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.*)

- **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 ________

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**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.)

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**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

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**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)