An Introduction to Quantitative Research Design for Students in Health Sciences

An Introduction to Quantitative Research Design for Students in Health Sciences

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Contents

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Introduction

An Introduction to Quantitative Research Design for Students in Health Sciences was developed to promote evidence-informed practice for healthcare professionals and students. The chapters of this book focus on Research Design. We believe that understanding Research Design can enhance confidence in reading research, and subsequently, help students become better consumers of research.
By the end of this module, learners will be able to:

- Identify the purpose of the Research Design
- Distinguish between the three main Research Designs – experimental, quasi-experimental, and non-experimental
- Determine which design to use
- Apply level of evidence based on the Research Design

1. Overview of Research Designs

Purpose of the Research Design

The Research Design provides a plan to help answer the research questions and test **hypotheses**.

- A well structured plan helps the researchers demonstrate the **independent variable** effect on the **dependent variable**, rather than another factor.

Important Aspects and Considerations of Research Designs

There are many factors to consider when determining the more appropriate research design, these include, but are not limited to, the degree of accuracy the design will address the research question, the strategies used to control and limit bias in the design, the degree of objectivity offered by the design, and feasibility of the study being successfully undertaken.

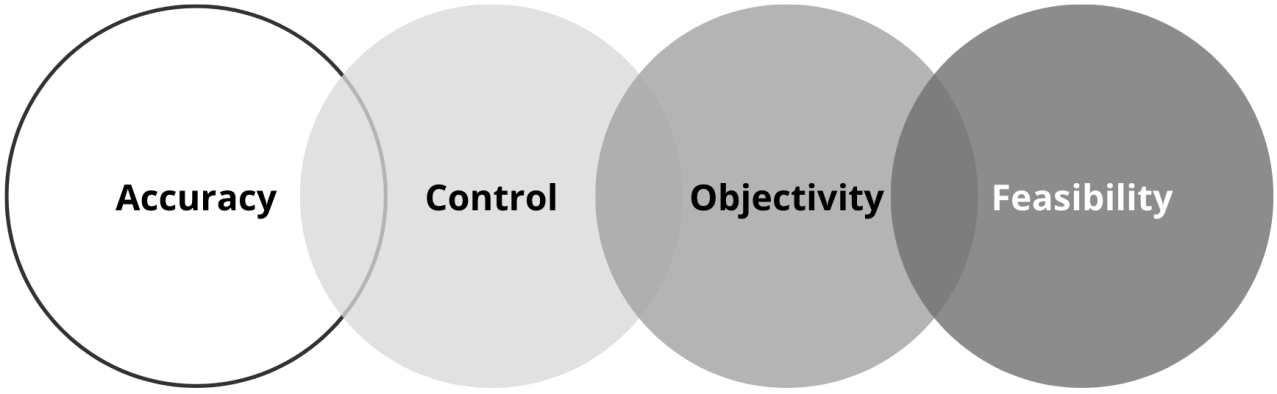


Figure 1. Factors influencing the Research Design.

Selecting a design

In selecting a Research Design, the researcher must consider the factors previously described. To help select a design, researchers can ask the following questions.

