by asking for feedback from each group.

During the last five years, four of 248 staff members of the Peachstate Community Center were diagnosed with lung cancer. Further inquiries led to the realization that another case of lung cancer in a previous employee was recently diagnosed. Based on Peachstate Community Center records, there have been 1395 employees from 1982 –2015.

The Peachstate Community Center has been a smoke-free environment since it opened. However, a smoke-free environment does not mean that smokers do not work there.

A request for an investigation was prompted by an increased concern among employees regarding the potential association between the workplace and cancer.

The health department asks you and your colleagues to consult on an investigation of the lung cancer cluster.

What is a cluster?

A cluster is an unusually high occurrence of a particular disease or disorder occurring in close proximity in terms of both time and geography. In this fictional scenario, the term "cluster" is used loosely in reference to a concentration of lung cancer cases in Peachstate Community Center.

Although it may be initially thought to be a cluster, the majority of clusters in workplace scenarios have shown that a true cluster is not very likely.

1. Write down two places where you would look to find any additional cases of lung cancer in this workplace.

Answer: Answers will vary. Possible answers include getting permission from workers to access their medical records and conducting a survey among the community center workers. De-identified cancer rates for the state/local area – not the specific workplace – could also be found using the state and local cancer registry, local hospitals, pathology laboratories, cancer treatment centers, and the insurer for that workplace.

2. Where might you go to determine what is the expected number of lung cancer cases diagnosed in the area?

Note: You may consider directing your students to the Georgia Department of Health state website and search for lung cancer information. You may also consider introducing you students to CDC WONDER, a collection of online databases for public health data, available at: <http://wonder.cdc.gov/>. Have students use their information from these websites to develop their answer.

Answer: Answers will vary. The expected number of cases in the area might be available from the Department of Health. Occupation-specific rates might be available through a review of the literature or from the Occupational Safety and Health Administration.

Survey Design

Note: Ask for a volunteer to read about survey design out loud, including the information in boxes: “What is demographic information?”, “What is a risk factor?”, and “What are risk factors for lung cancer?”. Direct students to work in groups to answer questions 3-5. After all groups have had time to discuss, review as a class by asking for feedback from each group.

CDC has provided guidance for investigating clusters of health events, available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001797.htm>.

During the first step in the investigation, your team is asked to help design a survey to collect information from patients.

What is demographic information?

Demographic information includes personal characteristics of a person or group (e.g., age, sex, race/ethnicity, residence, and occupation). Demographic information is used in descriptive epidemiology to characterize patients or populations.

3. Write five questions that you would use to collect demographic information regarding patients?

Answer: Answers will vary. Certain demographic information might include sex, age (or birthdate, age at diagnosis, and age at death), occupation, and race.

Note: Have each group present a limited number of their questions on the board. If a sensitive or unclear question is asked, discuss how you might reword it. Ask what students will do with each piece of information they collect. Although collecting substantial amounts of information is easy, you should be careful to respect people’s time by only collecting information that will help you determine the cause.

What is a risk factor?

A risk factor is an aspect of personal behavior or lifestyle, environmental exposure, or hereditary characteristic that is associated with an increase in the occurrence of a particular disease, injury, or other health condition.

What are risk factors for lung cancer?

Cancer is a disease in which cells in the body grow out of control. When cancer starts in the lungs, it is called lung cancer. Lung cancer begins in the lungs and can spread to lymph nodes or other organs in the body, such as the brain. Research has reported multiple risk factors that can increase a person's chances of developing lung cancer.

Cigarette smoking is the number one risk factor for lung cancer, and is associated with numerous other cancers. In the United States, approximately 90% of lung cancers are estimated to be caused by cigarette smoking. Using other combustible tobacco products, such as cigars or pipes, also increases the risk for developing lung cancer. Smoke from other person's cigarettes, pipes, or cigars (secondhand smoke) also causes lung cancer. There is no risk-free level of secondhand smoke exposure; even brief exposure can be harmful to health. In the United States, one out of four adults who do not smoke and two out of five children are exposed to secondhand smoke, and approximately 7,300 people who never smoked die from lung cancer caused by secondhand smoke every year.

