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Ecologic Studies

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Contents

Introduction

Statement to Keep in Mind

An epidemiologist's ultimate goal is the control of health problems. If an exposure that causes a health problem can be identified, avoiding or eliminating the exposure can control the health problem. Epidemiologists identify the causes of health problems by studying the distributions of health problems and exposures in a population.

In this instructional unit, students learn about the ecologic study design, which is one of the methods by which epidemiologists begin to explore the causes of health problems. In this type of study epidemiologists compare the distribution of a health problem and exposure in the population. From an epidemiologist's perspective, students recreate the data from an actual ecologic study and in doing so access a database, create a scatterplot diagram, interpret the results and compare their interpretation with that of the epidemiologist/author of the study.

Lesson Plan

SUBJECT AREA: Biology, mathematics, statistics, health education, social science

GOAL: To appreciate the value and limitations of the ecologic study design

OBJECTIVES

1. Introduce students to the principles and methods of designing and interpreting the results of an ecologic study
2. Understand the differences, advantages and disadvantages of ecologic studies as compared with other epidemiologic research designs
3. Identify the circumstances in which an ecologic study would be an appropriate study design

TIME FRAME: Approximately three 45- to 60-minute classes, with 1 hour of work outside class

PREREQUISITE KNOWLEDGE: Basic knowledge of descriptive epidemiology and the use of the 2 × 2 table

MATERIALS NEEDED: Ecologic Study Worksheet, Teacher's Cook's Index Sheet (Alphabetical Order and Rank Order) and copies of the Discussion section of the article "Firearm Availability and Unintentional Firearm Deaths."
4–6 poster board-sized pieces of paper. 200–300 3″ × 5″ cards.

Recommended References

Gordis L. *Epidemiology*, 2nd ed. Philadelphia: WB Saunders; 2000.

Last JM. *A Dictionary of Epidemiology*, 3rd ed. New York: Oxford University Press; 1995.

Stolley PD, Lasky T. *Investigating Disease Patterns: The Science of Epidemiology*, New York: Scientific American Library; 1998.

STANDARDS

Principles and Standards for School Mathematics

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems. (Number and Operations)
- Understand meanings of operations and how they relate to one another. (Number and Operations)
- Understand measurable attributes of objects and the units, systems, and processes of measurement. (Measurement)
- Apply appropriate techniques, tools, and formulas to determine measurements.

(Measurement)

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them. (Data Analysis and Probability)
- Develop and evaluate inferences and predictions that are based on data. (Data Analysis and Probability)
- Make and investigate mathematical conjectures. (Reasoning and Proof)
- Develop and evaluate mathematical arguments and proofs. (Reasoning and Proof)
- Select and use various types of reasoning and methods of proof. (Reasoning and Proof)
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others. (Communication)
- Analyze and evaluate the mathematical thinking and strategies of others. (Communication)
- Recognize and apply mathematics in contexts outside of mathematics. (Connections)
- Use representations to model and interpret physical, social, and mathematical phenomena. (Representation)

National Standards for School Health Education

- Students will comprehend concepts related to health promotion and disease prevention.
- Students will demonstrate the ability to practice health-enhancing behaviors and reduce health risks.
- Students will analyze the influence of culture, media, technology, and other factors on health.
- Students will demonstrate the ability to advocate for personal, family, and community health.

National Science Education Standards

- Identify questions and concepts that guide scientific investigations. (Scientific Inquiry)
- Use technology and mathematics to improve investigations and communications. (Scientific Inquiry)
- Formulate and revise scientific explanations and models using logic and evidence. (Scientific Inquiry)
- Recognize and analyze alternative explanations and models. (Scientific Inquiry)

- Communicate and defend a scientific argument. (Scientific Inquiry)
- Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected. (Interdependence of Organisms)
- Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms—sensory, motor, emotional, social, and technological—that can reduce and modify hazards. (Personal and Community Health)
- The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted. (Personal and Community Health)
- Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards—ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations. (Natural and Human-Induced Hazard)
- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding. (Science as a Human Endeavor)
- Because all scientific ideas depend on experimental and observational confirmation, all scientific knowledge is, in principle, subject to change as new evidence becomes available. The core ideas of science such as the conservation of energy or the laws of motion have been subjected to a wide variety of confirmations and are therefore unlikely to change in the areas in which they have been tested. In areas where data or understanding are incomplete, such as the details of human evolution or questions surrounding global warming, new data may well lead to change in current ideas or resolve current conflicts. In situations where information is still fragmentary, it is normal for scientific ideas to be incomplete, but this is also where the opportunity for making advances may be greatest. (Nature of