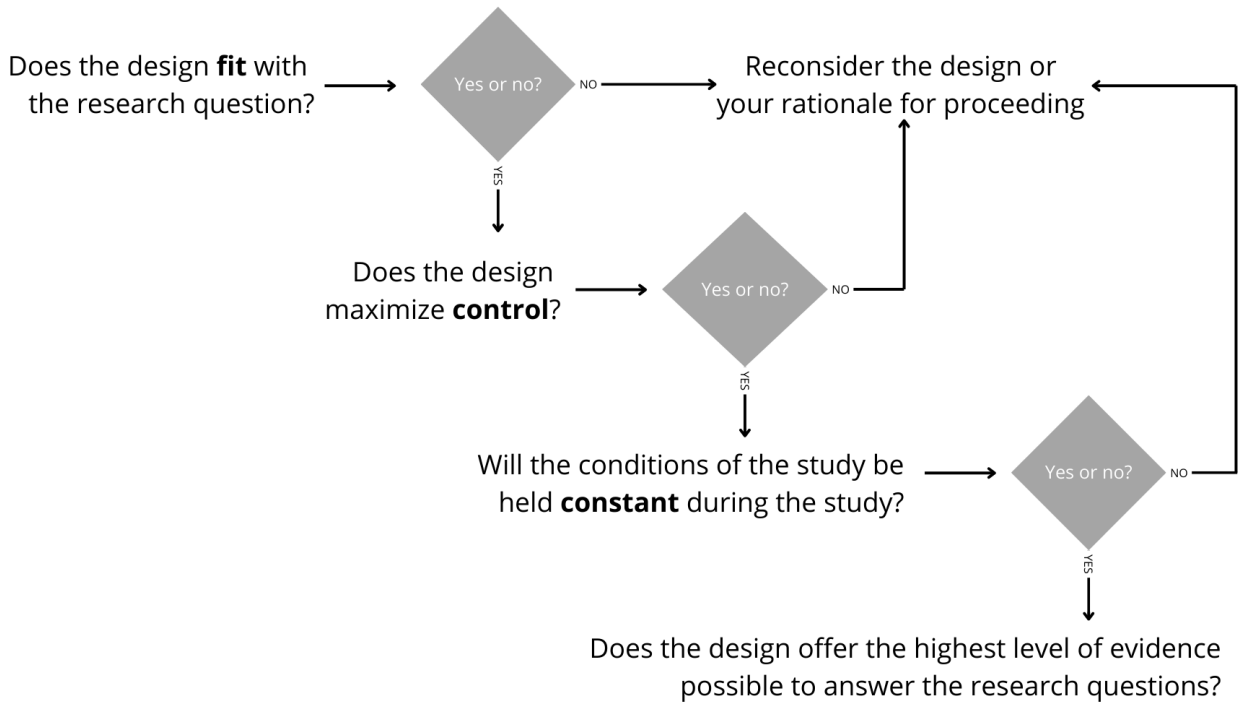


Figure 2. Important Aspects and Considerations of Research Design.

2. Types of Quantitative Research Designs

There are three main groups of Research Designs that will be explored in this chapter.

1. Experimental
2. Quasi-experimental
3. Non-experimental

When reviewing each design, the purpose and key features of the design, advantages and disadvantages, and the most commonly used designs within the category will be reviewed.

1. Experimental Design

Purpose: Evaluate outcomes in terms of efficacy and/or cost effectiveness

Experimental design features include:

- **Randomization** of subjects to groups
- Manipulation of independent variable (e.g., an intervention or treatment)
- Control – the use of a control group and control measures (for controlling **extraneous variables**)

Advantages:

- Most appropriate for testing cause-and-effect relationships (e.g., generalizability is most likely)
- Provides the highest level of evidence (e.g., level II) for single studies

Disadvantages:

- **Attrition** especially control group participants or with 'before-after' experimental designs
- Feasibility and logistics may be an issue is certain settings (e.g., long-term care homes)

Caution: Not all research questions are amenable to experimental manipulation or randomization

Most Commonly Used Experimental Designs

- **True experimental (pre-post-test) design (also referred to as Randomized Control Trials or RCTs):**