Radon is the second leading risk factor for lung cancer. Radon is a naturally occurring, radioactive gas that comes from rocks and soil, and it can accumulate in homes and buildings. It cannot be seen, tasted, or smelled. According to the U.S. Environmental Protection Agency (EPA), radon causes approximately 21,000 deaths of lung cancer each year. Approximately one out of every 15 homes in the U.S. is suspected to have high radon levels; in certain states one out of every four homes can have high levels. EPA recommends testing every home for radon and using proven ways to lower high radon levels.

Other substances that increase risk for lung cancer include asbestos, arsenic, diesel exhaust, certain forms of silica dust, and chromium. These substances can be found in certain workplaces.

The risk of lung cancer can also be higher if parents, siblings, or children have had lung cancer. This might be because they also smoke, or they live or work in the same place where they are exposed to radon or other substances that can cause lung cancer. It may also be due to genetic susceptibility.

Source: CDC http://www.cdc.gov/cancer/lung/basic_info/risk_factors.htm.

4. Write at least five questions related to determining exposure to risk factors among patients.
Note: Guide students to develop their questions into risk by person, place and time, and the different types of exposures (primary smoking questions, secondary smoking questions, radon questions). Then, have each group present a limited number of their questions on the board. If a sensitive or unclear question is asked, discuss how you might reword it. Ask students to explain what they will do with each piece of information they collect. Although collecting substantial amounts of information is easy, you should respect people's time by only collecting information that will contribute to finding an answer.

Answer: Answers will vary. Answer may include risk by person, place, and time (e.g., diagnosis, date of diagnosis, occupation) and different types of exposures, including smoking (e.g., years smoked, number of cigarettes smoked, exposure to secondhand smoke), family history (e.g., family history of lung cancer) and radon (e.g., length of time working at site of interest, average hours per week, radon levels in their home).

Lung Cancer at Peachstate Community Center

Part 2

Directions: Explain to students that after Part 1 was completed, the team developed the survey, made initial contact with all patients, and notified the health department concerning the contact. Have your students use CDC's website for lung cancer statistics to answer questions in Part 2. See: <http://www.cdc.gov/cancer/lung/statistics/race.htm>.

Note: Direct students to complete question 5-9 in groups. After all groups have had time to discuss, review as a class by asking for feedback from each group. Emphasize question 9 by having the speaker of each group present their hypothesis. As a class, agree on a hypothesis. Write the hypothesis on the board using the "if...then" format.

Student Directions: Read the information below regarding the next steps in the lung cancer cluster investigation.

Your team presents the questions to the CDC investigation team. They develop the survey and use the survey to collect information from all current and former Peachstate Community Center employees (n=1395), including lung cancer patients (n=5).

Data for the lung cancer patients are presented to your team in Table 1. The CDC investigation team continues efforts to collect data from all current and previous employees of Peachstate Community Center. They notify the health department that initial contact has been made and ask for additional assistance.

Table 1. Demographic information from patients and initial data concerning lung cancer cases at Peachstate Community Center.

	Age	Sex	Race/ethnicity	Occupation at Peachstate	Years at Peachstate	Average hours worked per week	Date of lung cancer diagnosis	Years smoked	Exposed to second-hand smoke?	Family history of lung cancer
1	61	M	White	Afterschool Director	23	40	02/2015	No	Wife smokes	No
2	50	M	White/Hispanic	Janitor	26	40	04/2012	Yes, 10 years	No	Brother
3	63	F	Black	Activities Director	21	45	10/2011	No	No	No
4	58	M	White/Hispanic	Gym Trainer	15	40	10/2014	No	No	No
5	72	F	Black	Front Desk Manager, retired	19	40	6/2010	No	No	No

*Note: These numbers are not based on a real scenario. In a more typical scenario, most of the observed cases would be smokers. This would not necessarily rule out an association with occupational exposure (e.g., radon), but present challenges in doing the investigation. For simplicity, in most of the observed cases in this scenario were non-smokers.

5. As a group, consider why the investigative team chose to look at each category, including age, sex, race/ethnicity, occupation, years working, average hours worked, date of lung cancer diagnosis, years smoked, exposure to secondhand smoke, and family history of lung cancer. Use CDC’s website concerning lung cancer statistics, available at: <http://www.cdc.gov/cancer/lung/statistics/index.htm>, to support your reasoning.

Note: The answers below are meant to provide you with basic information regarding each category in relation to lung cancer. It is not meant to be comprehensive. For more detailed information, please see: <http://www.cdc.gov/cancer/lung/statistics/index.htm>.