Scientific Knowledge)

National Curriculum Standards for Social Studies

- Social studies programs should include experiences that provide for the study of people, places, and environments.
- Social studies programs should include experiences that provide for the study of interactions among individuals, groups, and institutions.
- Social studies programs should include experiences that provide for the study of relationships among science, technology, and society.

Glossary

Construct	An abstract or general idea inferred or derived from specific instances.
Cook's Index	An abstract measure of gun availability, calculated by averaging the percentage of all suicides committed with a firearm and the percentage of all homicides committed with a firearm.
Ecologic fallacy	An error in inference due to a failure to distinguish between units of analysis. This error occurs because an association between variables at the group unit of analysis may not exist at the individual unit of analysis.
Ecologic study	A study in which the units of analysis are populations or groups of people, not individuals.
Outlier	An observation differing so widely from the rest of the data as to lead one to suspect that a gross error in measurement may have been committed.
Scatterplot diagram	A graphic method of displaying the distribution of two variables in relationship to each other, with the values of one variable measured on the vertical axis and the values of the other on the horizontal axis.

Teacher's Narrative

Part 1: A Classic Ecologic Study

This part is ideally held in a computer lab with Internet access.

To understand health problems, epidemiologists systematically collect data about how various phenomena are distributed in a population. These distributions are usually described in terms of person, place and time, that is, to whom they happen, where they happen, and when they happen.

Data may be collected to study a specific health problem or, like the recording of causes of deaths from death certificates, they may be gathered with no specific research question in mind. These latter, existing data sources can be used when a health problem is newly recognized to get a sense of whether or not there is support for a particular hypothesis about its cause.

For example, we did not always know that cigarette smoking caused lung cancer. After World War II, when we first suspected that this might be the case, epidemiologists turned to two separate and existing U.S. data sources. They looked at cigarette sales data to determine how cigarette consumption had changed over time, and they looked at the lung cancer incidence and mortality data to determine how lung cancer had changed over time.

They hypothesized that because of a latency period, if cigarette smoking caused lung cancer, as cigarette consumption increased there would be an accompanying increase in lung cancer with a 10- to 20-year lag.

Show students the figure depicting the relationship between "Per Capita Cigarette Consumption" and "Lung Cancer Deaths" by decade. **(Transparency 1)**

Ask students if the data support the hypothesis that cigarette smoking causes lung cancer. **(Yes)**

Tell students that this is an **ecologic study,** a study in which the units of analysis are populations or groups of people, not individuals. **(Transparency 2)**

Ask students to consider how they would label and complete a 2×2 table **(Transparency 3)** to depict the data depicted in Transparency 1. **(Students may label the 2×2 table as "Cigarette Smoking," "No Cigarette Smoking" and "Lung Cancer," "No Lung Cancer" [Transparency 4]; however, they will be stymied when trying to put the data into the cells. Because the unit of analysis was a group, as opposed to individuals, we do not know, for each individual, whether or not an individual smoked cigarettes, and we do not know, on an individual basis, whether or not an individual had lung cancer.)**

Ask students what might happen if they interpret group data as if such data were also true about individuals. **(If everyone in a group were ill [or well] and were exposed [or not exposed],**

then the group's characteristics would apply to all the individuals in the group. However, if individuals differ in their illness and exposure status, group averages may not apply to individuals. In a group with a high average rate of exposure and a high incidence of disease, it may be that the exposed individuals have a lower [not a higher] rate of disease than those who are not exposed.)

Ask students to consider a hypothetical ecologic study **(Transparency 5)** of the possible positive association between per capita income and automobile accidents in three communities, each with a population of seven people. **(Transparency 6)**

Show students **Transparency 7.** Tell students that the average incomes for the three communities were as follows: Community A = $24,086, Community B = $21,414 and Community C = $21,471.