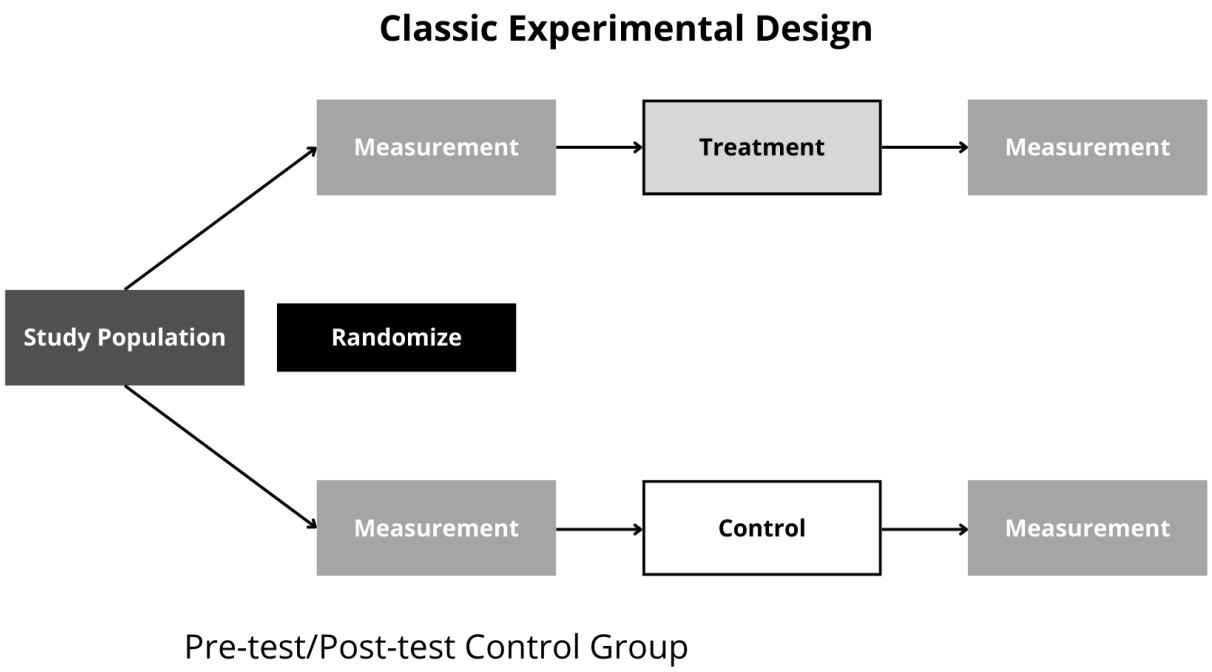


Figure 3. *True experimental design (pre-post-test).*

- **After-only (post-test only) design:**

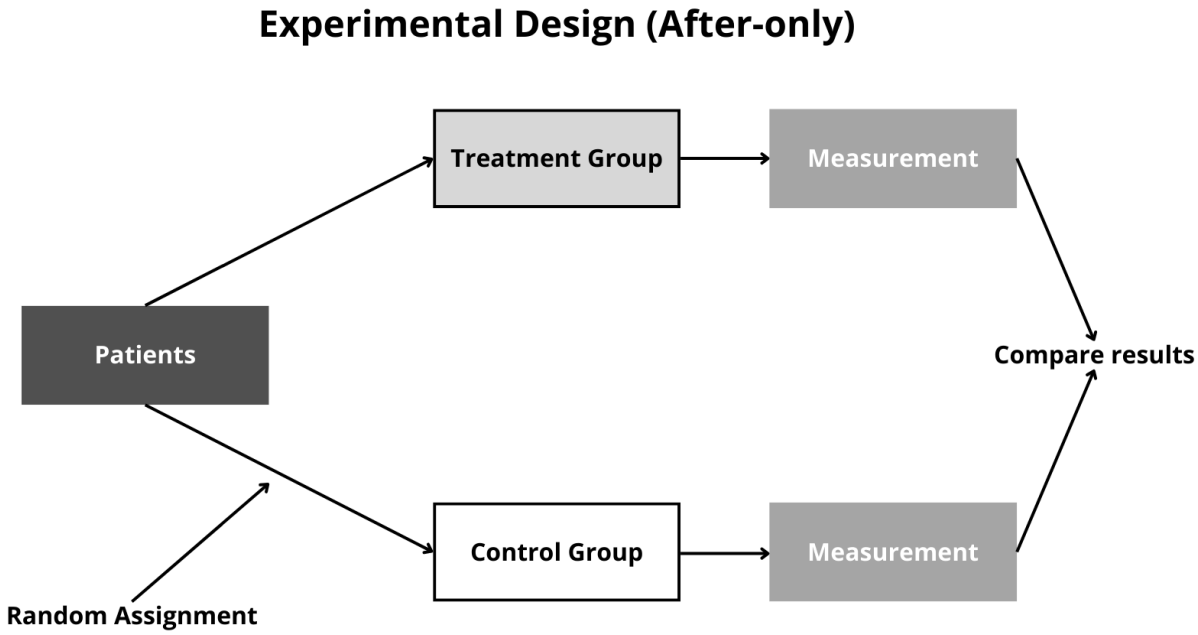


Figure 4. *After-only (post-test only) design.*

- **Solomon four-group design**

This design is similar to the true experimental design but has an additional two groups, for a total of four groups.

Two groups are experimental, while two groups are control. These “extra” groups do not receive the pre-test, allowing the researchers to evaluate the effect of the pretest on the post-test in the first two groups.

