

# Quantitative Study Designs

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## Breakout Session

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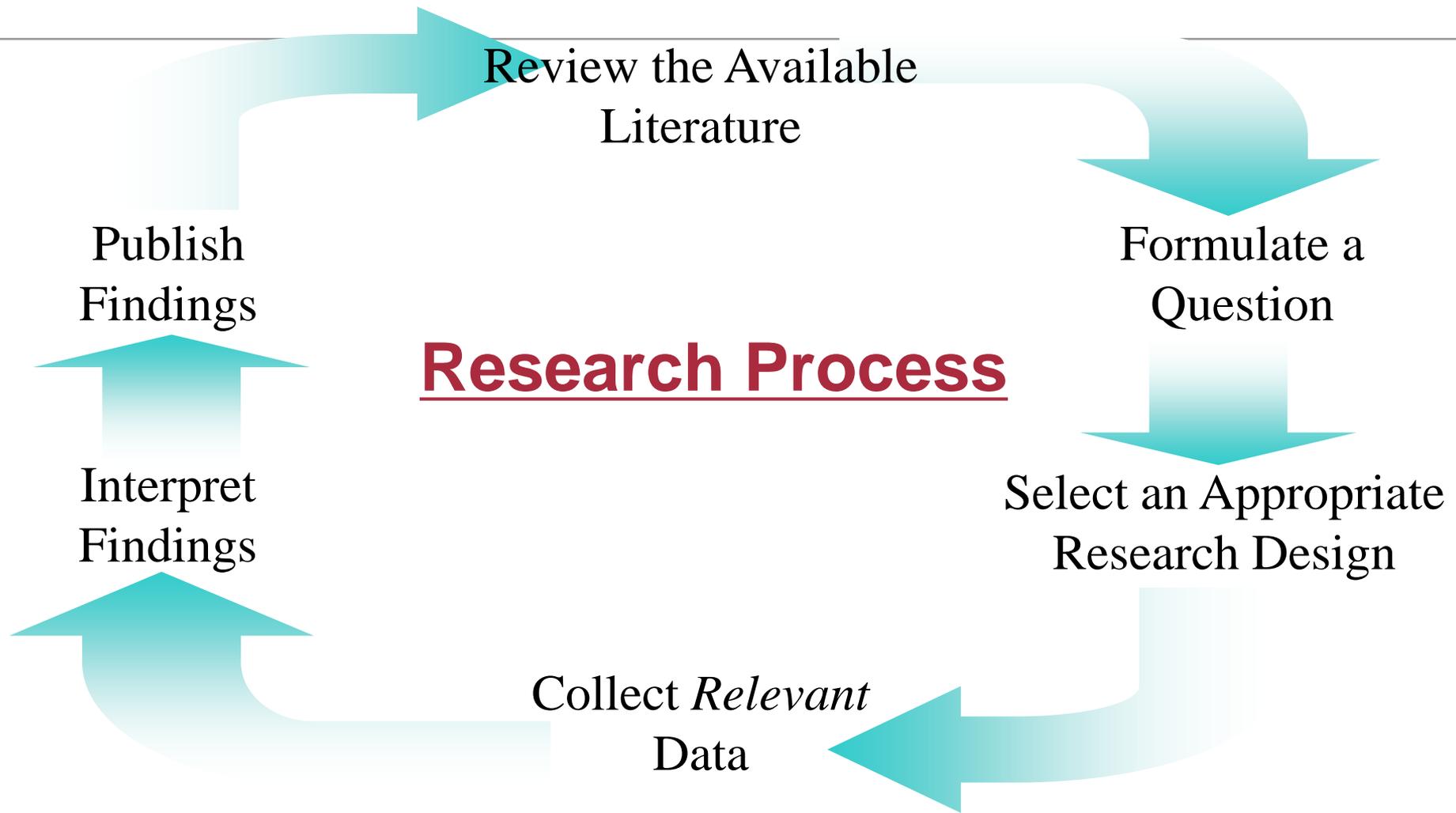
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# Objectives

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- ◆ To understand the purpose of quantitative research
- ◆ To obtain knowledge about common study designs in quantitative research
- ◆ To explore the pros and cons of each study design
- ◆ To discuss the potential uses of quantitative research in your clinical and non-clinical setting



# Introduction to Quantitative Study Designs

- ◆ **What is quantitative research?**
  - Collection and analysis of **numeric information**
  - Based on **empirical evidence**
  - Strives for **generalizability**
  
- ◆ **Why do we use quantitative research?**
  - Describe
    - Prevalence, frequency, characteristics
  - Explore
    - Related factors and antecedents
  - Make predictions
    - If X occurs, will Y follow?
  - Explanation
    - Identify cause, test hypothesis

# Study Variables

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- ◆ **Variable:** Something that changes/fluctuates
- ◆ **Independent:** Does not change based on other variables measured. Can be varied or manipulated by the researcher.
- ◆ **Dependent:** Varies based on the independent variable
- ◆ **Example: We want to compare the frequency of neutropenia following different doses of an experimental medication to treat cancer.**
  - What is our independent variable?
  - What is our dependent variable?

