Quantitative Research Design

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Key Features of Quantitative Research Design: Interventions

- Key questions:
  - ✓ Will there be an intervention?
  - ✓ What **specific design** will be used?
- Broad design options:
  - ✓ Experimental (randomized control trial)
  - ✓ Quasi-experimental (controlled trial without randomization)
  - ✓ Nonexperimental (observational study)

Key Features of Quantitative Research Design: Comparisons

- Key question:
  - ✓ **What type of comparisons** will be made to illuminate relationships?
- Some design options:
  - ✓ **Within-subjects design**: Same people are compared at different times or under different conditions
  - ✓ **Between-subjects design**: Different people are compared (e.g., men and women)

Other Key Features of Quantitative Research Design

- Control over confounds
  - ✓**How** will confounding variables be controlled?
  - ✓Which **specific** confounding variables will be controlled?

Other Key Features of Quantitative Research Design (cont.)

- Masking/blinding
  - ✓From whom will critical information be withheld to avert bias?
- Time frames
  - ✓**How often** will data be collected?
  - ✓**When**, relative to other events, will data be collected?

Other Key Features of Quantitative Research Design (cont.)

- Relative timing
  - ✓When will information on independent and dependent variables be collected—looking forward or backward in time?
- Location
  - ✓**Where** will the study take place?

Causality

Causality

- Many (if not most) quantitative research questions are about **causes** and **effects**

- Research questions that seek to illuminate causal relationships need to be addressed with appropriate designs.

Examples

- Does a telephone therapy intervention for patients with prostate cancer cause improvements in their psychological distress and coping skills? (intervention question)
- Do birthweights under 1,500 g *cause* developmental delays in children? (prognosis question)
- Does cigarette smoking *cause* lung cancer? (etiology/harm question)

The Counterfactual Model of Causality

- A **counterfactual** is what would have happened to the same people exposed to a "cause" if they simultaneously were **not** exposed to the cause.

- An **effect** represents the difference between what actually did happen when exposed to the cause and what would happen with the counterfactual condition

- "If *A* had not occurred, *C* would not have occurred".

Probability

- Address relative rather than absolute causality

- For example, smoking is a cause of lung cancer, but not everyone who smokes develops lung cancer, and not everyone with lung cancer was a smoker

Criteria for Causality

- Three key criteria for making causal inferences:
  - ✓The cause **must precede the effect** in time.
  - ✓There **must be a demonstrated association** between the cause and the effect.
  - ✓The relationship between the presumed cause and effect **cannot be explained by a third variable or confounder**; another factor related to both the presumed cause and effect cannot be the "real" cause.

Additional Criteria for Causality

- Additional criterion in health research:
  - ✓ **Biologic plausibility**: The causal relationship should be consistent with evidence from basic physiologic studies.

Research Questions & Research Design

- Different designs are appropriate for different questions
- Experimental designs offer the strongest evidence of whether a cause (an intervention) results in an effect (a desired outcome)
  - ✓That's why they are high on evidence hierarchies for questions about causes and effects

Experimental Design

Experimental Design

- **Intervention (Manipulation)**: The researcher does something to some subjects, introduces an **intervention** (or **treatment**)
- **Control**: The researcher introduces controls, including the use of a control group counterfactual
- ***Randomization***

Example

- Investigating the effect of physical exertion on mood in healthy young adults
- One experimental design for this research problem is a **pretest–posttest design (or before–after design).**

Characteristics of a True Experiment

- **Randomization** (also called **random assignment**): The researcher assigns subjects to groups **at random**.
  - ✓Typical assignment is to an **experimental group** or a **control group**.
  - ✓The purpose is to make the groups equal with regard to **all other factors** except receipt of the intervention.

Randomized Two-Group Design

- 2 levels
- Sample from population: RA into 2 groups: hold extraneous variables constant

R	X1	O
R	X2	O

R = random assignment

X = intervention

O = Observation

Experimental Designs

- **Posttest-only (or after-only) design**
  - ✓Outcome data collected only after the intervention
  - ✓Symbolic representation:

R X O

R O

  - R = Randomization;
  - X = Receipt of intervention;
  - O = Observation/measurement of dependent variable

Experimental Designs (cont.)

