

LESSON: Death by Particles

Summary: Students read a brief news article about a research study showing that ambient particulate matter (PM) less than 10 micrometers in size and other air pollutants increase women's relative risk for coronary heart disease. Then they use data from the article to create charts and graphs to illustrate the study's results. **Graphic Organization and Modeling**—This lesson has students organize information graphically (e.g., using figures, graphs, and/or webs) or by creating a model.

EHP Article: "Death by Particles"
EHP Student Edition, March 2006, p. A836–A837
<http://ehp.niehs.nih.gov/docs/2005/113-12/ss.html#deat>

Objectives: By the end of this lesson students should be able to:

1. summarize a research study's findings on the effect of smog on heart health among women;
2. define the term "relative risk" in the epidemiological sense; and
3. arrange and interpret relative risk data in a table and line graph.

Class Time: Ten minutes to introduce, one evening to complete as homework, 30 minutes to review homework

Grade Level: 10–12

Subjects Addressed: Biology, Environmental Health, Environmental Science, Health, Math/Statistics

► Prepping the Lesson (10 minutes)

INSTRUCTIONS:

1. Download the entire March 2006 *EHP Student Edition* at <http://ehp.niehs.nih.gov/science-ed/>, or download just the article "Death by Particles" at <http://ehp.niehs.nih.gov/docs/2005/113-12/ss.html#deat>.
2. Read the article and the Background Information section of the lesson.
3. Make copies of the Student Instructions.

MATERIALS (per student):

- 1 copy of the *EHP Student Edition*, March 2006, or 1 copy of the article "Death by Particles"
- 1 copy of the Student Instructions

VOCABULARY:

- Arrhythmia
- Body mass index (BMI)
- Coronary heart disease (CHD)
- Inflammation
- Nitrogen dioxide (NO₂)
- Ozone (O₃)
- Particulate matter (PM, PM₁₀, PM_{10-2.5}, PM_{2.5})
- Relative risk
- Sulfur dioxide (SO₂)
- Viscosity
- Zip code centroid



BACKGROUND INFORMATION:

The key background information necessary to complete the exercise is presented in Step 1 of the Student Instructions. There is extensive information available documenting the emerging connection between particulate matter in air pollution and cardiovascular health.

RESOURCES:

Environmental Health Perspectives, Environews by Topic page, <http://ehp.niehs.nih.gov>. Choose Air Pollution, Environmental Diseases
American Heart Association, Air pollution, heart disease, and stroke, <http://www.americanheart.org/presenter.jhtml?identifier=4419>

▶ Implementing the Lesson

INSTRUCTIONS:

1. Hand out the article “Death by Particles.”
2. Assign the article and activity described in the Student Instructions as homework.
3. Review the following day as a class.

NOTES & HELPFUL HINTS:

- If students are completely unfamiliar with the composition of smog or the health effects of air pollution, this lesson may require more preparation time and an introduction using the cited resources.

▶ Aligning with Standards

SKILLS USED OR DEVELOPED:

- Classification
- Communication (note taking, written—including summarization)
- Comprehension (listening, reading)
- Experimentation (data analysis)
- Graph reading
- Graphing
- Tables and figures (creating, reading)

SPECIFIC CONTENT ADDRESSED:**Unifying Concepts and Processes Standard**

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement

Science As Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Science in Personal and Social Perspectives Standard

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards



► **Assessing the Lesson**

Step 3: The paragraph beginning with the words “Women showed...” summarizes some of the relative risk values calculated in the study. Put the six values for relative risk into a table and correctly label the rows and columns. Be sure to add a meaningful title to your table.

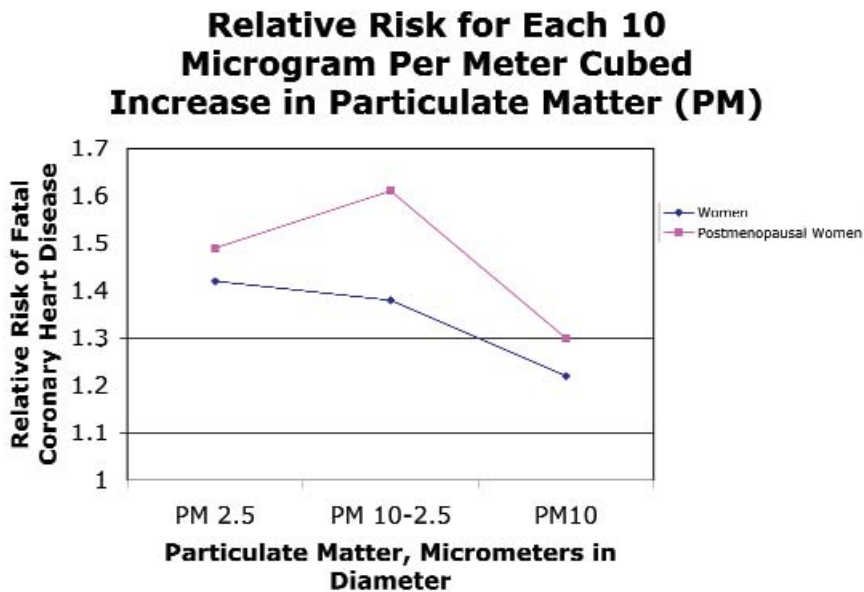
Relative Risks For Each 10 Microgram Per Meter Cubed Increase in Particulate Matter (PM) Concentration

