

Section 1.3 Introduction to Experimental Design

Objective: In this lesson you learned how to plan a statistical study.

Important Vocabulary

Census	Sample	Observational Study	Experiment
Placebo Effect	Control Group	Randomization	Replication

I. Planning a Statistical Study

What are two essential components for obtaining reliable information?

Planning a statistical study and gathering data.

Focus Point:

- Discuss what it means to take a census

Basic guidelines for planning a statistical study.

1. Identify the individuals or objects of interest
2. Specify the variables and protocols for taking measurements or making observations
3. Determine size of study
i.e. entire population vs. representative sample
4. Data collection plan should include issues of ethics
i.e. confidentiality, privacy, permission
5. Collect the data
6. Use appropriate methods
Descriptive and Inferential statistics
7. Note any concerns you might have about your data collection

One issue to consider is whether to use the entire population in a study or a representative sample.

In a census: measurements or observations from the entire population are used.

If we use data from only part of the population of interest, you have a(n) sample.

In a **sample**: measurements or observations from part of the population are used

II. Experiments and Observations

When gathering data for a statistical study, you want to:

distinguish between observational studies and experiments

In an **observational study**: observations and measurements of individuals are conducted in a way that doesn't change the response or the variable being measured.

In an **experiment**: a treatment is deliberately imposed on the individuals in order to observe a possible change in the response or variable being measured

Focus Point:

- Describe simulations, observational studies, and experiments
- Identify control groups, placebo effects, completely randomized experiments, and randomized block experiments

Statistical experiments are commonly used to determine the effect of a treatment. However, the design of the experiment needs to control for other possible causes of the effect. For instance, in medical experiments, the placebo effect is the improvement or change that is the result of patients just believing in the treatment, whether the treatment itself is effective or not.

The **placebo effect**: occurs when a subject receives no treatment but (incorrectly) believes he/she is in fact receiving treatment and responds favorably.

A common way to assign patients to treatment and control groups is by using a random process. This is the essence of a completely randomized experiment.

A **completely randomized experiment**: is one in which a random process is used to assign each individual to one of the treatments.

A block: is a group of individuals sharing some common features that might affect the treatment

Many experiments are also double-blind, meaning neither the individuals in the study nor the observers know which subjects are receiving the treatment.

There is a **control group**: that receives a dummy treatment, enabling the researchers to control for the placebo effect

Randomization: is used to assign individuals to the two treatment groups.

Replication: of the experiment on many patients reduces the possibility that the differences in pain relief for the two groups occurred by chance alone.

III. Surveys

A common means to gather data is to ask people questions. This process is the essence of surveying. Sometimes the possible responses are simply 'yes' or 'no'. Other times the respondents choose a number on a scale, called a(n)

Likert scale.

Some potential pitfalls of a survey

Nonresponse: Individuals either cannot be contacted or refuse to participate
* can result in significant undercoverage *

Truthfulness of response:

Respondents may lie intentionally or inadvertently

Faulty recall: Respondents may not accurately remember when or whether an event took place.

Hidden bias: The question(s) may be written in such a way as to elicit a specific response.

Focus Point:

- Discuss potential pitfalls that might make your data unreliable

Vague wording: words such as "often", "seldom", and "occasionally" mean different things to different people.

Interviewer influence: Factors such as tone of voice, body language, dress, gender authority, and ethnicity of the interviewer might influence responses.

Voluntary response:

Individuals with strong feelings about a subject are more likely than others to respond.

Sometimes our goal is to understand the cause-and-effect relationships between two or more variables. Such studies can be complicated by lurking variables or confounding variables.

A lurking variable: is one for which no data have been collected but that nevertheless has influence on other variables in the study.

Two variables are **confounded** when: the effects of one cannot be distinguished from the effects of the other.

IV. Choosing Data Collection Techniques

Which technique is best? The answer depends on:

the number of variables of interest and the level of confidence needed regarding statements of relationships among the variables

- **Surveys:** may be the best choice for gathering information across a wide range of many variables.
- **Observational studies:** 2nd most convenient technique for gathering data.
- **Experiments:** are the most stringent and restrictive data-gathering technique.

* Best technique for reaching valid conclusions.*

A data collection plan identifies:

- The population and sampling frame.
- the variable(s)
- Whether data are observational or experimental
- whether there is a control group, use of placebos, double-blind treatment, etc.
- Sampling technique to be used.
- Method used to collect the data for the variables

Section 1.3 Examples – Introduction to Experimental Design

(1) Which technique for gathering data (sampling, experiment, simulation, or census) do you think might be the most appropriate for the following studies?

- a. Study the effect of stopping the cooling process in a nuclear reactor.

Simulation

NOTE: since you probably don't want to risk a nuclear meltdown

- b. Study the amount of time college students taking a full course load would spend watching TV.

Sampling with observational study.

Note: obtaining information from students is not likely to effect the time spent watching TV.

- c. Study of the effect on bone mass of a calcium supplement given to young girls.

Experiment

- d. Study of the credit hour load of *each* student enrolled at your college at the end of the drop/add period this semester.

Census

Note: the office of the registrar can obtain records for every student

(2) In 1778 Captain James Cook introduced goats to the Hawaiian Islands. It was later observed that the Silver Sword plant appeared to be less and less common. Botanists suspected the goats to be the cause and conducted a statistical study. They set up stations around the island with similar climate and soil conditions. Each station consisted of two plots of land, one with a fence around it to keep the goats out. Identify the following:

- a. the treatment – the fence.

- b. the experimental group – the fenced in plot(s) of land

- c. the control group – the unfenced plot(s) of land.

(3) Comment on the usefulness of the data collected as described.

- a. A uniformed police officer interviews a group of 20 college freshmen. She asks each one his or her name and then if he or she has used an illegal drug in the last month.

Respondents may not answer truthfully or may refuse to participate

- b. Jessica saw some data that show that cities with more low-income housing have more homeless people. Does building low-income housing cause homelessness?

There may be some other confounding or lurking variables
i.e. size of the city.