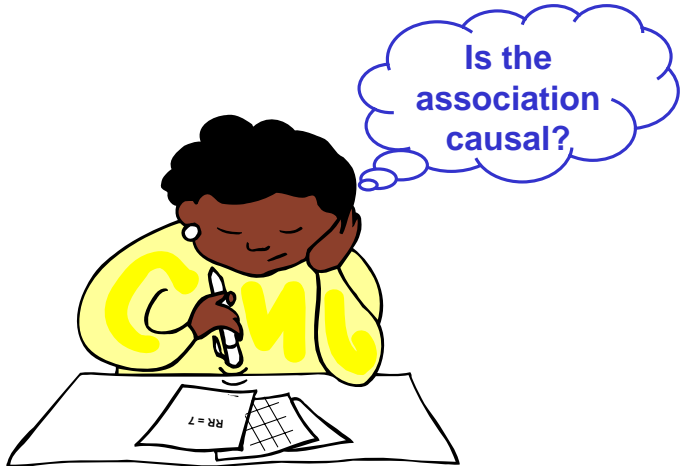


Selection Bias



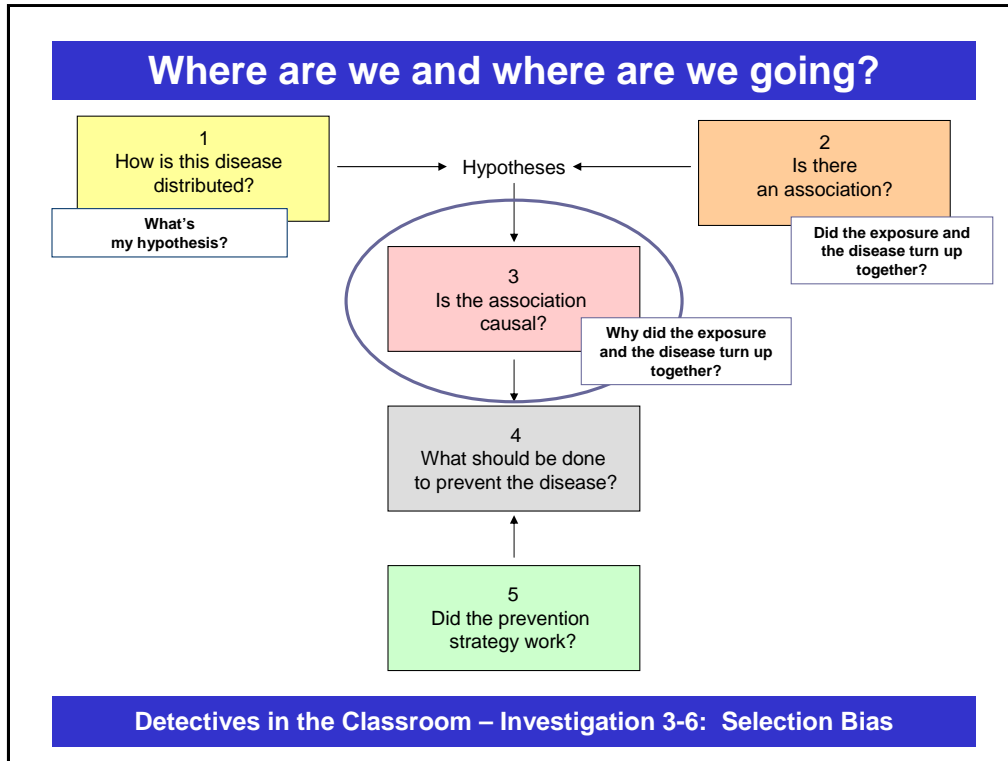
Selection Bias

Detectives in the Classroom - Investigation 3-6: Selection Bias

The illustration shows a person with dark skin and curly hair, wearing a yellow shirt with the letters 'CML' on it. They are sitting at a desk, looking thoughtful with their hand to their chin. On the desk is a piece of paper with a grid and the text 'RR = 7'. A thought bubble above them contains the question 'Is the association causal?'.