Category	Rationale
Age	Answer: The risk for developing lung cancer increases with age. For example, 20–30 of every 1,000 men who are aged 60 years today will develop lung cancer by age 70 years; whereas, 2 of every 1,000 men who are aged 30 years today will get lung cancer by age 40 years.
Sex	Answer: The risk for developing lung cancer is greater among men than women. For example, 2–3 of every 100 men who are aged 60 years today will develop lung cancer by age 70 years; whereas, only 1–2 of every 100 women who are aged 60 years will get lung cancer by age 70 years.
Race/ethnicity	Answer: The rate of persons developing lung cancer or dying from lung cancer varies by race and ethnicity. During 2012, among men, blacks had the highest rate of developing lung cancer, followed by whites, Asian/Pacific Islanders, American Indian/Alaska Natives, and Hispanics. Among women, whites had the highest rate of developing lung cancer, followed by blacks, American Indian/Alaska Natives, Asian/Pacific Islanders, and Hispanics.
Occupation at Peachstate	Answer: Occupation can affect exposure to known carcinogens. Typically, occupations such as miners and waiters have higher rates of lung cancer.
Years at Peachstate	Answer: Length of time in an occupation might be used as a proxy to determine if patients might have been exposed to a known carcinogen in the workplace, because of the extended latency period required for the majority of known carcinogens.

Category	Rationale
Average hours worked per week	Answer: Average hours worked per week multiplied by years might help determine length of time or duration of exposure to workplace carcinogens.
Date of lung cancer diagnosis	Answer: Standard epidemiologic practice is to collect the date of diagnosis of any disease onset. Most importantly this provides you with assurance that a person has the disease, because it was diagnosed by a physician. Date of diagnosis will also help you better understand whether more patients had received a diagnosis because of improved or expanded surveillance for the disease. Yet with cancer, this question is not as helpful to collect as it would be in investigating other diseases. Lung cancer has a long and variable latency period meaning that the disease takes a long time to develop and can take from 10 to 40 years to develop. Rather than the date of lung cancer, researchers would compare the length of exposure (cumulative effect) since workers get hired at different times.
Years smoked	Answer: Cigarette smoking is the number one risk factor for lung cancer. Persons who smoke cigarettes are 15–30 times more likely to develop lung cancer or die from lung cancer than persons who do not smoke. Even smoking a limited number of cigarettes a day or smoking occasionally increases the risk for lung cancer. The more years a person has smoked and the more cigarettes smoked each day, the more that risk increases.
Exposed to secondhand smoke?	Answer: Smoke from other person’s cigarettes, pipes, or cigars also can cause lung cancer. There is no risk-free level of secondhand smoke exposure; even brief exposure can be harmful to health. In the United States, 25% of adults who do not smoke and 40% of children are exposed to secondhand smoke, and approximately 7,300 people who never smoked die from lung cancer that can be attributed to secondhand smoke every year.
Family history of lung cancer	Answer: Risk for lung cancer can be higher if parents, brothers or sisters, or children have had lung cancer. A genetic component to lung cancer might be involved. This might also be true because family members also smoked, or they lived or worked in the same places where they were exposed to radon and other substances that can cause lung cancer.

6. Describe any patterns in age, sex, or race/ethnicity among lung cancer patients based on the data presented in Table 1.
Answer: Answers will vary. The age range was 50–72 years. Three male and two female patients were reported, including two blacks, two white/hispanics, and one white patient. Certain students might ask how this compares with the demographic pattern of other center employees or the broader community.
7. Describe any patterns in occupation or years working at Peachstate Community Center among lung cancer patients.
Answer: All patients have worked at Peachstate Community Center for >15 years. Occupations varied, but the majority are management positions.
8. Describe any patterns in date diagnosed with lung cancer among lung cancer patients.
Answer: Diagnosis with lung cancer occurred within a 5-year time frame.
9. On the basis of the data, what would you hypothesize regarding smoking, secondhand smoke, and family history of lung cancer among the lung cancer patients?
Answer: Of the five patients, the majority did not smoke (n = 4, 80%), did not report being exposed to secondhand smoke (n = 4, 80%), and did not have a family history of lung cancer (n = 4, 80%). A hypothesis can be formulated that the cause among the majority of patients was unlikely to be smoking, secondhand smoke, or family history of lung cancer, and another cause might exist. However, caution is advised, since this study design does not allow for such conclusions to be drawn. In order to answer this question, students would need to compare these numbers to the total number of community center employees and/or the rest of the community center employees who did not get sick.