Ask students to put the three communities in rank order according to their average incomes. Compare the students' answer with the answer on **Transparency 8.**

Show students **Transparency 9.** Tell students that the automobile accident rates for the three communities were as follows: Community A (4/7) = 57%, Community B (3/7) = 43% and Community C (2/7) = 29%.

Ask students to put the three communities in rank order according to their automobile accident rates. Compare the students' answer with the answer on **Transparency 10.**

Ask students, based on the communities' ranking for average income and automobile accident rates, if it appears that there is a positive association between the two. **(Yes, the greater a community's average income, the greater its automobile accident rate.)**

Ask students to draw a 2 × 2 table like the one depicted on **Transparency 11.**

Show students **Transparency 12.** Ask students if they can complete the 2 × 2 table based on the community data that they have. **(No, because they do not know on an individual basis what an individual's income is and they do not know on an individual basis whether or not an individual had an accident.)**

Ask students how data would be distributed in a 2 × 2 table if there was a positive association between an individual's income and his or her risk of having an automobile accident. **(Individuals with incomes of more than $20,000 would be at higher risk of having an automobile accident than individuals with incomes less than $20,000.)**

Show students **Transparency 13.** Tell students that the dollar amount next to each individual is his or her income and the "X" indicates an individual who had an automobile accident.

Now ask students to complete the 2 × 2 table. Compare students' 2 × 2 tables with the table depicted in **Transparency 14.**

Ask students, based on how the data are distributed in their 2 × 2 tables, if there was a positive association between an individual's income and the risk of having an automobile accident. **(No)**

Ask students what this hypothetical ecologic study illustrates about associations between variables at the community level of analysis and at the individual level of analysis. **(Associations that exist at the community level of analysis may not exist at the individual unit of analysis.)**

Tell students that the assumption that an association found at the group level of analysis is also true at an individual level of analysis is called an **ecologic fallacy,** " . . . an error in inference due to a failure to distinguish between units of analysis. An association between variables at the group unit of analysis may not exist at the individual unit of analysis." (Adapted from John M. Last, *A Dictionary of Epidemiology*, 3rd ed., New York: Oxford University Press; 1995.) **(Transparency 15)**

Now ask students to consider an actual ecologic study that was published in 1951, in Emile Durkheim's book *Suicide: A Study in Sociology*. **(Transparency 16)** Dr. Durkheim was interested in the possible association between religion and suicide in Prussian communities during the late nineteenth century.

When he looked at the dominant religion in a community and the community's suicide rate, he found that at the community level of analysis, communities in which the dominant religion was Protestantism, as opposed to Catholicism, had higher suicide rates. **(Transparency 17)**

Ask students what they would infer from this distribution of religion and suicide. **(Protestants are more likely to commit suicide than Catholics.) (Transparency 18)**

If students infer that Protestants are more likely to commit suicide than Catholics, probe until students realize that they do not know on an individual basis what an individual's religion was and they do not know on an individual basis whether or not an individual committed suicide.

Ask students to consider the possibility of an ecologic fallacy, ". . . an error in inference due to a failure to distinguish between units of analysis. An association between variables at the group unit of analysis may not exist at the individual unit of analysis." **(Transparency 19)**

Ask students if it is possible that the association between Protestantism and suicide that was present in the communities (group unit of analysis) might not exist at the individual unit of analysis. **(Yes)**

Ask students if, in fact, at the individual level of analysis, it might be the Catholics who, living in communities that were predominantly Protestant, had committed suicide. **(Yes)**

Ask students if such a possibility seems logical. **(It may have been that in communities in which Catholics were in the minority, they felt socially isolated and were therefore at higher risk of suicide.) (Transparency 20)**

Ask students, given the possibility that associations between variables at the group unit of analysis may not exist at the individual unit of analysis, if ecologic studies have value. **(Yes. Ecologic studies can be done quite quickly using existing data sources and can give one a sense of whether or not there is support for a particular causal hypothesis.)**

Ask students what they would do to determine if the association that was apparent on the group level of analysis was true at the individual level of analysis. **(Test the hypothesis using an analytical epidemiologic study design that determines the distribution of cigarette smoking and lung cancer on an individual basis.)**

Show students **Transparency 21** and emphasize that cigarette smoking and lung cancer have been found to be associated with each other in numerous analytical epidemiologic studies using a variety of designs and cigarette smoking has been judged to be a cause of lung cancer.

