

Lecture 3: Chapter 3, Section 3 Designing Studies (Focus on Observational Studies)

- Design; Experiment or Observational Study
- Establishing Causation
- Paired vs. Two-sample Design
- Pitfalls of Observational Studies

Looking Back: Review

- **4 Stages of Statistics**
 - Data Production
 - Obtain unbiased sample (*discussed in Lecture 1*)
 - Design a study that assesses sampled values of single variable or relationship without bias
 - Displaying and Summarizing
 - Probability
 - Statistical Inference

Definitions

- **Observational study:** researchers record variables' values as they naturally occur (can be **retrospective** or **prospective**).
- **Sample survey:** observational study with self-reported values, often opinions
- **Experiment:** researchers manipulate explanatory variable, observe response
- **Anecdotal evidence:** personal accounts by one or a few individuals selected haphazardly or by convenience. (*To be avoided.*)

Definitions

- **Retrospective** observational study: researchers record variables' values **backward in time**, about the past.
- **Prospective** observational study: researchers record variables' values **forward in time** from the present.

Example: Scientific Evidence?

Background: In response to a newspaper report, a mother wrote to the editor:

“I have a problem with the study that stated that breast-fed babies are smarter than bottle fed... My 10-month old son has always been bottle fed and he is very smart. I have been told by his pediatrician that in some aspects he is ahead for his age. I feel that this study contains some inaccuracies. Obviously, the people who conducted this study have never met my son.”

Question: What kind of evidence does she provide?

Response:

Example: Studies Claiming Causation

Background: Consider these headlines...

- When your hair's a real mess, your self-esteem is much less*
- Dental X-rays might result in small babies*
- Family dinners benefit teens*
- Moderate walking helps the mind stay sharper*

Question: How convinced should we be that changes in the first variable actually *cause* changes in the second variable?

Response: It depends on _____
Since various designs are subject to various pitfalls, the first step is identify type of design.

Example: Identifying Study Design

Background: Suppose researchers want to determine if TV makes people snack more.

- While study participants are presumably waiting to be interviewed, half are assigned to a room with a TV on (and snacks), the other half to a room with no TV (and snacks). See if those in the room with TV consume more snacks.*

Question: What type of study design is this?

Response:

Example: Identifying Study Design

Background: Suppose researchers want to determine if TV makes people snack more.

- Poll the class: “How many of you tend to snack more than usual while watching TV?”*

Question: What type of study design is this?

Response:

Example: Identifying Study Design

- **Background:** Suppose researchers want to determine if TV makes people snack more.
 - *Give participants journals to record hour by hour their activities the following day, including TV watched and food consumed. Afterwards, assess if food consumption was higher during TV times.*
- **Question:** What type of study design is this?
- **Response:**

Example: Identifying Study Design

- **Background:** Suppose researchers want to determine if TV makes people snack more.
 - *Ask participants to recall for each hour of the previous day, whether they were watching TV and what food they consumed. Assess if food consumption was higher during TV times.*
- **Question:** What type of study design is this?
- **Response:**

Example: Designing Particular Type of Study

- **Background:** Suppose researchers want to determine if sugar makes children hyperactive.
- **Question:** How can they test this, using each of the following types of design?
 - observational study
 - experiment
- **Response:** Obtain a sample of children, compare proportions hyperactive for low vs. high sugar intake
 - (for an **observational study**) with sugar intake determined by _____
 - (for an **experiment**) with sugar intake determined by _____

Example: Main Pitfall in Observational Studies

- **Background:** Suppose the observational study shows that a greater proportion of children with high sugar intake were found to be hyperactive.
- **Question:** Can we conclude sugar *causes* hyperactivity?
- **Response:** _____
Individuals who opt for certain explanatory values may differ in ways that also affect the response.

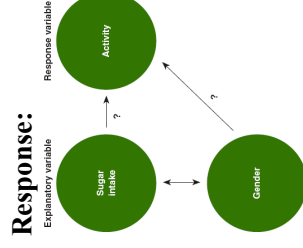
Definition

- **Confounding variable:** one that confuses the issue of causation because its values are tied in with those of “explanatory” variable, and also play a role in “response” variable’s values.

Looking Ahead: Confounding variables are by far the most common weakness of observational studies.

Example: Controlling for Confounding Variables

- **Background:** Gender may be a confounding variable in the relationship between sugar and hyperactivity.
- **Question:** How can researchers take this possible confounding variable into account?
- **Response:**



Example: Multiple confounding variables

- **Background:** Suppose researchers want to determine if sugar makes kids hyperactive.
- **Question:** What are other possible confounding variables besides gender?
- **Response:** There are many other possible confounding variables:

Definitions

- **Two-sample design:** compares responses for two independent groups.
- **Paired design:** a pair of response values is recorded for each unit.

A Closer Look: Paired design is sometimes called “matched pairs”. Typical paired designs include before-and-after studies and comparisons of responses for pairs of individuals like twins, siblings, or married couples.

Example: Two-sample vs. paired study

- Background:** Researchers seek evidence that sugar causes hyperactivity in children. A **two-sample** design would compare proportions hyperactive for 2 groups (low or high sugar).
- Question:** How could evidence be gathered via a **paired** design?
- Response:**

A Closer Look: Either design could be an observational study or an experiment.

Example: Drawback of prospective study

- Background:** Suppose researchers use a **prospective** study to determine if TV makes people snack more.
 - *Give participants journals to record hour by hour their activities the following day, including TV watched and food consumed. Afterwards, assess if food consumption was higher during TV times.*
- Question:** What is the study design's disadvantage?
- Response:**

Example: Drawback of retrospective study

- Background:** Suppose researchers use a **retrospective** study to determine if TV makes people snack more.
 - *Ask participants to recall for each hour of the previous day, whether they were watching TV and what food they consumed. Assess if food consumption was higher during TV times.*
- Question:** What is the disadvantage of this study design?
- Response:**

Example: Vulnerability to Confounding Variables

- Background:** Consider these headlines...
 - *When your hair's a real mess, your self-esteem is much less*
 - *Dental X-rays might result in small babies*
 - *Family dinners benefit teens*
 - *Moderate walking helps the mind stay sharper*
- Question:** To decide if each study is vulnerable to confounding variables, what should be the first step?
- Response:** Determine if it was _____

Example: Considering Confounding Variables

- **Background:** Consider this headline...
 - *When your hair's a real mess, your self-esteem is much less*
- **Questions:** Was the study observational? Are there possible confounding variables?
- **Responses:** We'd suspect it to be _____

Example: More on Confounding Variables

- **Background:** Consider this headline...
 - *Dental X-rays might result in small babies*
 - **Questions:** Was the study observational? Are there possible confounding variables?
 - **Responses:** It had to be _____
- No obvious confounding variables would link dental X-rays and small babies. (_____ if anything, would cause the opposite result.)

Example: More Examples of Confounding

- **Background:** Consider these headlines...
 - *Family dinners benefit teens*
 - *Moderate walking helps the mind stay sharper*
- **Questions:** Were the studies observational? Are there possible confounding variables?
- **Responses:** The first had to be _____

The second was probably _____
There's possible confounding due to _____

Lecture Summary (Designing Studies)

- Types of Study
 - Experiment
 - Observational study (includes sample survey)
 - Anecdotal evidence
- Causation and confounding variables in observational studies
- Paired or two-sample design
- Other pitfalls of observational studies
 - Faulty memory (retrospective design)
 - Less natural behavior (prospective design)