Note: Ask for a volunteer to read about incidence rate. Read questions 10-14 out loud. Direct students to complete question 10-14 in groups. After all groups have had time to discuss, review as a class by asking for feedback from each group. Emphasize questions 13-14 by having the speaker of each group present their justification for whether there is a problem or not and suggestions for additional studies. On the board, create two headings “Problem”, “Not a Problem”, and “Studies” to map student answers. As a class, come to a consensus about whether there is a problem or not and additional studies that could be conducted.

While the CDC investigation team continues efforts to collect data from the entire cohort, your team decides to look at lung cancer rates in Fulton County, where the Peachstate Community Center is located. This information can be used to determine if the number of lung cancer cases is abnormal in the larger community. For all races, sex, and persons aged >50 years, the team finds that the average incidence rate during 2008–2012 was 193.8/100,000 persons/year with a reported 404 cases. Source: <http://statecancerprofiles.cancer.gov/incidencerates/index.php>.

Note: A software program like the NIOSH Life Table Analysis system (www.cdc.gov/niosh/lta) could be used to compare the lung cancer rates in the workforce, compared to the county of interest, adjusting for important risk factors like sex, race, age and calendar year. Such calculations are really the only valid way to compare rates in the workplace population to those in the general population.

What is an incidence rate?

An incidence rate is the number of new cases of a disease among a given population in a specific period. In this scenario the incidence density would be used to standardize the rate. The incidence density requires the number of new cases of a disease among a given population (e.g., people who currently and previously worked at Peachstate Community Center, n=1395) and how many years each person was exposed (e.g., number of years worked at Peachstate Community Center).

Standardization to a rate/100,000 persons/year is common. Standardizing the incidence rate to the number of cases/100,000 persons/year allows you to compare regions with substantial populations to those with limited populations. It is calculated by dividing the number of new cases of disease or injury during a specified period by the total population during that period. In this case, it is the number of new cases of lung cancer from the most current period/100,000 population/year.

A team member notes that the majority of lung cancer cases in Fulton County are attributed to smoking. Although the majority of the persons in this investigation did not smoke, you need to identify the number of cases unlikely attributable to smoking.

10. How many cases of lung cancer [among people age >50 years] in Fulton County can likely be attributed to cigarette smoking? Hint: review the information from Part 1, What are the risks of lung cancer?

Answer: Approximately 90% of lung cancer cases can be attributed to smoking. Thus, in Fulton County, Georgia, approximately 363.6 of 404 lung cancer cases can be attributed to smoking.

11. How many cases of lung cancer in Fulton County, Georgia, were unlikely attributable to cigarette smoking? What might these cases be associated with? Hint: review the information from the from Part 1, “What are the risks of lung cancer?”.

Answer: If 10% of lung cancer cases cannot be attributed to smoking, then approximately 40.4 of the 404 cases of lung cancer are not as a result of cigarette smoking. The second major risk of lung cancer is radon exposure. Thus, certain cases might be associated with radon.

12. What percentage of cases [not attributable to smoking] in Fulton County, GA does this possible cluster represent?

Answer: It could represent 12.5% (5 out of 40 cases). However, since one of the cases smoked and another was exposed to second hand smoke, it is more likely to represent 7.5% (3 out of 40 cases)

13. Interpret your finding. As a team, decide if this could be a true cluster of lung cancer.

Answer: Five cases, three that are unlikely attributable to tobacco smoke, in this one workplace is a disproportionately large portion of the 40 cases in Fulton County, GA. This could suggest that there is a cluster. However, data from the cohort (n=1395) is needed to substantiate any claims.

14. Based on your answer the question 13, determine what additional studies your team could conduct.

Answer: Answers will vary. Next steps might include analysis of data from the cohort of current and former employees (n=1395) and testing for radon throughout the Peachstate Community Center.

Lung Cancer at Peachstate Community Center

Part 3

Directions: Explain that the team decided to collect environmental data concerning radon levels in and around Peachstate Community Center while continuing to wait for cohort data. Part 3 refers to results of those tests. Ask for a student volunteer to read Part 3 of the scenario. Review Table 2 and Figure 1 as a class. Direct students to work in their groups from Day 1 to answer questions 15-21. After all groups have had time to discuss, review as a class by asking for feedback from each group. As a class, discuss whether student groups concluded an association existed between radon levels at Peachstate Community Center and the reported lung cancer cluster). Have student groups provide evidence that supports their decision (question 19). Write “Association”, “No Association”, and “Evidence” as headings on the board. As student groups present their answers, write their answers on the board. Then, ask students to provide short- and long-term recommendations for Peachstate Community Center and its employees (question 21).