In **Investigation 3-6: Selection Bias**, students will continue to learn that causation is only one explanation for finding an association between an exposure and an outcome; because observational studies are flawed, other explanations must also be considered, including selection bias.

Next Slide



Remind students again that in the Module 3 investigations, they are learning how to answer the third Essential Question: “Is the association causal?”

Next Slide

Investigation 3-6

1. Cause
2. Chance
3. Confounding
4. Reversed Time Order
5. Selection Bias

Detectives in the Classroom - Investigation 3-6: Selection Bias

In Module 3, students are exploring five explanations for why two things turn up together.

In **Investigation 3-2: Cause**, they examined the possibility that an exposure and an outcome turn up together because the exposure causes the outcome.

In **Investigation 3-3: Chance**, they explored the possibility that an exposure and an outcome turn up together by chance.

In **Investigation 3-4: Confounding**, they explored the possibility that an exposure and an outcome turn up together as a result of confounding.

In **Investigation 3-5: Reversed Time Order**, they examined the possibility that an exposure and an outcome could have turned up together because of reversed time order.

In **Investigation 3-6: Selection Bias**, they will look at another reason why an exposure and an outcome may turn up together: selection bias.

Next Slide

Explanations for Finding an Association

Bias

Detectives in the Classroom - Investigation 3-6: Selection Bias

Ask students:

- What does the word *bias* mean to you?
- What comes to mind when you think of bias?

Write students' ideas on the board and ask them to identify what their ideas have in common.

Next Slide

Epi Talk

Epi Talk

Bias

A faulty assumption in a study that makes things appear differently from how they really are.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Ask students to find “Bias” in the **Epi Talk** list.

Review its definition.

Compare the students’ thoughts about bias that are on the board with an epidemiologist’s concept of bias. Identify commonalities.

Next Slide

Explanations for Finding an Association

Selection



Detectives in the Classroom - Investigation 3-6: Selection Bias

Ask students:

- What does the word *selection* mean to you?

The meaning of selection in the context of our investigation means the choosing of a study sample.

Next Slide

Epi Talk

Epi Talk

Selection Bias

A faulty assumption in a study because of a systematic difference in how subjects were chosen to be in the study.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Ask students to find “Selection Bias” in the **Epi Talk** list.

Review its definition.

Discuss with students the idea that in an epidemiology study, the researcher has to be clever enough to choose the *right sample* to conduct a scientifically valid study of a natural experiment.

Next Slide

Association

	Outcome	No Outcome		
Exposure	a	b		Risks or 50 %
No Exposure	c	d		or 5 %

10



Detectives in the Classroom - Investigation 3-6: Selection Bias

Remind students that, to an epidemiologist, an association between an exposure and an outcome exists when there is a large difference between the risks of the outcome in exposed and unexposed groups of people. Epidemiologists determine if there is an association between an exposure and an outcome by calculating and comparing risks of disease in exposed and unexposed groups of people to see how different they are. If there is a large difference between the risks, epidemiologists say that they have found an association between the exposure and the outcome.

Next Slide

Study finds

Study Finds Association Between Heavy Backpacks and Back Pain

Martin Luther King High School

Heavy Backpack =
15% or more of body weight

200 students



Detectives in the Classroom - Investigation 3-6: Selection Bias

Present the following scenario.

When José read the newspaper this morning, he found a headline that read “Study Finds Association Between Heavy Backpacks and Back Pain.”

As José read on, he learned that the article was about a study that tested the hypothesis “carrying heavy backpacks causes back pain.”

At the beginning of a school day in November, at Martin Luther King High School, the investigators asked, over the public address system, that all students who had physical education classes that day bring their backpacks to the gymnasium at class time. In their physical education classes that day, students weighed themselves and their backpacks, and reported their body weight, the weight of their backpacks, and whether or not they had back pain.

For the purposes of the study, students whose backpacks weighed 15% or more of their body weight were classified as having heavy backpacks.

At the end of the school day, the investigators had collected information from 200 students.

Next Slide

Epi Log Worksheet

1

Detectives in the Classroom Name: _____

Investigation 3-6: Epi Log Worksheet Date: ____/____/____

Explanations for Finding an Association: Selection Bias

1.