Part 2: Firearm Availability and Unintentional Firearm Deaths

More recently an ecologic study has been used to explore the possible reasons for the high rates of unintentional firearm deaths that occur in the United States as compared with the rest of the industrialized nations. Show students a comparison of unintentional firearm death rates in different industrialized nations. **(Transparency 22)**

(Transparency 23) Dr. Matthew Miller, of the Injury Control Research Center at the Harvard School of Public Health, was interested in exploring the possible relationship between the frequency of unintentional firearm deaths and the availability of firearms in the United States.

(Transparency 24) He hypothesized that the rates of unintentional firearm deaths would be highest in places where firearms were most available and lowest where firearms were least available.

Ask students where they might find data about the rates of unintentional firearm deaths.

Tell students to go to the National Center for Injury Prevention and Control's Web-Based Injury Statistics Query and Reporting System (WISQARS) Web site at http://www.cdc.gov/ncipc/wisqars/ **(Transparency 25)**

Tell students to:

- Click on *Fatal Injury Reports*. **(Transparency 26)**
- Click on *Data from 1998 and Earlier*. **(Transparency 27)**
- Under the heading *Output by 5-Year Age Groups*, click on *Data from 1998 and Prior*. **(Transparency 28)**

Tell students to take a few minutes to experiment with completing the *Report Options* and to *Submit Request*.

Now ask students if they wanted to find the rate of unintentional firearm deaths for each state in 1998, what option they would select for Question 1: What was the intent or manner of the injury? **(Unintentional) (Transparency 29)** Tell students to select *Unintentional*.

Ask students if they wanted to find the rate of unintentional firearm deaths for each state in 1998, what option they would select for Question 2: What was the cause or mechanism of the injury? **(Firearm) (Transparency 30)** Tell students to select *Firearm*.

Ask students if they wanted to find the rate of unintentional firearm deaths for each state in 1998, what options they would select for Section 3: Select specific options. **(Leave the options as they are: Census Region/State [*United States*], Race [*All Races*], Sex [*Both Sexes*], Year(s) of Report [*1998 to 1998*], Hispanic Origin [*All*], and Output Options [*Standard Output*].) (Transparency 31)**

Ask students if they need any of the Advanced Options before they are ready to *Submit Request*. **(Yes)**

Ask students if they wanted to find the rate of unintentional firearm deaths for each state in 1998, what option they would select for Select Age Groups. **(Transparency 32) (All Ages [includes unknown age])**

Ask students if they wanted to find the rate of unintentional firearm deaths for each state in 1998, what option they would select for Compare injury rates using age-adjusting.[1] **(Transparency 33) (Use 1990 as the Standard Year.)**

Ask students if they wanted to find the rate of unintentional firearm deaths for each state in 1998, what option they would select for Select output group(s). **(For 1 select *State. None* should remain for 2, 3 and 4.) (Transparency 34)**

Now tell students to *Submit Request*.

Ask students why there are so many asterisks (*) on the report. **(Transparency 35) (The rates are based on 20 or fewer deaths. When the number of deaths is so small, chance variation can cause great swings from year to year in the resulting death rates. In that situation, one year's death rate is a poor predictor of the actual risk of death.)**

Ask students what they could do to get more than 20 unintentional firearm deaths in a state. **(Increase the number of years in the *Years(s) of Report*.)**

Tell students that when Dr. Miller did his analysis, he looked at deaths over a 19-year period.

Tell students to complete another *Report Options* in the same manner as described above, except this time for Year(s) of Report in Section 3, select *1981 to 1998*. **(Transparency 36)**

[1]Age-adjustment is a method of minimizing the effect that the differences in the age make-up of different populations have on a particular measure, in this case the effect of the different age make-ups of different state populations on the rate of unintentional firearm deaths.

Tell students to *Submit Request*.

Ask students what happened to the asterisks on the report. **(Except for Rhode Island, all have been eliminated.) (Transparency 37)**

Part 3

Divide the class into groups of four to six students and give each group a deck of 50 index cards. Ask students to hold the cards horizontally, write the name of each state at the top of a different card and divide the card in half by drawing a vertical line. **(Transparency 38)**

Tell students that you want them to write the Age-Adjusted Rate for Unintentional Firearm Deaths, from 1981–1998, on the left-hand side of the card. **(Transparency 39)**

Tell all groups to complete a card for the state of Georgia and compare it with **Transparency 40.**

Have each group of students record the Age-Adjusted Rate for Unintentional Firearm Deaths for each of the other 49 states on the left-hand side of the appropriate card.