Student Directions: Read the information below concerning the next steps in the lung cancer cluster investigation.

Prerequisite reading

Read A Citizen’s Guide to Radon, available at: <http://www.epa.gov/radon/citizens-guide-radon-guide-protecting-yourself-and-your-family-radon> and A Consumer’s Guide to Radon Reduction, available at: <http://www.epa.gov/radon/consumers-guide-radon-reduction-how-fix-your-home>.

Scenario, Part 3

You and your team recommend that the CDC investigation team collect environmental data regarding the radon levels in and around Peachstate Community Center. You also request testing for asbestos, arsenic, diesel exhaust, and certain forms of silica and chromium. You emphasize that testing should occur in different locations of the community center. You also request a historical report on smoking policies at Peachstate Community Center.

The CDC investigation team collected the data as requested. The majority of test results were <0.4 pCi/L (the lowest level detectable by using 3-day radon tests), but certain interesting test results for radon were noted. See Table 2. The historical report confirms that Peachstate Community Center has been a smoke-free environment since its opening with strict no-smoking policies on all of its facilities.

What is a picocurie?

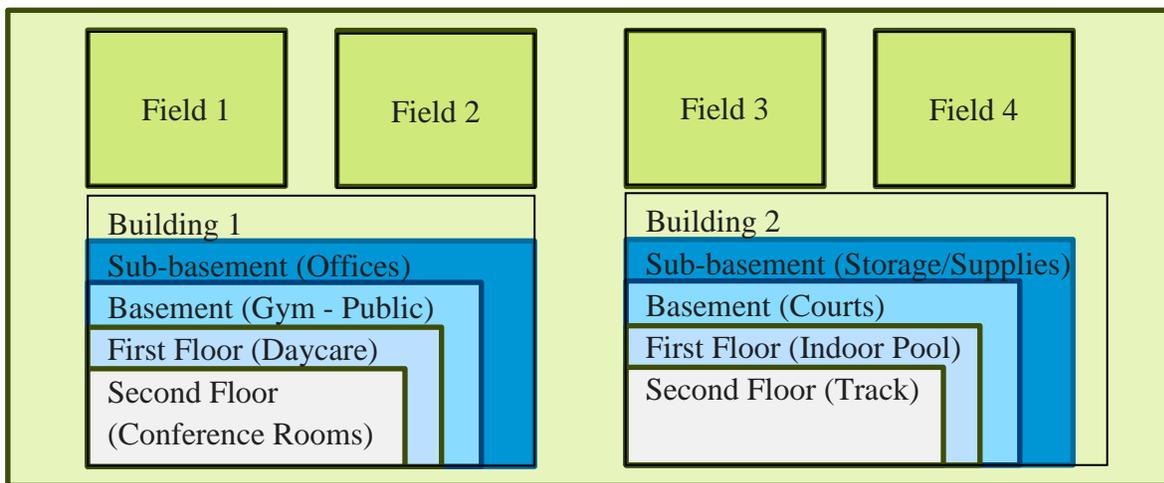
The curie (abbreviated Ci) is a measurement unit of radioactivity used in the US that is named after either Pierre Curie or Marie Curie, who discovered radioactivity. A curie is the amount of radiation released from one gram of radium in one minute (2.2×10^{22} disintegrations). A picocurie is one trillionth (1×10^{12}) of a curie and radon exposure is measured in picocuries per liter of air (pCi/L). This means that in a room with a measurement of 1 pCi/L approximately 2.2 disintegrations per minute are reported. By using pCi/L, scientists approximate the amount of radiation that a person is exposed to by breathing in that air (<http://www2.epa.gov/radiation/radiation-basics>).

Table 2: Radon levels in various locations of the Peachstate Community Center[§].