# Types of Quantitative Research Designs

## ◆ Non-Experimental

- Descriptive
  - Describe frequency, incidence, prevalence
- Correlational
  - Examine relationships between variables
  - Does not allow for establishment of causality

## ◆ Experimental

- Quasi-experimental, True-experimental
- Direct assessment of how one variable influence another
- Allows for the establishment of causality

## ◆ Meta-Analysis

- Synthesis of available studies about a topic to arrive at a single summary

# Non-Experimental Designs: Descriptive

## ◆ Descriptive Design

- **Definition:** A study where we describe “what is” or “what was” as it naturally occurs
- **Purpose:**
  - Observe, describe and document aspects of a phenomena
- **Example: Incidence of Drug Use in Teenagers**
  - Survey teenagers between 15-18 years of age regarding drug use to determine percentage of persons using
- **Advantages:**
  - Provides foundational knowledge needed to perform additional research
- **Disadvantages:**
  - Cannot determine causal relationships

# Non-Experimental Designs: Correlational

## ◆ Correlational Design

### • Definition:

- A study that examines whether there are relationships between 2 or more variables

### • Purpose:

- To measure the extent to which variables are connected to one another
- Often used when the effect of a potential cause cannot be manipulated

### • Example: Relationship between tobacco use and lung cancer (Doll & Hill)

- Retrospective case-control study examining the relationship between tobacco smoking and lung cancer
  - Examine controls (those without lung cancer) who are as similar as possible to cases (those with lung cancer) and look for differences in exposure to tobacco
- Prospective cohort study starting with comparable group of smokers and nonsmokers and compare lung cancer incidence

# Non-Experimental Designs: Correlational

- **Advantages:**
  - Allows study of phenomena not amenable to experimentation
  - Can explore many relationships in a short period of time
    - This information is often needed to justify intervention
- **Disadvantages:**
  - Cannot determine causal relationships
  - Selection bias: We cannot assume groups being compared are similar
  - Cannot determine the direction of the relationship
- **Example: Marriage and Cancer Death**
  - Married people with cancer have a 23% higher overall survival rate than the unmarried. Evidence that married people have a better chance of surviving cancer than do singles means that the unmarried might be good targets for cancer-prevention programs.

# Quasi-Experimental Designs

## ◆ Definition

- One in which experimental and control (comparison) are present but randomization is NOT
- Ex. Pre/post testing

## ◆ Purpose

- Provides alternate means for examining causality in situations which are not conducive to experimental control
- The designs should control as many threats to validity as possible in situations where at least one of the three elements of true experimental research is lacking (i.e. manipulation, randomization, control group)

## ◆ Advantages:

- Useful in the social sciences where pre-selection and randomization of groups is often difficult
- Can be used to generate results for general trends
- Reduction of time and resources needed for experimentation as extensive pre-screening and randomization are not undertaken

# Quasi-Experimental Designs

- **Disadvantages:**
  - Without proper randomization, statistical tests can be meaningless (difficult to control for confounding factors)
- ◆ **Example: Prenatal education and maternal alcohol consumption (nonequivalent groups pretest posttest)**
  - We would like to study the effect of a specialized prenatal education program on maternal alcohol consumption
  - We choose 2 prenatal clinics with similar patient populations. Mothers at one clinic receive specialized prenatal education specific to the effect of alcohol consumption on the fetus and mothers at the other clinic receive standard prenatal education
  - Participants are not randomized to a treatment group
  - We ask mothers to report alcohol consumption before and after the intervention and examine differences between the groups

# Experimental Designs

## ◆ Definition

- To be classified as a true experimental design, it must fit all of the following criteria:
- Sample groups must be assigned RANDOMLY
  - Goal of randomization: eliminate selection bias
  - Levels of randomization: patient, unit, hospital
- There must be a viable CONTROL GROUP
- Only ONE variable can be manipulated/tested\*
- The tested subjects must be randomly assigned to either the control or experimental group

## ◆ Purpose

- True experimental design is regarded as the most accurate form of experimental research in that it tries to prove or disprove a hypothesis mathematically, with statistical analysis.