2.

	a	b	
	c	d	

Risks = ____ %

Relative Risk = ____ %

Based on the above calculations, place a check next to the correct statement and complete the statement if necessary.

The risk of getting back pain was the same for those who carried and did not carry a heavy backpack.

Those who carried heavy backpacks were ____ times as likely to have back pain as those who had not carried heavy backpacks.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Give each student an **Investigation 3-6: Epi Log Worksheet**.

Students should complete Part 1 on their **Investigation 3-6: Epi Log Worksheets** by drawing a flow diagram of the research design.

Next Slide

Epi Teams



Detectives in the Classroom - Investigation 3-6: Selection Bias

Divide the class into Epi Teams of four or five students per team.

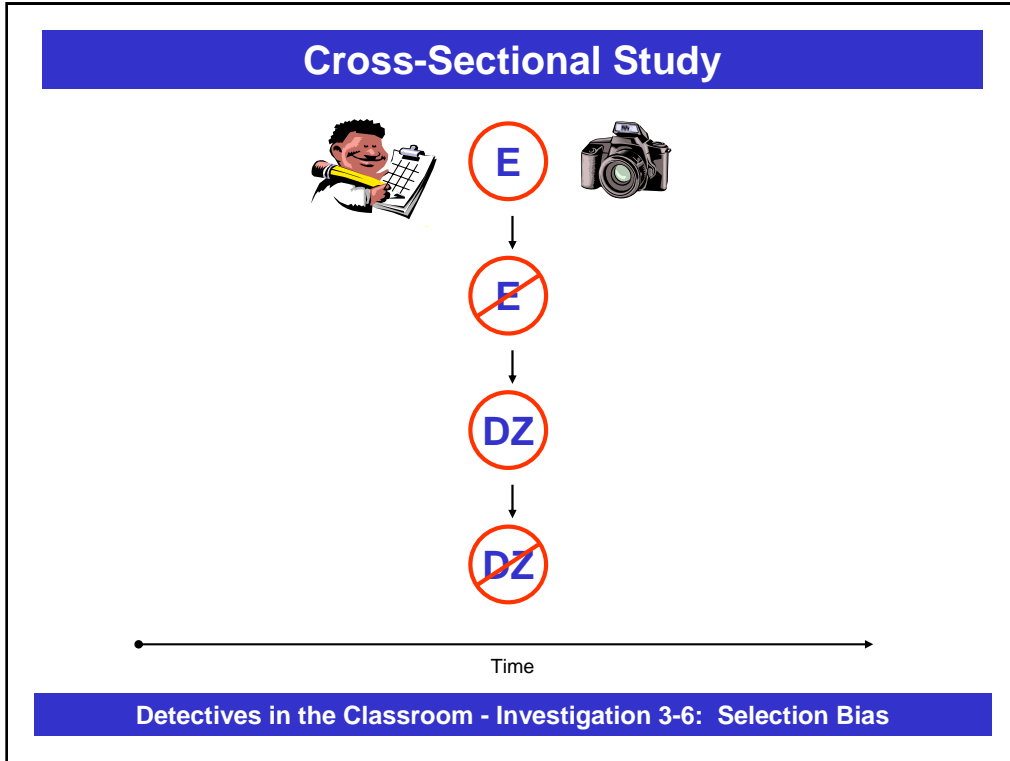
Have students share and compare their answers with those of the other members of the Epi Team.

Ask a member of one Epi Team to draw the team's flow diagram of the research design on the board. Share, compare, and edit as needed.

Encourage students to edit their answers as needed.

Compare their answers with the diagram on the next slide.

Next Slide



(Cross-sectional study diagram)

Next Slide

Investigators found

Study Finds Association Between Heavy Backpacks and Back Pain

20 heavy backpacks
10 students with back pain

180 no heavy backpacks
30 students with back pain



Detectives in the Classroom - Investigation 3-6: Selection Bias

The investigators found that 20 of the 200 students carried heavy backpacks and 10 of those students had back pain.