- **Pretest–posttest (before–after) design**
  - ✓ Outcome data collected both at **baseline** and after the intervention
  - ✓ Symbolic representation:

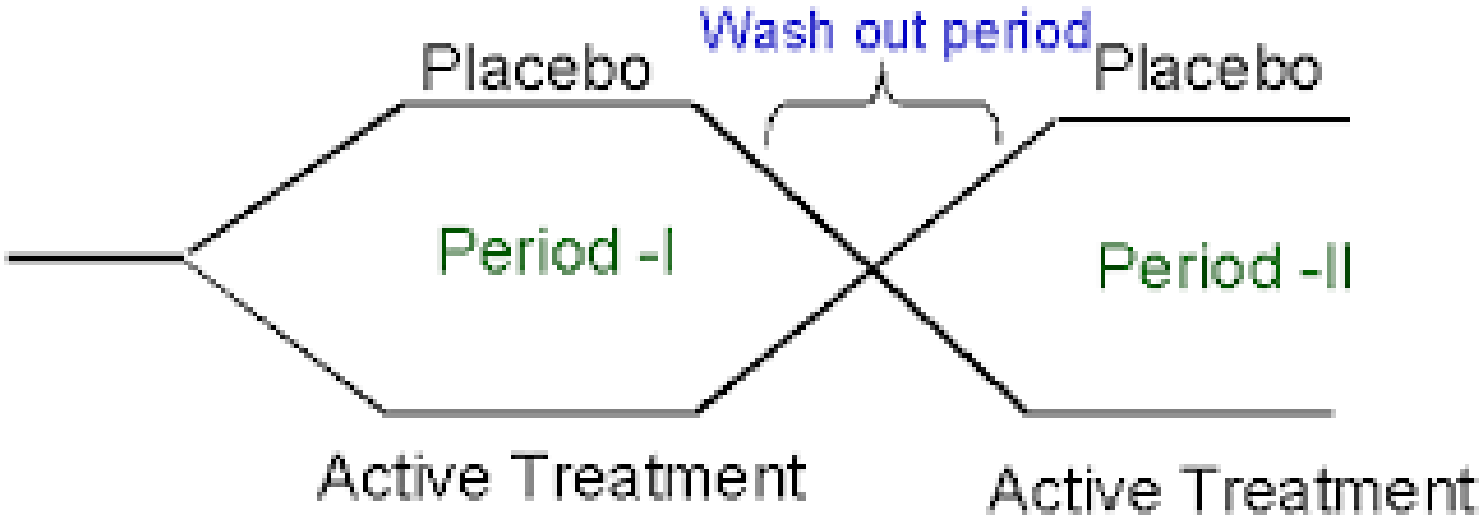
    R O1 X1 O2

    R O3 X2 O4
  - ✓ Adding a pretest adds another level of control but also additional threats of which to be careful (e.g., testing)

Experimental Designs (cont.)

- **Crossover design**
  - ✓Subjects are exposed to 2+ conditions in random order
  - ✓Subjects serve as their own control.
  - ✓Symbolic representation:

R	O1	X_A	O2	X_B	O3
R	O4	X_B	O5	X_A	O6



Crossover design

Experimental Condition

- Must be designed with sufficient intensity and duration that effects might reasonably be expected

Attention must be paid to **intervention fidelity** (or treatment fidelity), that is, whether the treatment as planned was actually delivered and received

Control Group Conditions (Counterfactuals)

- **No intervention** is used; control group gets no treatment at all
- **"Usual care":** standard or normal procedures used to treat patients
- An **alternative intervention** is used (e.g., auditory vs. visual stimulation)
- A **placebo** or pseudointervention, presumed to have no therapeutic value, is used
- **A lower dose or intensity of treatment or only portions** of it are administered

Control Group Conditions (cont.)