Particulate Matter Size Ranges in Micrometers	Relative Risk of Fatal Coronary Heart Disease	
	All Women	Postmenopausal Women
PM _{2.5} (<2.5)	1.42	1.49
PM _{10-2.5} (2.5–10)	1.38	1.61
PM ₁₀ (<10)	1.22	1.30

The inclusion of the units in the title is critical and requires a close reading of the paragraph.

Step 4: Now take the same numbers and display them as a line graph in which the y-axis (dependent variable) denotes “Relative Risk of Fatal Coronary Heart Disease” and the x-axis (independent variable) denotes “Particulate Matter, Micrometers in Diameter.” Can you use the same title as you did for your table?

Yes, the title remains the same.



Step 5: Answer the following questions:

1. What do the data show with respect to relative risk for postmenopausal women compared to women in general?

Postmenopausal women appear to have a higher relative risk of fatal coronary heart disease from exposure to particulates.

2. Do smaller particles ($<PM_{10}$) or larger particles (PM_{10}) appear to be more of a problem?

Smaller particles appear to be more of a problem.

Step 6: Which format, table or graph, was easier to create? Which was easier to interpret?

Tables are generally quick and easy to make, but require the reader to make mental calculations and imagine underlying relationships. An accurate line or bar graph is more time-consuming to create but displays the ordinal relationships between the data points in a rapidly understandable way.

► Authors and Reviewers

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Step 1: Read the following background information:

Scientists report the results from research studies about the effects of various activities and substances on our health using statistical calculations such as “relative risk.” Imagine the relative risk in the following scenario: Who has the greater relative risk of having a chronic cough, someone who lives in East Los Angeles, where the amount of air pollution is high, or someone who lives on a remote desert island, where the amount of air pollution is low? That sounds like an easy question. The answer should be the one living in the city with the high air pollution (assuming all other things being equal), and that is correct. But how does one measure how *much* more at risk the city dweller is? That is where statistics come in. The term relative risk (when used scientifically) is actually a ratio:

Percentage of people who have a chronic cough cases among those exposed to the air pollution

Percentage of people who have a chronic cough cases among those not exposed to the air pollution

The ratio of these two numbers is the relative risk of having a chronic cough, i.e., how much more likely you are to develop a cough as a result of being exposed to pollution than could ordinarily be expected. Even under normal circumstances, there is a certain level of illness—an “expected rate.” If the relative risk is 2, the exposure has doubled the risk. A relative risk of 1 indicates there is no increase in risk. In fact, under certain circumstances it might be possible to have a relative risk of less than 1, which would suggest that instead of being a risk factor, the exposure of interest might actually be a protective factor.

Step 2: Read the article “Death by Particles.” $PM_{2.5}$ means particulate matter whose aerodynamic diameter is less than 2.5 micrometers. (Aerodynamic diameter is the diameter of a sphere having a density of 1 gram per cubic meter that behaves like the particle of interest in air.) PM_{10} means particulate matter whose aerodynamic diameter is less than 10 micrometers. $PM_{10-2.5}$ means particulate matter whose aerodynamic diameter is between 2.5 and 10 micrometers. $PM_{10-2.5}$ concentrations are calculated by subtracting $PM_{2.5}$ from PM_{10} concentrations.

Step 3: The paragraph beginning with the words “Women showed...” summarizes some of the relative risk values calculated in the study. Put the six values for relative risk into the table below and correctly label the rows and columns. Be sure to add a meaningful title to your table that includes the units.

Title:

Particulate Matter Size Ranges in Micrometers	Relative Risk of Fatal Coronary Heart Disease	
	All Women	Postmenopausal Women

Step 4: Now take the same numbers and display them as a line graph in which the y-axis denotes "Relative Risk" and the x-axis denotes "Particulate Matter Size Ranges in Micrometers." Can you use the same title as you did for your table?

Step 5: Answer the following questions:

1. What do the data show with respect to relative risk for postmenopausal women compared to women in general?

2. Do smaller particles ($<PM_{10}$) or larger particles (PM_{10}) appear to be more of a problem?

Step 6: Which format, table or graph, was easier to create? Which was easier to interpret?