Among the 180 students who did not carry heavy backpacks, the investigators found that 30 students had back pain.

Next Slide

Epi Log Worksheet

2

Detectives in the Classroom Name: _____

Investigation 3-6: Epi Log Worksheet Date: ____/____/____

Explanations for Finding an Association: Selection Bias

1.

2.

	a	b	
	c	d	

Risks
= ____ %
= ____ %

Relative Risk
○

Based on the above calculations, place a check next to the correct statement and complete the statement if necessary.

The risk of getting back pain was the same for those who carried and did not carry a heavy backpack.

Those who carried heavy backpacks were ____ times as likely to have back pain as those who had not carried heavy backpacks.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Students should complete Part 2 on their **Investigation 3-6: Epi Log Worksheets** by completing the 2 x 2 table, calculating back pain risks, calculating a relative risk, and making an inference.

Next Slide

Study finds

Study Finds Association Between Heavy Backpacks and Back Pain

20 heavy backpacks
10 students with back pain

180 no heavy backpacks
30 students with back pain



Detectives in the Classroom - Investigation 3-6: Selection Bias

Have students share and compare their answers with those of the other members of the Epi Team.

Ask a member of one Epi Team to write his or her answer to Part 2 on the board. Share, compare, and edit as needed.

Encourage students to edit their answers as needed.

Compare their answers with the 2 x 2 table on the next slide.

Next Slide

Epi Log Worksheet

2.

	Back Pain	No Back Pain			
Heavy Backpacks	10	10	20	$\frac{10}{20}$	= $\frac{50}{100}$ %
No Heavy Backpacks	30	150	180	$\frac{30}{180}$	= $\frac{16.7}{100}$ %

a b
c d

Risks

Relative Risk

2.9

Based on the above calculations, place a check next to the correct statement and complete the statement if necessary.

- The risk of getting back pain was the same for those who carried and did not carry a heavy backpack.
- Those who carried heavy backpacks were 2.9 times as likely to have back pain as those who had not carried heavy backpacks.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Have students edit their answers accordingly.

Next Slide

Selection Bias



Detectives in the Classroom - Investigation 3-6: Selection Bias

Return to the backpack scenario.

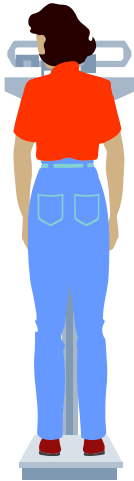
José's older sister and brother are both students at Martin Luther King High School. His sister plays sweeper on the soccer team, and his brother is a point guard on the basketball team.

José knows that Martin Luther King High School has a policy of excusing athletes from physical education classes when their sports are in season.

Ask students what effect this policy might have on the results of the cross-sectional study that was used to test the hypothesis "carrying heavy backpacks causes back pain."

Next Slide

Selection Bias



	<u>Weight</u>	<u>Weight of Backpack</u>	<u>Back Pain</u>
<u>Sister</u>	140 lbs	25 lbs	No
<u>Brother</u>	185 lbs	31 lbs	No

Detectives in the Classroom - Investigation 3-6: Selection Bias

That evening when José's brother and sister come home from practice, he asks them to weigh themselves and their backpacks and asks if they have back pain.

José found the results shown on the slide.

Ask students:

- Are José's brother and sister carrying heavy backpacks? (Yes)
- How many sports are in season in November when this study was done? (Soccer, football, and cross-country are completing their seasons, and basketball, wrestling, and swimming are beginning training for theirs.)
- How many students would have been excused from physical education classes in November because of Martin Luther King High School's policy of excusing athletes from physical education classes when their sports are in season? (The number of students participating in or trying out for soccer, football, cross-country, basketball, wrestling, and swimming)
- Are there other reasons why students could have been excused from physical education classes? (Health, driver's education, or first aid classes)

Next Slide

Selection Bias

2.