Building 1	Radon Level	Building 2	Radon Level	Field #	Radon Level
Subbasement	9.6 pCi/L	Subbasement	9.4 pCi/L	1	0.3 pCi/L
Basement	9.2 pCi/L	Basement	9.1 pCi/L	2	0.2 pCi/L
First floor	4.6 pCi/L	First floor	3.6 pCi/L	3	0.3pCi/L
Second floor	2.9 pCi/L	Second floor	2.1 pCi/L	4	0.3pCi/L

*Note: These numbers are provided only for this scenario and would be unlikely to appear in a real scenario of a lung cancer cluster in the workplace. For simplicity, the numbers are provided to show actionable radon levels.

Figure 1. Map of locations in Peachstate Community Center tested for radon, including the types of activities that happen on each floor of the building.



15. Why did you and your team decide to test for radon in various locations of the Peachstate Community Center?

Answer: Radon gas typically moves up through the ground to the air above and into buildings through cracks and other holes in the foundation. Since radon comes from the soil, and the sub-basement and basement are the closest levels to the ground, they are usually the ones where you would find the highest concentrations. Also, the levels drop as radon mixes with fresh air. In this case, students might have hypothesized that the subbasement and basement might trap radon because it has less ventilation.

[§] Radon levels normally drop as you go to higher floors, unless there is forced air heating, which is typical in north Georgia.

16. According to the EPA, the U.S. average indoor radon level is 1.3 pCi/L. Throughout the county, 16% of homes had radon levels ≥ 4 pCi/L; 28% of homes had radon levels ranging from 2.0 to 3.9 pCi/L and 57% had radon levels of < 2 pCi/L. As a group, construct at least two possible explanations for this pattern.

Answer: Answers will vary. Answers might include a variation in where the test was done (e.g., basements versus other floor), geographic location (e.g., type of soil, tightness of soil), neighborhoods that have been tested because of high levels reported in a home or areas with known high radon levels.

Sources:

https://www.epa.gov/sites/production/files/2016-02/documents/2012_a_citizens_guide_to_radon.pdf
<http://county-radon.info/GA/Fulton.html>.

17. Describe any patterns among radon levels by location at Peachstate Community Center. Construct a scenario to explain these patterns in radon levels, according to location.

Answer: Higher levels of radon in the subbasement and basement levels than the first or second floor were reported. However, levels are still elevated on the first and second floors. Students should construct a scenario. Student scenarios should point out that radon is higher in the lower levels because those levels are closer to the ground. Radon levels tend to drop as you move to higher floors due to decay and dilution with ambient air. Levels in this example didn't drop as much, possibly due to the type of HVAC system or the number of air exchanges.

18. Review Table 1: Demographic information of patients and initial data regarding the lung cancer cluster. Describe any patterns in radon levels in different locations and occupation of each lung cancer case.

Answer: The majority of patients would have, in theory, spent a substantial amount of time in the basement levels, including managers who would likely have had an office in the subbasement, the janitor to access supplies in the subbasement and to clean the subbasement, as well as the gym trainer, activities director, and afterschool director working in the gymnasium, courts, or other areas of the basement levels. The latency period for lung cancer due to any risk factor is 15–20 years or longer, which falls within the exposure to diagnosis time frame.

19. As a group, hypothesize if an association exists between radon levels at Peachstate Community Center and the potential lung cancer cluster. Provide at least three pieces of evidence to support your decision. Note: In order to identify if a true association exists, data from the cohort of all current and former employees is needed. Use the information your team has collected to make a hypothesis that you can test using the cohort data.

Answer: Answers will vary, but should provide evidence to support the decision. If students hypothesize that if an association exists between radon levels at Peachstate Community Center and the lung cancer cluster, evidence to support this might include high levels of radon exposure, long duration of exposure, and lack of smoking or other risk factors for lung cancer among patients. When a known or suspected cancer-causing agent is present and the types of cancer occurring have been associated with these exposures in other settings, an association between cancer and a workplace exposure can likely be concluded.

20. Design a study to test your hypothesis.

Answer: Answers will vary. A cohort study can be designed to enroll all previous and current employees of Peachstate Community Center to determine levels and duration of exposure and track employees over time to identify any new cases of lung cancer. Prior to enrolling employees in this study, it is important that radon mitigation be performed. For more information about ethics, see <http://www.cdc.gov/od/science/integrity/phethics/>.

Drawing Conclusions

CDC has been asked to investigate numerous cancer clusters in workplaces and nearly all of them have shown that a “true” cluster is not very likely. This scenario would not be considered a cluster because it is a small number of cases (n=5) among a relatively small workforce (n=1395).