- **Attention control**: extra attention, but not the active ingredient of the intervention
- **Delayed treatment ("wait-listed controls")**—the intervention is given at a later date.
  - ✓Symbolic representation:

R	O	X	O		O
R	O		O	X	O

Advantages and Disadvantages of Experiments

- **Advantages**: most powerful for detecting cause and effect relationships

✓ **Generalizable!**

- **Disadvantages**: often not feasible or ethical, Hawthorne effect (knowledge of being in a study may cause people to change their behavior.), often expensive

Quasi-Experimental design

Quasi-Experiments

- Involve an intervention but lack either randomization or control group
- Two main categories of quasi-experimental designs:
  - ✓**Nonequivalent control group designs**
    - Those getting the intervention are compared with a nonrandomized comparison group
  - ✓**Within-subjects designs**
    - One group is studied before and after the intervention.

Quasi-Experiments

- The hallmark of strong quasi-experiments is the effort to introduce some controls, such as **baseline measurements**

Nonequivalent Control Group Designs

- If preintervention data are gathered, then the comparability of the experimental and comparison groups at the start of the study can be examined
  - ✓ **Nonequivalent control group pretest–posttest design**
  - ✓ Symbolic representation:

$$O_1 \quad X \quad O_2$$
$$O_1 \qquad\quad O_2$$

Nonequivalent Control Group Designs (cont.)

- Without preintervention data, it is risky to assume the groups were similar at the outset
  - ✓ **Nonequivalent control group posttest only** is **much** weaker.
  - ✓ Symbolic representation:

$$X \quad O_1$$
$$\quad\quad O_1$$

Example of a nonequivalent control group design

- Jones and colleagues (2007) used a nonequivalent control group before–after design to test the effectiveness of the Deaf Health Heart Intervention in increasing self-efficacy for heart health behaviors in deaf adults
- Participants in Tucson, who received the intervention, were compared with similar adults from Phoenix who did not receive it.

Within-Subjects Quasi-Experiments

- **One-group pretest–posttest designs** typically yield extremely weak evidence of causal relationships.

✓Symbolic representation:

O_1 X O_2

Within-Subjects Quasi-Experiments

- **Time series designs** gather pre-intervention and post-intervention data over a longer period.
- It's comprised of one group because of unavailability of a control group
  - ✓Symbolic representation:

    $O_1\ O_2\ O_3\ O_4\ X\ O_5\ O_6\ O_7\ O_8$

Example Time series

- ✓ For example, the director of the “Institute of Child Health and Development” wanted to improve the situation of the employee by applying continuing education programs
- ✓ The dependent variables are employee turnover, number of sick leaves, and absentee rate
- ✓ No other institute have similar characteristics, so no control group is available.

Example Time series

- The researcher in this case collects data related to the dependent variables for about six months continuously
- then apply the educational programs which take another six months
- then data related to the independent variables will be collected again.
- If the rate of turn over & number of sick leaves and absentee rate were reduced then the continuing programs are good solution for improving the situation of the employee

Example Time series

Infection rates for surgery(X) are collected for 3 months

- and then a new cleaning procedure (T) is introduced.
- Infection rates are collected for 3 months thereafter to see if there are any differences over time

Advantages & Disadvantages of Quasi-Experiments

- May be easier and more practical than true experiments, **but**
  - ✓They make it more difficult to infer causality
  - ✓Usually there are several alternative **rival hypotheses** for results

Non-experimental design

Nonexperimental Studies

- If researchers do not intervene by controlling independent variable, the study is nonexperimental (observational)
- Not all independent variables ("causes") of interest to nurse researchers can be experimentally manipulated.
  - ✓ For example, gender cannot ever be manipulated.
  - ✓ Smoking cannot **ethically** be manipulated
  - ✓ Do birthweights under 1,500 grams cause developmental delays in children?

