Unit 14: The Question of Causation

PREREQUISITES

Even though there are no specific mathematical or statistical prerequisites, the ideas presented are too sophisticated for most pre-secondary students. Unit 12, Correlation, is helpful for full appreciation of this unit, but it is not an essential prerequisite.

This video can also be shown in connection with science, because the issue of how to get evidence for cause-and-effect arises there.

ACTIVITY DESCRIPTION

In this activity, students are asked to use the Internet to find retrospective and prospective studies that have been conducted. To help narrow student searches, physical activity is specified as a suspected risk factor or protective factor for the retrospective study. For the prospective study, the outcome is specified as some disease or disorder. Question 3 is open and students are free to find any retrospective or prospective study. Give students an opportunity to share some of the studies they have found with the class.

THE VIDEO SOLUTIONS

1. People who have a higher standard of living are more likely to own multiple cars. Also, people who have more money tend to live longer, probably because they can afford excellent medical care and good quality food. The variable responsible for the car-lifespan association is wealth.

2. There could be a lurking variable, perhaps some gene, that made some people more apt to smoke but that also caused lung cancer. Hence, the lurking variable was the cause for the cancer, not the smoking.

3. A retrospective study takes a group of people – say a group with lung cancer – and looks back to see what characteristics members of the group have in common. With the lung cancer group, smoking stood out. A prospective study takes a group of people – say a group that contains both smokers and nonsmokers but otherwise have many similar characteristics – and then follows the group members over time. For example, years later the cancer rates in the smoking and nonsmoking group could be compared.

4. The smokers chose to smoke. Smoking was not imposed as a treatment on these group members.

5. The animal studies showed that smoking caused cancer in animals – hence, it was carcinogenic.

UNIT ACTIVITY SOLUTIONS

1. Sample study: Study involved 21 Type 2 diabetics; found increased physical activity associated with decreased healthcare costs. Data were gathered from participants' previous medical records. This study does not prove that increased physical activity causes a decrease in healthcare costs. More evidence is needed.

2. Sample study: A prospective study involved 3,875 young adults (age 20 – 32) who were not diabetic at the time of the study. The study was conducted to assess whether there was an association between mercury levels (determined from toenail clippings) and incidence of diabetes. These young adults were followed for 18 years. The study found that there was a significantly higher risk of diabetes associated with greater levels of mercury exposure. Because this is not an experiment, the study does not prove that mercury exposure causes diabetes.

3. Sample study: A prospective study to see if emotions of younger adults were more affected by physical activity and sleep than older adults. Participants reported in diaries their current day's mood and physical activity, as well as how many hours of sleep they got the night before. They recorded this information for four weeks. Findings of the study indicate that emotions of younger adults were more affected by physical activity and sleep than emotions of older adults. Prospective studies do not prove cause-and-effect relationships.

EXERCISE SOLUTIONS

1. The children range from 6 to 11 years in age. Because older children have had more time to develop their reading skills, generally they will be better readers than the younger children. In addition, older children tend to be bigger than younger children and should have bigger feet. In this situation, age is a lurking variable that explains the observed association between foot length and reading level.

2. Students who elect to take at least two years of a foreign language are, on average, both better students and more interested in language than those who take no foreign language. They would do better in English even if they did not study a foreign language. These characteristics of the students are lurking variables.

3. a. Sample answer: A retrospective study starts with the outcomes and looks back. Select two groups, one a group of patients with heart disease and the other a group of people of similar age and background who do not have heart disease. Look for differences between the groups – in particular, do the heart disease patients tend to be more overweight?

In the discussion, ask about matching the people in the two groups, which is an important part of comparative studies. Also ask about problems with such a study. For example, perhaps people in the heart disease group lost weight after becoming ill, so they do not appear overweight at the time of the study but might have been overweight before the diagnosis. Perhaps the heart problems affected memory and the people in the heart disease group don't remember past habits accurately.

b. Sample answer: A prospective study starts with the suspected cause and looks forward to the outcome. Select two groups of people, one with people who are overweight and another group of similar people (in age, sex, type of occupation, etc.) who are not overweight. Follow all the subjects for many years and observe the heart disease rates in both groups.

In the discussion, note that directly comparing overweight and normal weight people is more convincing than a retrospective study. Also note that the prospective study is expensive and takes many years.

4. a. Study 2 is the retrospective study. We start with the outcomes – workers who filed lost-time claims due to back injuries. The data from those workers were then retrieved from past

records that were available. Study 1 is the prospective study. In that study, the group was all workers. Researchers had to wait until a worker was injured before following up to see if the worker had physical therapy or returned to work.

b. Study 1 would be more costly. Researchers have to work over a period of years to both collect and analyze the data. In addition, the outcome of missed work due to a low-back injury is probably somewhat rare. So, the group to be followed would have to be pretty large.

c. Sample answer: Even though prospective studies are generally preferred, in this case, the outcome, low-back pain due to injury, is probably somewhat uncommon. So, the cost and time required to conduct a prospective study makes it not feasible in this situation. Sources of the data for the retrospective study have already been identified. So, that study would be more cost-effective and faster to conduct.

REVIEW QUESTIONS SOLUTIONS

1. Economic conditions may have improved over time, especially if the program was started during an economic downturn. Perhaps a major employer moved into the region during the four years. (Any change over the four years that helps employment is confounded with the training program.)

2. Positive association does not imply causation. Education, mental health, and home environment are other variables that might affect both marijuana usage and relationship problems for teens a number of years later.

3. This is not an experiment because nothing is actually done to the subjects. They are just observed over time. In particular, they choose whether to exercise. An experiment would assign subjects to different amounts of exercise. Instead, this is a prospective study. The two groups are chosen because they differ in the suspected cause (regular exercise) of reduced risk for heart disease. We follow them forward in time to observe the outcome of interest, whether they have heart attacks.

4. a. Clearly, Study 1 is a retrospective study. The men are dead – so, it would not be possible to do a prospective study.

b. Study 2 is a prospective study. The women joined the study and then the study followed them over time.

c. Breast cancer rates are relatively low (even though it is a common cancer), so the group size being studied would need to be large. If not sufficiently large, there would be a risk that none of the participants in the study develop breast cancer. In a large group, it is likely that there will be sufficient numbers of women who develop breast cancer. In Study 1, since it is a retrospective study, we already have a sizable group of white men who had heart disease. We don't have to wait to see if the disease develops in a retrospective study.