2. Quasi-Experimental Design

Purpose: Similar to experimental design, but used when not all the features of an experimental design can be met:

- Manipulation of the independent variable (e.g., an intervention or treatment)
- Experimental and control groups may not be randomly assigned (no randomization)
- There may or may not be a control group

Advantages:

- Feasibility and logistics are enhanced, particularly in clinical settings
- Offers some degree of generalizability (e.g., applicable to population of interest)
- May be more adaptable in real-world practice environments

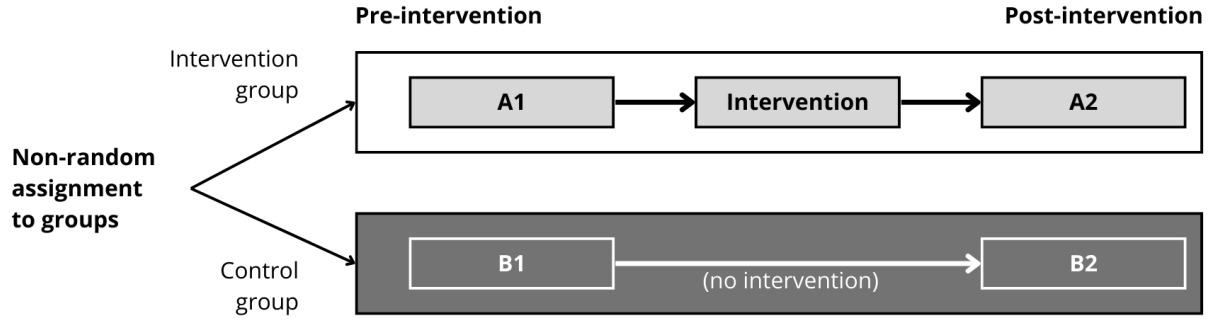
Disadvantages:

- Generally weaker than experimental designs because groups may not be equal with respect to **extraneous variable** due to the lack of randomization
- As a result, cause-and-effect relationships are difficult to claim

Options for Quasi-experimental Designs include :

- **Non-equivalent control group design**

Classical Quasi-Experimental Design



A1, B1 = Pre-intervention data collection points
A2, B2 = Post-intervention data collection points

Figure 5. *Classical Quasi-Experimental Design. Adapted from Knowledge for Health*

- **After-only control group design**

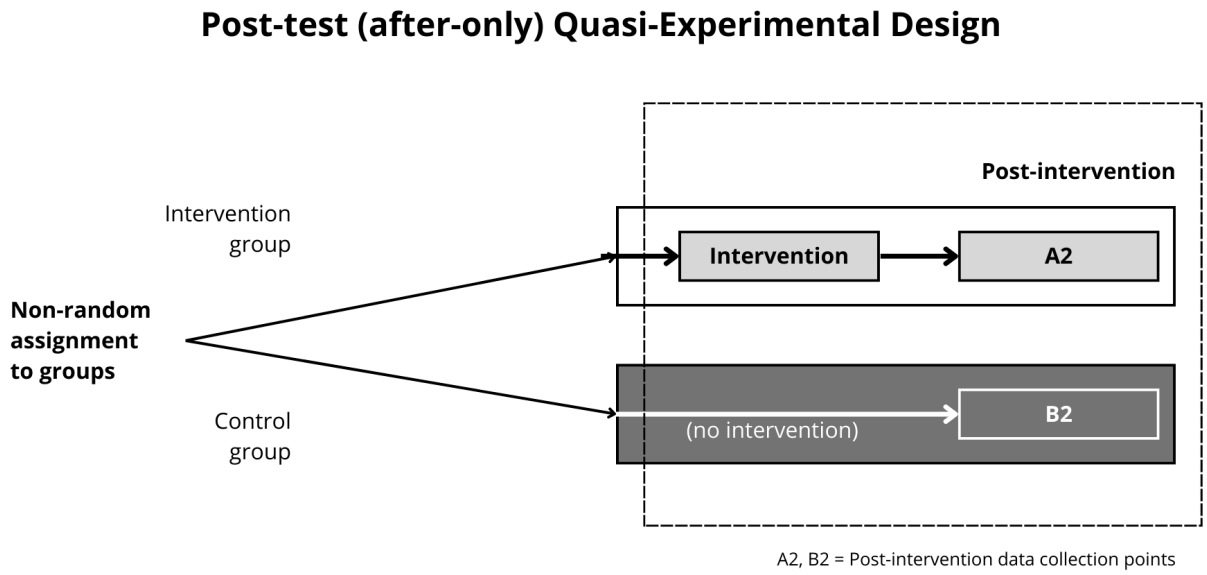


Figure 6. *Post-Test Only Quasi-Experimental Design. Adapted from Knowledge for Health.*

- **Time-series design**
  Important note: The time series design is considered quasi-experimental because subjects serve as their 'own controls' (same group of people, compared before and after the intervention for changes over time).

