

## 1.14: Putting It Together- Types of Statistical Studies and Producing Data

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### Let's Summarize

- There are four steps in a statistical investigation:
  - Ask a question that can be answered by collecting data.
  - Decide what to measure, and then collect data.
  - Summarize and analyze.
  - Draw a conclusion, and communicate the results.
- There are two types of statistical studies:
  - Observational studies: An *observational study* observes individuals and measures variables of interest. We conduct observational studies to investigate questions about a population or about an association between two variables. An observational study alone does not provide convincing evidence of a cause-and-effect relationship.
  - Experiments: An *experiment* intentionally manipulates one variable in an attempt to cause an effect on another variable. The primary goal of an experiment is to provide evidence for a cause-and-effect relationship between two variables.
- In statistics, a *variable* is information we gather about individuals or objects.

### Observational Studies

- In an observational study, we draw a conclusion about the population on the basis of a sample. To draw a valid conclusion, the sample must be representative of the population. A representative sample is a subset of the population. It also reflects the characteristics of the population.
- A sample is biased if it systematically favors a certain outcome. Voluntary response samples (such as Internet polls) and convenience samples (such as surveys at a mall) are biased.
- Random selection eliminates bias. In a simple random sample, everyone in the population has an equal chance of being chosen. In this way, random selection helps ensure that the sample is representative of the population.
- Larger samples tend to be more accurate than smaller samples if the samples are chosen randomly. The size of the population does not affect the accuracy of a random sample as long as the population is large.
- If an attempt is made to include every individual from a population in a sample, then the investigation is called a *census*.

### Experiments

The goal of the experiment is to provide evidence for a cause-and-effect relationship between two variables. When we investigate a relationship between two variables, we identify an explanatory variable and a response variable. To establish a cause-and-effect relationship, we want to make sure the explanatory variable is the only factor that impacts the response variable. But other factors, called *confounding variables*, may also influence the response.

- A well-designed experiment takes steps to eliminate the effects of confounding variables. These steps include direct control, random assignment of people to treatment groups, use of a control or placebo, and blind conditions. Incorporating such precautions, a well-designed experiment provides convincing evidence of cause-and-effect.
- Random assignment uses random chance to assign participants to treatments, which creates similar treatment groups. With random assignment, we can be fairly confident that any differences we observe in the response of treatment groups is due to the explanatory variable. In this way, we have evidence for a cause-and-effect relationship.
- A well-designed experiment provides evidence for a cause-and-effect relationship. But even in a well-designed experiment, differences in the response might be due to chance. We learn to describe chance behavior when we study probability later in the course.

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