Part 4

Give each group of students a large piece of paper and tell them to draw a long line about 6 inches from the left-hand side of the paper. **(Transparency 41)**

Tell students to divide the line into five equal sections by putting short lines across the long line. Make sure students put a short line at the bottom and top of the long line. **(Transparency 42)**

Tell students to label the short lines from 0 to 5, starting at the bottom of the long line. **(Transparency 43)**

Tell students to plot the index card for the state of Georgia along the vertical line according to its Age-Adjusted Rate for Unintentional Firearm Deaths. **(Transparency 44)**

Tell students to plot their remaining 49 index cards along the vertical line according to each state's Age-Adjusted Rate for Unintentional Firearm Deaths.

Ask students how they would describe Alaska's position on the line in comparison to the other 49 states.

Tell students that epidemiologists would call Alaska an **outlier,** "An observation differing so widely from the rest of the data as to lead one to suspect that a gross error may have been committed." (Adapted from John M. Last, *A Dictionary of Epidemiology,* 3rd ed. New York: Oxford University Press; 1995.) **(Transparency 45)**

Part 5

Return to Dr. Matthew Miller's hypothesis: The rates of unintentional firearm deaths would be highest in places where firearms were most available and lowest where firearms were least available. **(Transparency 46)**

Ask students how they would define "firearm availability."

Ask students where they might find data about firearm availability.

This was a challenge to Dr. Miller because, during the time period of the study, direct measures of gun ownership were not available at the state level. So Dr. Miller considered using a proxy for state-level gun availability called the **Cook's Index.**

The Cook's Index is calculated by averaging the percentage of all suicides committed with a firearm and the percentage of all homicides committed with a firearm. **(Transparency 47)**

The Cook's Index is a **construct.** A construct is an abstract or general idea inferred or derived from specific instances. The Cook's Index is an abstract or general idea inferred or derived from specific instances, for gun availability. **(Transparency 48)**

Although Dr. Miller did not see ". . . any particular intuitive value" in Cook's Index **(Transparency 49),** he realized that, if the Cook's Index correlated well with other data on gun availability, he could use it as a proxy measure of gun availability for each state.

Dr. Miller knew of two other sources of such data: the General Social Surveys and the Behavioral Risk Factor Surveillance System **(Transparency 50),** neither of which gave him exactly what he wanted—a measure of gun availability for each of the 50 states. The General Social Surveys measured gun availability by region, not state, and the Behavioral Risk Factor Surveillance System provided data for only 21 self-selected states.

To make a long story short, when Dr. Miller calculated the Cook's Index for each of the General Social Surveys' regions and determined the degree to which the Cook's Index and the General Social Surveys' measure of gun availability correlated with each other, he found a correlation coefficient[2] of .87, close to the maximum possible for complete agreement, which is 1.0. **(Transparencies 51 and 52)**

When Dr. Miller calculated the Cook's Index for each of the 21 states for which there were Behavioral Risk Factor Surveillance System data about gun availability and determined the degree to which the Cook's Index and the Behavioral Risk Factor Surveillance System's measure of gun availability correlated with each other, he found a correlation coefficient of .83. **(Transparency 53)**

[2]The correlation coefficient is a measure of association that ranges from 1.0 (complete agreement) through 0.0 (no relation) to −1.0 (complete disagreement).

Given these (strong) correlations, Dr. Miller concluded that the Cook's Index was an appropriate proxy measurement for gun availability that he could calculate for each of the 50 states.