# Experimental Designs

- **Advantages:**
  - The results of a true experimental design can be statistically analyzed and there can be little argument about the results
  - Allows for replication of the experiment and validation of results by other investigators
- **Disadvantages:**
  - While the “gold standard” in principle, the design can be almost too “perfect”. Conditions being under complete control are not representative of real world conditions
  - Difficult and expensive to complete a true experimental designed study
  - Can be impractical

# Experimental Designs

## ◆ Example: Randomized Controlled Trial

- The study done in this example was to determine whether the early use of bed nets had an effect on the morbidity rate of infants in rural Burkina Faso. An experimental group of infants used bed nets at birth, and a control group of infants used bed nets at 6 months of age. Results showed no significant difference in morbidity rates, but use of bed nets from birth was related to lower incidence of both malaria and moderate to severe anemia.

*Muller O, Traore C, Kouyate B, Ye Y, Frey C, Coulibaly B, et al (2006). Effects of insecticide-treated bednets during early infancy in an African area of intense malaria transmission: A randomized controlled trial. Bulletin of the World Health Organization, 84(2), 120-126.*

# Meta analysis

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## ◆ Definition

- Process of drawing from a larger body of research and using powerful statistical analysis on the conglomerated data
- Numerous experimental studies with reported statistical analysis are compared

## ◆ Purpose

- Allows for a analysis of a larger sample population and generation of more meaningful and usable data
- Social studies, psychology, medicine often use small sample sizes, so any statistics used will generally provide results containing large margins of error, proving to be a problem when interpreting and drawing conclusions due to masking of underlying trends and correlations

# Meta analysis

- **Advantages:**
  - Reduces complexity and breadth of research
  - For rare medical conditions, allows researchers to collect data from further afield than would be possible for one investigator
  - Database programs have allowed for continual quality assessments
  - More rigorous than literature reviews
- **Disadvantages:**
  - Publication bias and skewed data
  - Pre-selection of studies that are of sufficient quality must be completed
  - Research generating results not refuting a hypothesis tend to remain unpublished
- ◆ **Example: “FERTILITY AND WOMEN’S EMPLOYMENT”**
  - <http://www.demogr.mpg.de/papers/working/wp-2006-048.pdf>

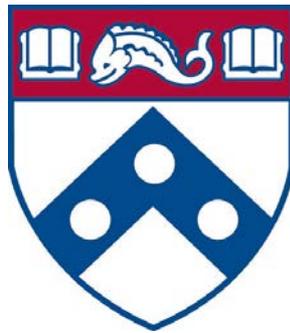
# Key Considerations

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## ◆ Quantitative research in your setting

- The type of approach you choose will be determined by your research question, your epistemological and ontological stances and your ability and knowledge of a specific research approach
- What are your resources (including environment, time, money, support from colleagues, “buy in”)?
- How long will the study take to complete?
- How can you get the information you need?
- Resources
  - BioMed Library, PennDataStore, RedCap, Penn IRB

# QUESTIONS?



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# APPENDIX

# Basic Research Methods

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- ◆ **Quantitative research (i.e. survey)**
- ◆ **Qualitative research (i.e. face-to-face interviews; focus groups; site visits)**
- ◆ **Case studies**
- ◆ **Participatory research**

# Decision to Conduct a Quantitative Study

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- ◆ **When is a Quantitative Study appropriate?**
  - Problem definition is the first step in ANY research study
  - Rather than fitting a technique to a problem, we allow the potential solutions to a problem to determine the BEST methodology to use
  - Problem DRIVES methodology ...most of the time

# Then...why do correlational research?

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- ◆ **Allows for the study of problems that would be difficult to study in the laboratory setting**
- ◆ **Cannot manipulate who is married or not, who has a stressful job or not, gender, race/ethnicity**
- ◆ **Useful for generating hypotheses that can be tested later in a controlled experiment**

# Quantitative versus Qualitative

## Quantitative Research Strategy

- Investigation aims to assess a pre-stated theory (Deductive Reasoning)
- Often involves hypothesis testing
- Attempts to minimise the influence of the researcher on the outcome
- Quantitative data infers statistics
- Data collection therefore requires 'closed' responses

## Qualitative Research Strategy

- Investigation aims to create a novel theory (Inductive Reasoning)
- Researcher becomes an inherent part of the study - *ethnography*
- Qualitative data infers complex statements or opinions
- Data collection therefore permits 'open' responses