Types of Nonexperimental Studies

Correlational designs:

- Explanatory research
- Process of identifying specific constructs / variables that will be measured and compared to another construct or variable
- An examination of the relationship between variables leading to uni / bi / multivariate analysis
- This relationship is then examined as a strong or weak relationship
- A **correlation** is an association between variables and can be detected through statistical analysis
- (e.g., people's height and weight).

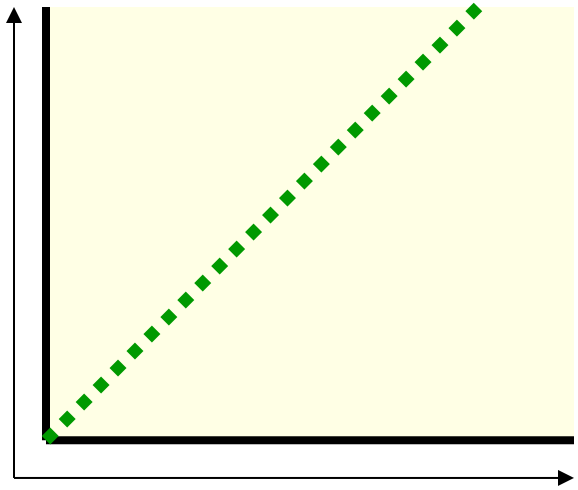
Correlational designs

- The researcher is not testing whether one variable causes another variable but whether the variables related; that is, as one variable change, does a related change occur in the other variable?
- The researcher is interested in **quantifying the magnitude or strength** of the relationship between the variables.
- The positive or negative **direction** of the relationship is also a central concern of the researcher for a complete explanation of the correlation coefficient
- **Correlation does not prove causation**

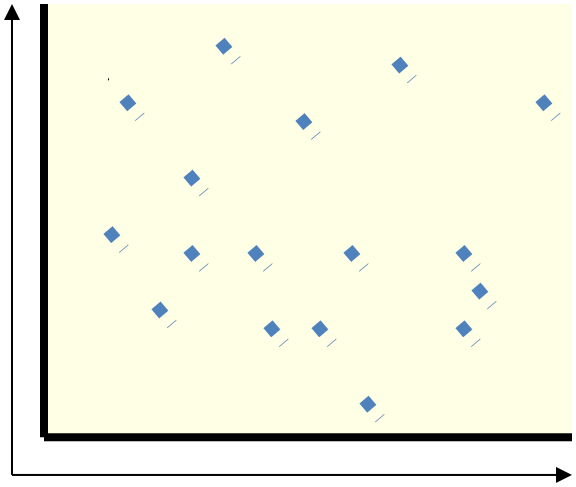
Correlational Research

- Interpretation:
  - ✓Positive
  - ✓Negative
  - ✓No relationship vs nonlinear relationship
  - ✓Scatterplot

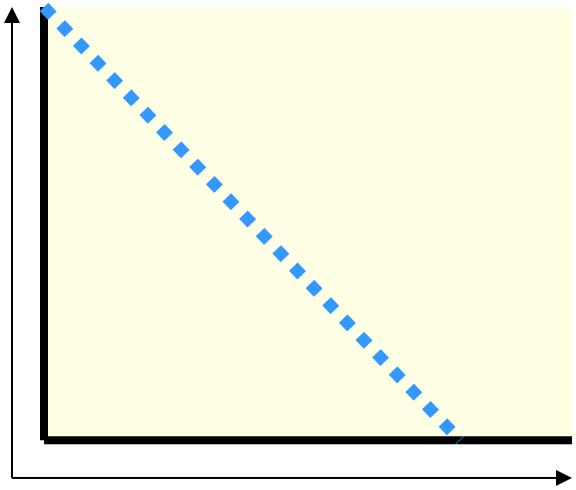
Example of Relationship: Predicting Behavior



Perfect positive correlation (+1.00)



No relationship (0.00)



Perfect negative correlation (-1.00)

Types of Nonexperimental Studies (cont.)