Part 6

Reshow the Cook's Index formula transparency. **(Transparency 54)**

Ask students how they would calculate the "% of all suicides committed with a firearm." **(Divide the total number of suicides committed with a firearm by the total number of suicides from all causes.) (Transparency 55)**

Have students to return to the WISQARS' *Report Options*. **(Transparency 56)**

Ask students how they could complete the *Reports Option* form to find the total number of *suicides committed with a firearm* for the years 1981–1998, by state. **(Transparency 57) (Complete the *Report Options* in the same manner as described above, except this time for Question 1: What was the intent or manner of the injury? select *Suicide*.) (Transparency 58)**

Ask students how they could complete the *Reports Option* form to find the total number of *suicides committed with a firearm* for the years 1981–1998, by state. **(Complete the *Report Options* in the same manner as described above, except this time for Question 2: What was the cause or mechanism of the injury? select *Firearm*.) (Transparency 59)**

Ask each group of students to give the "total number of suicides committed with a firearm" for the state of Georgia. **(10,945)** Compare it with **Transparency 60.**

Now ask students how they could complete the *Reports Option* form to find the total number of *suicides from all causes* for the years 1981–1998, by state. **(Transparency 61) (Complete the *Report Options* in the same manner as described above, except this time for Question 1: What was the intent or manner of the injury? select *Suicide*.) (Transparency 62)**

Ask students how they could complete the *Reports Option* form to find the total number of *suicides from all causes* for the years 1981–1998, by state. **(Complete the *Report Options* in the same manner as described above, except this time for Question 2: What was the cause or mechanism of the injury? select *All injury*.) (Transparency 63)**

Ask each group of students to give the "total number of suicides from all causes" for the state of Georgia. **(14,570)** Compare it with **Transparency 64.**

Now ask students how they would calculate the "% of all suicides committed with a firearm" for the state of Georgia. **(Transparency 65)**

Ask students to calculate the "% of all suicides committed with a firearm" for the state of Georgia. **(.751)** Compare it with **Transparency 66.**

Ask students what the .751 means. **(It means that 75.1% of all the suicides that occurred in Georgia from 1981–1998 were due to firearms.) (Transparency 67)**

Tell students to record Georgia's "% of all *suicides* committed with a firearm," from 1981–1998, on the top of the right-hand side of the appropriate card. **(Transparency 68)**

Reshow the Cook's Index formula transparency. **(Transparency 69)**

Ask students how they would calculate the "% of all homicides committed with a firearm." **(Divide the total number of homicides committed with a firearm by the total number of homicides from all causes.) (Transparency 70)**

Have students to return to the WISQARS' *Report Options*.

Ask students how they could complete the *Reports Option* form to find the total number of *homicides committed with a firearm* for the years 1981–1998, by state. **(Complete the *Report Options* in the same manner as described above, except this time for Question 1: What was the intent or manner of the injury? select *Homicide*.) (Transparency 71)**

Ask students how they could complete the *Reports Option* form to find the total number of *homicides committed with a firearm* for the years 1981–1998, by state. **(Transparency 72) (Complete the *Report Options* in the same manner as described above for Question 2: What was the cause or mechanism of the injury? select *Firearm*.) (Transparency 73)**

Ask each group of students to give the "total number of homicides committed with a firearm" for the state of Georgia. **(9,408)** Compare it with **Transparency 74.**

Now ask students how they could complete the *Reports Option* form to find the total number of *homicides from all causes* for the years 1981–1998, by state. **(Transparency 75) (Complete the *Report Options* in the same manner as described above for Question 1: What was the intent or manner of the injury? select *Homicide*.) (Transparency 76)**

Ask students how they could complete the *Reports Option* form to find the total number of *homicides from all causes* for the years 1981–1998, by state. **(Complete the *Report Options* in the same manner as described above, except this time for Question 2: What was the cause or mechanism of the injury? select *All injury*.) (Transparency 77)**

Ask each group of students to give the "total number of homicides from all causes" for the state of Georgia. (13,930) Compare it with **Transparency 78.**

Now ask students how they would calculate the "% of all homicides committed with a firearm" for the state of Georgia. **(Transparency 79)**

Ask students to calculate the "% of all homicides committed with a firearm" for the state of Georgia. (.675) Compare it with **Transparency 80.**

Ask students what the .675 means. **(It means that 67.5% of all the homicides that occurred in Georgia from 1981–1998 were due to firearms.) (Transparency 81)**

Tell students to record Georgia's "% of all *homicides* committed with a firearm," from 1981–1998, on the top of the right-hand side of the appropriate card. **(Transparency 82)**

Ask students how they would calculate Georgia's Cook's Index. **(Transparency 83)**

Ask students to calculate Georgia's Cook's Index. **(71.3)** Compare it with **Transparency 84.**

Now ask students to calculate the Cook's Index for the remaining 49 states. To decrease the tediousness of this task, have each group of students calculate the Cook's Index for a proportion of the remaining 49 states.

