

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.



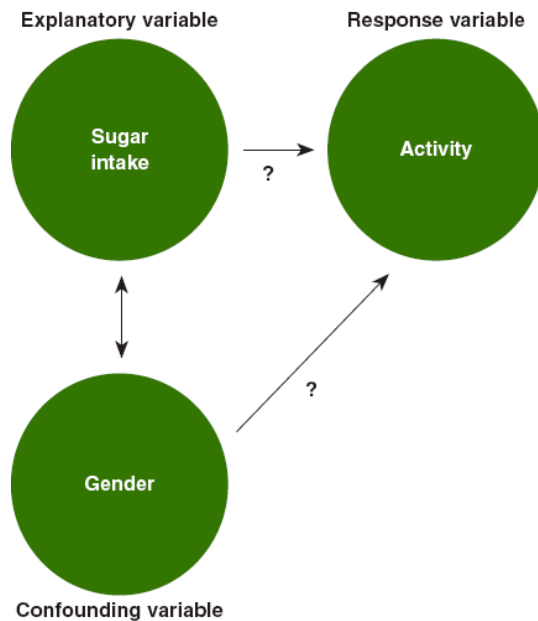
Definition

- **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)