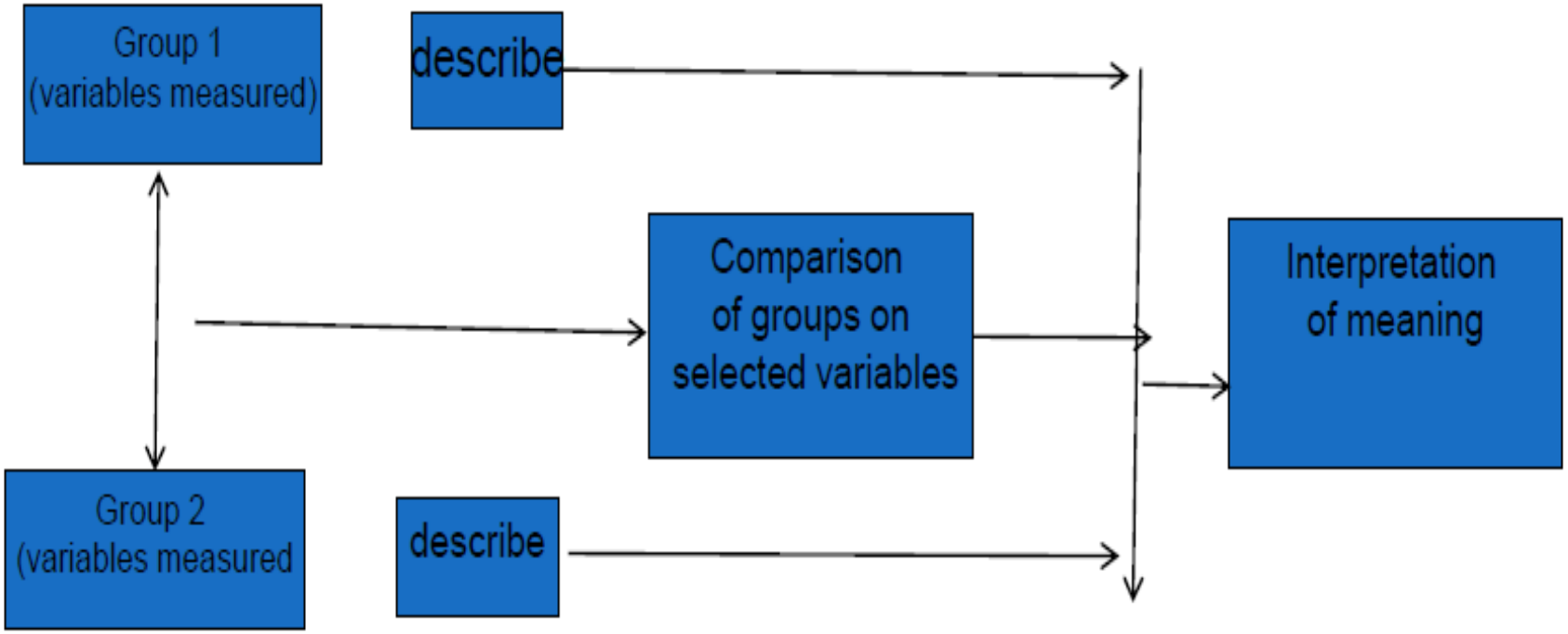
- In a **prospective** correlational design, a potential cause in the present (e.g., experiencing vs. not experiencing a miscarriage) is linked to a hypothesized later outcome (e.g., depression 6 months later).
- This is called a **cohort study** by medical researchers
- Prospective designs are stronger than retrospective designs in supporting causal inferences, but neither is as strong as experimental designs

Retrospective Designs

- In a **retrospective** correlational design, an outcome in the present (e.g., depression) is linked to a hypothesized cause occurring in the past (e.g., having had a miscarriage).
- One retrospective design is a **case–control design** in which "cases" (e.g., those with lung cancer) are compared to "controls" (e.g., those without lung cancer) on prior potential causes (e.g., smoking habits).

Descriptive Research

- Not all research is cause probing
- Some research is **descriptive** (e.g., ascertaining the prevalence of a health problem)
- Studies that summarizes the status of phenomena
- Other research is **descriptive correlational**: the purpose is to describe whether variables are related, without ascribing a cause-and-effect connection
- A comparative descriptive design compares descriptive data obtained from each group and compares it in quantitative and outcomes studies.