To check for accuracy, tell students to compare their calculations with those on the Teacher's Cook's Index Sheet (Alphabetical Order). **(Transparency 85;** see also page 127 of this unit**)**

Part 7

Ask students to take out their large pieces of paper again. **(Transparency 86)**

Ask students how they might depict the possible relationship between a state's rate of unintentional firearm deaths and its firearm availability. Probe until students suggest drawing a horizontal line at the bottom of the large sheet of paper along which to plot each state's Cook's Index.

Ask students to draw a horizontal line at the bottom of the large sheet of paper, making sure that the left-hand end of the line abuts with the bottom of the vertical line and the right-hand end of the line ends about 6 inches from the right-hand side of the paper. **(Transparency 87)**

Tell students to divide the line into five equal sections by putting short lines across the horizontal line. Make sure students put a short line at the left- and right-hand ends of the horizontal line. **(Transparency 88)**

Tell students to label the short lines, from left to right, 30, 40, 50, 60, 70, and 80. **(Transparency 89)**

Ask students to think about Dr. Miller's hypothesis again: The rates of unintentional firearm deaths would be highest in places where firearms were most available and lowest where firearms were least available. **(Transparency 90)**

Ask students what they will need to do with a card in order to depict how a state's rate of unintentional firearm deaths relates to its gun availability, as measured by the Cook's Index. (They will move each state's card horizontally across the paper until it is directly above its Cook's Index on the horizontal line.)

Tell students to plot the index card for the state of Georgia along the vertical line according to its Age-Adjusted Rate for Unintentional Firearm Deaths (0.76) and, at the same time, along the horizontal line according to its proxy for firearm availability, its Cook's Index (71.3). **(Transparency 91)**

Before asking the students to plot the remaining 49 states, ask them to predict how the cards will be distributed if, as Dr. Miller hypothesized, the rates of unintentional firearm deaths would be highest in places where firearms were most available and lowest where firearms were least available. (The cards will be lowest on the left-hand side of the paper and gradually become higher as they move to the right-hand side of the paper.) **(Transparency 92)**

Ask students to predict how the cards will be distributed if the rates of unintentional firearm deaths would be lowest in places where firearms were most available and highest where firearms were least available. **(The cards will be highest on the left-hand side of the paper and gradually become lower as they move to the right-hand side of the paper.) (Transparency 93)**

Ask students to predict how the cards will be distributed if there was no relationship between the rates of unintentional firearm deaths and firearm availability. **(There will be no pattern to the way the cards are distributed.) (Transparency 94)**

Now ask students to position each state's card on the large sheet of paper according to its Age-Adjusted Rate for Unintentional Firearm Deaths and its Cook's Index.

Ask students to describe the relationship between the rates of unintentional firearm deaths and firearm availability, based on the distribution of the cards. **(On average, in states where firearms were most available, there were more unintentional firearm deaths.)** Be sure students' descriptions do not interpret group data as if the data were true about individuals—for example, individuals who have firearms are more likely to experience unintentional firearm death.

Ask students if the distribution of the cards supports Dr. Miller's hypothesis. **(Yes)**

Tell students that epidemiologists call what they have just created a **scatterplot diagram,** a graphic method of displaying the distribution of two variables in relationship to each other, with the values of one variable measured on the vertical axis and the values of the other on the horizontal axis. (Adapted from John M. Last, *A Dictionary of Epidemiology*, 3rd ed. New York: Oxford University Press; 1995.) **(Transparency 95)**

Show students Dr. Miller's figure, average state level unintentional firearm death rate by average state level firearm availability, all ages (1979–1997). **(Transparency 96)**

Ask students to compare their scatterplot diagrams with Dr. Miller's.

Point out to students the difference between their x-axis (from 30 to 80) and Dr. Miller's x-axis (1 to 2.2). The difference is because Dr. Miller, to facilitate comparison, divided each state's Cook's Index by the Cook's Index of the state with the lowest value. Dr. Miller's x-axis therefore represents a ratio, showing how many times larger a state's Cook's Index was than the state with the lowest Cook's Index. (Based on personal communication with Dr. Miller.)

