Section 1.3 - Observational Studies versus Designed experiments

Objectives:
1) Observational studies and designed experiments – what is the difference
2) What is a treatment? In which one does the scientist impose a treatment?
3) What is confounding? In which one do we observe confounding?
4) What do we mean by randomization? In which one is it used?
5) How can you accomplish randomization?
6) In which one can we talk about cause and effect?
7) Treatment and control groups
8) What do we mean by blinding? Double blinding? Placebo effect?

Example 1:
Which diet is more effective to reduce weight; diet A or B?

- Scenario 1. Some patients follow diet A and others diet B. After a few months, data on weight loss is collected and the information is used to decide which diet is more effective.

- Scenario 2. The doctor divides the patients randomly into two groups, and assigns each group to one of the two diets A or B. After a few months, data on weight loss is collected and the information is used to decide which diet is more effective.

What do you think? Which is a better procedure to help us decide which diet is more effective? Why?
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Example 2
Testing a medicine – Scenario 1 –
Suppose a pharmaceutical company has developed a new medicine to cure a disease. To see whether or not this medicine is effective in curing this disease, it will have to be tested on a group of humans. Suppose there are 100 persons who have this disease; 50 of them voluntarily decide to take this medicine, and the remaining 50 decide not to take it. The researcher then compares the cure rates for the two groups of patients.

A) Is this an example of a designed experiment or an observational study? Explain
B) Can we conclude that the medicine is effective in curing the disease? Explain
C) Name possible confounding variables

Testing a medicine – Scenario 2 –
Reconsider the above example. Now, suppose that out of the 100 people who have this disease, 50 are selected at random. These 50 people make up one group, and the remaining 50 belong to the second group. One of these groups is the treatment group, and the second is the control group. The researcher then compares the cure rates for the two groups of patients.

A) Is this an example of a designed experiment or an observational study?
B) Can we conclude that the medicine is effective in curing the disease? Explain
Section 1.3: Experiments and Observational Studies

ASSOCIATION
Two variables are associated if values of one variable tend to be related to the values of the other variable. This does not mean that changes in one variable cause changes on the other variable.

CAUSATION
Two variables are causally associated if changing the value of one variable influences the value of the other variable.

Example 1: a study found that people who own two cars live longer than people who own only one car. Does having more cars make you live longer?

Example 2: Does smoking cause lung cancer?

APPLYING THE CONCEPTS – try some odd numbered problems from the end of the section

1) In Exercises 1.66 to 1.71, we give a headline that recently appeared online or in print. State whether the claim is one of association and causation, association only, or neither association nor causation.
   a) 1.66 - Daily exercise improves mental performance.
   b) 1.68 - Cell phone radiation leads to deaths in honey bees.
   c) 1.70 - Cat owners tend to be more educated than dog owners.

CONFOUNDING VARIABLE
A confounding variable, also known as a confounding factor or lurking variable, is a third variable that is associated with both the explanatory variable and the response variable. A confounding variable can offer a plausible explanation for an association between two variables of interest.

APPLYING THE CONCEPTS – try some odd numbered problems from the end of the section

2) Exercises 1.72 – 1.77 describe an association between two variables. Give a confounding variable that may help to account for this association.
   a) 1.72 - More ice cream sales have been linked to more deaths by drowning.
   b) 1.74 - People who own a yacht are more likely to buy a sports car.
   c) 1.76 - Air pollution is higher in places with a higher proportion of paved ground relative to grassy ground.
Section 1.3: Experiments and Observational Studies

OBSERVATIONAL STUDIES AND EXPERIMENTS
An experiment is a study in which the researcher actively controls one or more of the explanatory variables. An observational study is a study in which the researcher does not actively control the value of any variable but simply observes the values as they naturally exist.

CAUSATION CAUTION
It is difficult to avoid confounding variables in observational studies. For this reason, observational studies can almost never be used to establish causality.

APPLYING THE CONCEPTS – try some odd numbered problems from the end of the section

3) In Exercises 1.78 to 1.81, we describe data collection methods to answer a question of interest. Are we describing an experiment or an observational study?

   a) 1.78 - To examine whether eating brown rice affects metabolism, we ask a random sample of people whether they eat brown rice and we also measure their metabolism rate.

   b) 1.80 - To examine whether planting trees reduces air pollution, we find a sample of city blocks with similar levels of air pollution and we then plant trees in half of the blocks in the sample. After waiting an appropriate amount of time, we measure air pollution levels.

4) Read your book to explore the following concepts. Then summarize below.

   a. Treatment and Control (or placebo) group

   b. Placebo effect

   c. Blinding

   d. Double blinding

   e. What is the objective of using “blinding or double blinding” in experiments?

5) For the results of a study to be unbiased and valid, an experiment must be __________________________
Section 1.3: Experiments and Observational Studies

RANDOMIZED EXPERIMENT
In a randomized experiment, the value of the explanatory variable for each unit is determined randomly, before the response variable is measured.

If a randomized experiment yields an association between the two variables, we can establish a causal relationship from the explanatory to the response variable.

6) Causal relationships can be established from?
   Observational studies or randomized experiments?

TWO TYPES OF RANDOMIZED EXPERIMENTS
In a randomized comparative experiment, we randomly assign cases to different treatment groups and then compare results on the response variable(s).

In a matched pairs experiment, each case gets both treatments in random order (or cases get paired up in some other obvious way), and we examine individual differences in the response variable between the two treatments.

7) Are the following examples of “randomized comparative” or “matched pairs” experiments?

a) Testing if tutoring has an effect on the math scores.
   Five students took a math test before and after tutoring. Their scores were as follows.
   
<table>
<thead>
<tr>
<th>Subject</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
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<tbody>
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<td>Before</td>
<td>69</td>
<td>70</td>
<td>74</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td>After</td>
<td>73</td>
<td>79</td>
<td>72</td>
<td>73</td>
<td>87</td>
</tr>
</tbody>
</table>

b) The effectiveness of a new headache medicine is tested by measuring the amount of time before the headache is cured for patients who use the medicine and another group of patients who use a placebo drug.

c) The effect of caffeine as an ingredient is tested with a sample of regular soda and another sample with decaffeinated soda.

d) The effectiveness of a headache medicine is tested by measuring the intensity of a headache in patients before and after drug treatment. The data consist of before and after intensities for each patient.
A WORD ABOUT RANDOMIZATION

- To generalize from a sample to a population we select at random the units (individuals, cases) in the sample.
- To establish causality, we assign at random the values of the explanatory variable to each unit in the sample.

Figure 1.3
Two fundamental questions about data collection