Group 1
(variables measured)
describe
Comparison
of groups on
selected variables
Interpretation
of meaning
Group 2
(variables measured
describe

Advantages & Disadvantages of Nonexperimental Research

- Does not yield persuasive evidence for causal inferences, but efficient way to collect large amounts of data when intervention and/or randomization is not possible

Time Dimension in Research Design

Time Dimension in Research Design

- **Cross-sectional design**: Data are collected at a single point in time
- Observes cohorts of people at different ages for particular variable
- Advantages:

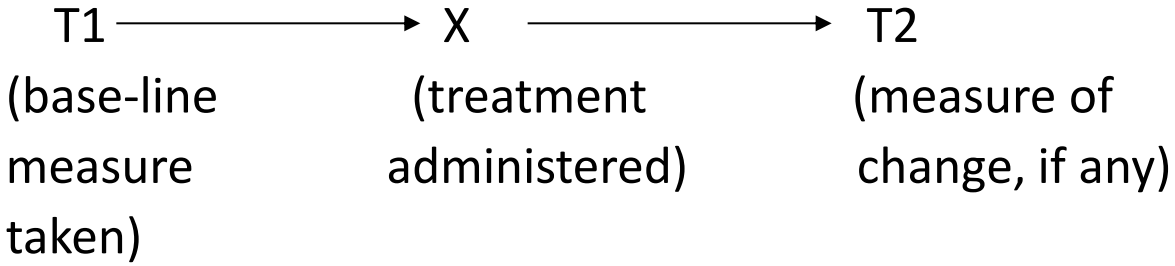
✓ more efficient use of resources

- Disadvantages:
  - ✓ Unequal groups

Time Dimension in Research Design (cont.)

- **Longitudinal design:** Data are collected two or more times over an extended period
- Longitudinal designs are better at showing patterns of change occurring over time and at clarifying whether a cause occurred before an effect (outcome)
- A challenge in longitudinal studies is **attrition** تناقص or the loss of participants over time

Longitudinal design



Follow-up studies: A study undertaken to determine the outcomes of individuals with a specified condition or who have received a specified treatment.

Example of a follow-up study

- Lauver and colleagues (2007) did a follow-up study of cancer survivors at 4 weeks and after radiation or chemotherapy treatment to examine patterns of stress and coping.

Control

Controlling the Study Context

- Controlling external factors
  - ✓Achieving **constancy of conditions**
  - ✓Control over environment, setting, time
  - ✓Control over intervention via a formal protocol: **intervention fidelity**

Controlling Participant Factors

- Randomization
  - ✓ Subjects as own controls (crossover design)
- Homogeneity (restricting sample i.e. females only)
- Matching
- Statistical control (e.g., **analysis of covariance**)

Randomization

- a table of random numbers to randomize
- https://www.randomizer.org/

Homogeneity

- In which only subjects who are homogeneous with respect to confounding variables are included in the study
- If gender were a confounding variable, we might recruit only men (or women) as participants
- One problem is **limited generalizability**

Example of control through homogeneity

- Ngai and colleagues (2010) studied factors that predicted maternal role competence and satisfaction among mothers in Hong Kong.
- Several variables were controlled through homogeneity, including ethnicity (all were Chinese), parity (all primiparous),and marital status (all were married).

Matching

- Using information about subject characteristics to form comparable groups
- Case-control designs
- Drawbacks

Example of control through matching

- Talashek and colleagues (2006) compared inner-city teenagers who were pregnant or never-pregnant to examine factors that might predict pregnancy status.
- Although homogeneity controlled participants' area of residence (living in an inner city), matching was used to control the teenagers' age & ethnicity.

Statistical control

- Analysis of covariance controls by statistically removing the effect of confounding variables on the outcome
- Confounding variables that need to be controlled—variables that correlate with the outcomes—should be identified through a literature review

End of Presentation