Part 8

Ask students if the "units of analysis" in Dr. Miller's study were populations or individuals. **(Populations)**

Ask students what type of study Dr. Miller used to test his hypothesis that the rates of unintentional firearm deaths would be highest in places where firearms were most available and lowest where firearms were least available. **(Ecologic Study) (Transparency 97)**

Ask students to consider how they would label and complete a 2 × 2 table **(Transparency 98)** to depict the data from their scatterplot diagrams. **(Students may label the 2 × 2 table as "High Firearm Availability," "Low Firearm Availability," and "Unintentional Firearm Death," "Not an Unintentional Death by Firearm" [Transparency 99]; however, they will be stymied when trying to put the data into the cells. Because the unit of analysis was a group, as opposed to individuals, we do not know whether or not an individual had a high or low firearm availability. Note that although the data presented here do not identify whether an individual's death was due to unintentional firearms, these data are available on death certificates.)**

Ask students which of the following statements would accurately describe what Dr. Miller found:

A. People who live in states with "High Firearm Availability" are more likely to experience unintentional firearm deaths than people who live in states with "Low Firearm Availability."

B. Individuals who live in homes with "High Firearm Availability" are more likely to experience unintentional firearm deaths than individuals who live in homes with "Low Firearm Availability."

Review the definition of an **ecologic fallacy,** ". . . an error in inference due to a failure to distinguish between units of analysis. An association between variables at the group unit of analysis may not exist at the individual unit of analysis." (Adapted from John M. Last, *A Dictionary of Epidemiology*, 3rd ed. New York: Oxford University Press; 1995.) **(Transparency 100)**

Ask students what might happen if they interpret their group data as if they were also true about individuals. **(A person who lives in a "Low Firearm Availability" *state* may, individually, live in a "High Firearm Availability" *home* and, likewise, a person who lives in a "High Firearm Availability" *state* may, individually, live in a "Low Firearm Availability" *home*.)**

Part 9: Assessment

For homework, ask students to read the Discussion section of Dr. Miller's article **(Transparency 101)** and answer the questions on the Worksheet. **(Transparency 102)**

Part 10: Assessment

Discuss students' answers to the Worksheet questions. Probe until students uncover the points that are in parentheses below.

1. How might the possibility that ". . . where there are more guns parents care less about their children's welfare. . . ." influence the inference one can reach from Dr. Miller's study? **(This is a possible explanation for why the correlation between firearm availability and unintentional firearm death was found. This could be explored in an analytical epidemiologic study in which the degree of association between parental "caring" and unintentional firearm deaths is measured among firearm-owning parents.)**

2. Why did Dr. Miller ". . . control for state level of poverty, urbanization and regionalization"? **(These are factors that are known to be associated with unintentional firearm death. Dr. Miller wanted to see if after accounting for the influence of these factors, whether there would still be an association between firearm availability and unintentional firearm death.)**

3. How does Dr. Miller address the possibility of the ecologic fallacy? **(Dr. Miller points out that there is no question that at the time of an unintentional firearm death a firearm was "available" to deliver the fatal bullet. Thus, worries about the possibility of an ecologic fallacy [where an association seen at the population level does not occur at the individual level] are probably not warranted in this case.)**

4. Should a death from Russian roulette be considered an unintentional firearm death or a suicide? **(This is a thought-provoking circumstance that shows the need to create precise case definitions and to apply those definitions uniformly. For example, data would be skewed if some states classified a death due to Russian roulette as an unintentional firearm death and other states classified it as a suicide.)**

5. How are deaths due to air bags relevant to Dr. Miller's study? **(Dr. Miller compares the number of deaths associated with air bags and firearms to point out the inconsistency in our efforts to weigh the magnitude of the problem when we decide whether or not to try to reduce risks from various exposures. When associations are identified, decisions about possible prevention strategies are based on more than the scientific evidence. Explore with students the competing values that might be responsible for this inconsistency.)**

6. Do you agree with Dr. Miller's conclusion that ". . . where there are more guns, more people are dying from unintentional gunshot injuries?" **(This is an accurate interpretation of the evidence. Note that Dr. Miller's statement applies to groups of people and not to individuals.)**