Occupational levels of radon exposure in indoor buildings are unlikely to produce a detectable excess risk of lung cancer in a small cluster investigation. In this scenario, no conclusions could be drawn about an association between radon exposure and lung cancer. Even with the cohort data, this investigation would likely be considered inconclusive. Lung cancer takes years to develop following exposure to an occupational or environmental carcinogen. It is also highly associated with smoking, which makes it difficult to provide evidence for an alternative exposure, especially when the anticipated excess attributable risk of lung cancer from typical indoor radon exposure levels is very low.

Regardless of inconclusive findings, radon levels presented in this scenario are actionable.

21. Write three short-term and two long-term recommendations for Peachstate Community Center and its employees.

Answer: Answers will vary. Short-term recommendations might include informing past and current employees regarding radon levels and possibly encouraging them to go to the doctor for a clinical assessment, offering smoking cessation treatment for any employees who smoke, hiring a certified or qualified radon mitigation contractor to further assess the situation and identify potential solutions, and implementing radon reduction techniques. Long-term recommendations might include installing a radon reduction system and setting up a system to monitor radon levels.

Lung Cancer at Peachstate Community Center

Part 4

Directions: Hand out Part 4 of Worksheet 1A. Ask for a volunteer to read Part 4 of the scenario. Explain to students that they will need to design a public service announcement (PSA) campaign for their audience. Show students a sample PSA from the online resources section. Projects will be graded by using the rubric provided. Emphasize that students should be creative in developing the campaigns and consider taking multiple approaches (e.g., radio, TV, or Internet). Students do not necessarily need to develop all of the materials for the campaign. They will design a proposal for each aspect of a campaign, including key messages, content, strategies to engage the audience, and steps to address or eliminate the issue.

Student Directions: Read the information below regarding the next steps in the lung cancer cluster investigation.

Scenario, Part 4

Peachstate Community Center is grateful to you, the state, and the CDC investigation teams for identifying a potential cause of the lung cancer among their employees. In addition to hiring a contractor to install a radon mitigation system, the management team has offered your team funding to develop and implement a multifaceted public service announcement campaign concerning radon for all of Georgia, including Fulton County. Your team accepts the grant and begins the development process.

Your team quickly realizes the need to target multiple audiences, which will require different approaches. You decide to break it down into the following categories

- Homeowners
- Business owners
- School community
- Administrators/teachers
- Students
- PTA?
- Specialty workers
- Medical workers
- Coal-fired power plant workers
- Coal mine workers
- Other

In groups, you will develop a public awareness campaign concerning radon for your target audience. Be creative in developing your campaign and consider taking multiple approaches. For example, in addition to creating a flyer, you would also develop a 1-hour education session regarding radon held at the community center. Note that you do not need to develop the materials for your campaign, but you will need to design a proposal for each aspect of it, including key messages for your audience, what type of information should be included, ways to make you audience care about radon, and steps to address or eliminate the issue. Consider scientific, social, economic, environmental, cultural, and political impacts of how you present your message.

Use the rubric to help guide you.

Rubric

	1	2	3	4
Is the audience considered in campaign messages?	Audience is not clear or all messages are not audience-appropriate.	Audience is named and certain messages are not audience-appropriate.	Audience is clear and the majority of messages are audience-appropriate.	Audience is clear; all messages are audience-appropriate.
Do messages and strategies appeal to the audience?	Messages do not appeal to the audience.	Certain messages appeal to the audience.	The majority of messages appeal to the audience.	All messages appeal to the audience.
Does the campaign address reasons why the audience should care about radon exposure?	The reason proposed is unclear.	The reason proposed is stated, but does not provide any convincing evidence.	The reason proposed is stated and provides certain convincing evidence.	The reason proposed is stated and provides convincing evidence.
Does the campaign provide clear steps to address or eliminate the issue?	The steps are unclear.	The steps are stated clearly, but description of each step is unclear.	The steps are stated clearly, and description of each step is somewhat clear.	The steps are stated clearly, and the description of each step is clear.
Will the campaign make the audience feel informed and confident to take the necessary steps?	The audience will feel scared or overwhelmed.	The audience will feel overwhelmed and will unlikely be able to take the necessary steps.	The audience will feel hesitant, but informed enough to take the necessary steps.	The audience will feel informed and confident to take the necessary steps.