	Back Pain	No Back Pain	
Heavy Backpacks	10	10	20
	a	b	
No Heavy Backpacks	30	150	180
	c	d	

$\frac{10}{20}$	Risks	$= \frac{50}{100} \%$	<div style="border: 1px solid black; border-radius: 50%; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 0 auto;"> 2.9 </div>
$\frac{30}{180}$	Risks	$= \frac{16.7}{100} \%$	

Based on the above calculations, place a check next to the correct statement and complete the statement if necessary.

- The risk of getting back pain was the same for those who carried and did not carry a heavy backpack.
- Those who carried heavy backpacks were 2.9 times as likely to have back pain as those who had not carried heavy backpacks.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Remind the class that *students* who carried heavy backpacks were **2.9 times as likely** to have back pain as *students* without heavy backpacks.

Ask students:

- Is there any reason to think that *athletes* who carried heavy backpacks would be **2.9 times as likely** to get back pain as *athletes* who did not? (Athletes, who are practicing or playing games 5 or 6 days a week, are probably more physically fit than nonathletes. People who are physically fit may be more likely to carry heavy backpacks and less likely to develop back pain.)
- If this were so, what effect might this have on the results of the cross-sectional study used to test the hypothesis “carrying heavy backpacks causes back pain”? (The relative risk would become smaller.)
- How could you determine if this were the case? (Do the study again and this time select all students to participate.)

Next Slide

Selection Bias



Selection Bias

A faulty assumption that occurs because there are systematic differences in characteristics between those who are selected for study and those who are not.

Detectives in the Classroom - Investigation 3-6: Selection Bias

Selection bias is a form of bias that occurs when there are systematic differences in characteristics between those who are selected for study and those who are not.

Ask students:

- How does this definition apply to this study? (There were systematic differences in athletic status, and possibly back strength status, between those who were selected for study and those who were not.)

Next Slide

Explanations for Finding an Association

Could the association have been found because of selection bias?



Detectives in the Classroom - Investigation 3-6: Selection Bias

Tell students that when they find, read, or hear about an association, they should think about it carefully. A good detective will not jump to the conclusion that the association is causal and will consider the possibility that the association was found as a result of selection bias. It is important to ask, “How did the researchers select the study groups?”


Ask students:

- What would you do to determine if an association was due to selection bias? (Do the study again and select a study sample that is representative of all students.)

Next Slide

Explanations for Finding an Association

1. Cause
2. Chance
3. Confounding
4. Reversed Time Order
5. Selection Bias



Study Finds Possible Link Of Cancer and Power Lines
 Studies Link AIDS Virus Directly to Cancer and Dementia
 Chemical Tie to Cancer Hinted
 Study Links Intelligence And Myopia
 Mist in Grocery's Produce Section Is Linked to Legionnaires' Disease
 Coffee linked to heart disease
 Dairy Sugar Linked to Ovarian Cancer
 Report Links Snoring to Impaired Thinking
 Children's Height Linked to Test Scores
 Why would an exposure and an outcome turn up together?
 China's Search for Nutrient Link to Cancer Proves Elusive
 Study Links Eating M&M's To Decreased Risk of Flu
 GUN CORBS LINKED TO HOMELESS RATE

Detectives in the Classroom - Investigation 3-6: Selection Bias

Students know from **Investigation 3-2** that one of the possible explanations for finding an association between an exposure and an outcome—that is, they turn up together—is that the exposure causes the outcome. The exposure actually produces the effect of the outcome.

Point out that when an association is found, the causal explanation is often the first one we consider. But students have also learned to consider the possibility that an association is found because of chance (**Investigation 3-3**), confounding (**Investigation 3-4**), and reversed time order (**Investigation 3-5**).

In **Investigation 3-6**, students have learned about a fifth possible explanation for why an epidemiologist might find a tie, link, relationship, or an association between an exposure and an outcome: *selection bias*.

☼ Teacher Alert: There are other types of bias, such as errors in measuring the exposure or in measuring the outcome. Study errors will lead to a biased finding that may not be the truth. Some consider confounding a type of bias, since it leads to a faulty assumption.

Next Slide

Selection Bias



Detectives in the Classroom - Investigation 3-6: Selection Bias

This concludes **Investigation 3-6: Selection Bias** and students can now put away their **Epi Logs**.