Section 1.2

Observational Studies versus Designed Experiments

Now to one of the main objectives for this section. Two other very common sources of data are **observational studies** and **designed experiments**. We're going to take some time here to describe them and distinguish between them - you'll be expected to be able to do the same in homework and on your first exam.

The easiest examples of observational studies are surveys. No attempt is made to influence anything - just ask questions and record the responses. By definition,

> An **observational study** measures the characteristics of a population by studying individuals in a sample, but does not attempt to manipulate or influence the variables of interest.

For a good example, try visiting the Pew Research Center. Just click on any article and you'll see an example of an observational study. They just sample a particular group and ask them questions.

In contrast, *designed experiments* explicitly do attempt to influence results. They try to determine what affect a particular treatment has on an outcome.

> A **designed experiment** applies a treatment to individuals (referred to as **experimental units** or **subjects**) and attempts to isolate the effects of the treatment on a **response variable**.

> Probably the biggest difference between observational studies and designed experiments is the issue of *association* versus *causation*. Since observational studies don't control any variables, the results can only be *associations*. Because variables are controlled in a designed experiment, we can have conclusions of *causation*.

Look back over the three examples linked above and see if all three reported their results correctly. You'll often find articles in newspapers or online claiming one variable *caused* a certain response in another, when really all they had was an *association* from doing an observational study.

The discussion of the differences between observational studies and designed experiments may bring up an interesting question - why are we worried so much about the difference?

We already mentioned the key at the end of the previous page, but it bears repeating here:

> Observational studies only allow us to claim *association*,not *causation*.

The primary reason behind this is something called a *lurking variable* (sometimes also termed a *confounding factor*, among other similar terms).

> A **lurking variable** is a variable that affects both of the variables of interest, but is either not known or is not acknowledged.

Types of Observational Studies

There are three major types of observational studies, and they're listed in your text: cross-sectional studies, case-control studies, and cohort studies. Your textbook does a good job describing each, but we'll summarize them again here and give a couple quick examples of each.

Cross-sectional Studies

This first type of observational study involves collecting data about individuals at a certain point in time. A researcher concerned about the effect of working with asbestos might compare the cancer rate of those who work with asbestos versus those who do not.

Cross-sectional studies are cheap and easy to do, but they don't give very strong results. In our quick example, we can't be sure that those working with asbestos who don't report cancer won't eventually develop it. This type of study only gives a bit of the picture, so it is rarely used by itself. Researchers tend to use a cross-sectional study to first determine if their might be a link, and then later do another study (like one of the following) to further investigate.

Case-control Studies

Case-control studies are frequently used in the medical community to compare individuals with a particular characteristic (this group is the *case*)with individuals who do not have that characteristic (this group is the *control*). Researchers attempt to select homogeneous groups, so that on average, all other characteristics of the individuals will be similar, with only the characteristic in question differing.

One of the most famous examples of this type of study is the early research on the link between smoking and lung cancer in the United Kingdom by Richard Doll and A. Bradford Hill. In the 1950's, almost 80% of adults in the UK were smokers, and the connection between smoking and lung cancer had not yet been established. Doll and Hill interviewed about 700 lung cancer patients to try to determine a possible cause.

This type of study is ***retrospective***,because it asks the individuals to look back and describe their habits(regarding smoking, in this case). There are clear weaknesses in a study like this, because it expects individuals to not only have an accurate memory, but also to respond honestly. (Think about a study concerning drug use and cognitive impairment.) Not only that, we discussed previously that such a study may prove ***association***, but it cannot prove **causation**.

Cohort Studies

A cohort describes a group of individuals, and so a cohort study is one in which a group of individuals is selected to participate in a study. The group is then observed over a period of time to determine if particular characteristics affect a response variable.

Based on their earlier research, Doll and Hill began one of the largest cohort studies in 1951. The study was again regarding the link between smoking and lung cancer. The study began with 34,439 male British doctors, and followed them for over 50 years. Doll and Hill first reported findings in 1954 in the British Medical Journal, and then continued to report their findings periodically afterward. Their last report was in 2004,again published in the British Medical Journal. This last report reflected on 50 years of observational data from the cohort.

This last type of study is called **prospective**, because it begins with the group and then collects data over time. As your textbook mentions,cohort studies are definitely the most powerful of the observational studies,particularly with the quantity and quality of data in a study like the previous one.