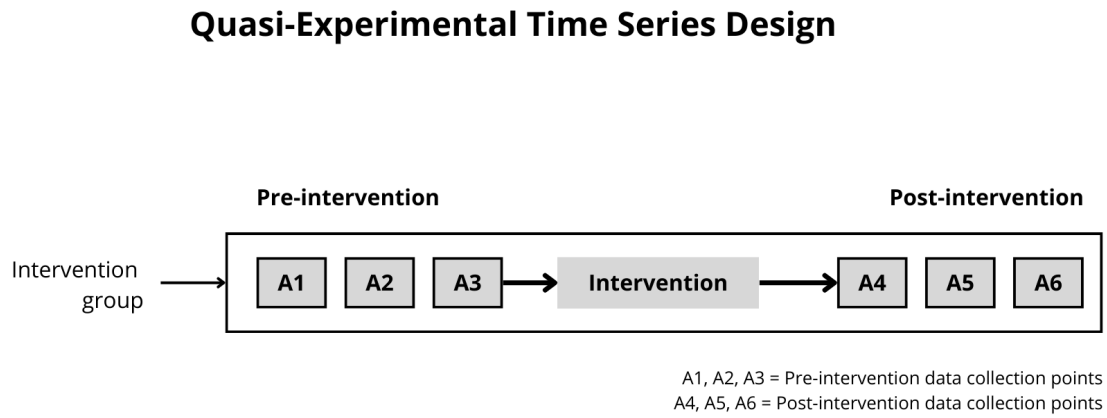


Figure 7. *Time-series design. Adapted from Knowledge for Health*

- **One group pre-test-post-design design**
  In this design there is no control group. The one group, considered the experimental group, is tested pre

and post the intervention. The design is still considered quasi-experimental as there is manipulation of the intervention.

3. Non-experimental

Purpose: When the problem to be solved or examined is not amenable to experimentation; used when the researcher wants to:

- Study a phenomenon at one point in time or over a period of time
- Study (and measure) variables as they naturally occur
- Test relationships and differences among variables

Advantages:

- Used when the knowledge base on a phenomenon of interest is limited or when the research question is broad or exploratory in nature
- Appropriate for forecasting or making predictions
- Useful when the features of an experiment (e.g., randomization, control, and manipulation) are not appropriate or possible (e.g., ethical issues)

Disadvantages:

- Inability to claim cause-and-effect relationships

Options for Non-experimental Designs include:

- Survey studies: descriptive, exploratory, comparative
- Relationship or difference studies: Correlational, developmental
- Cross-sectional studies
- Longitudinal or Prospective studies

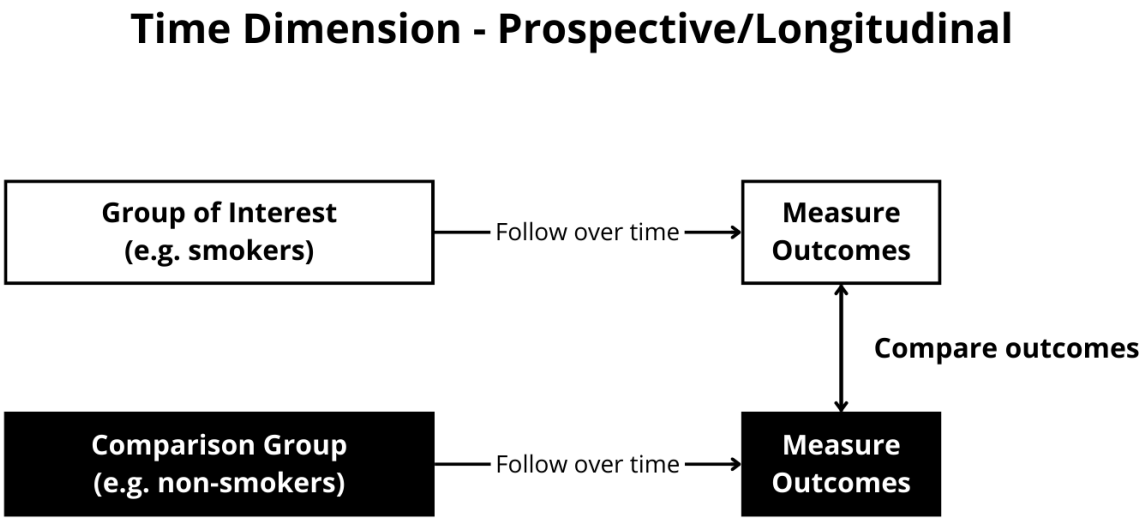


Figure 8. *Longitudinal or Prospective studies.*
Adapted from University of Minnesota, Driven for Discover Libraries.

- Retrospective (Ex Post Facto) studies

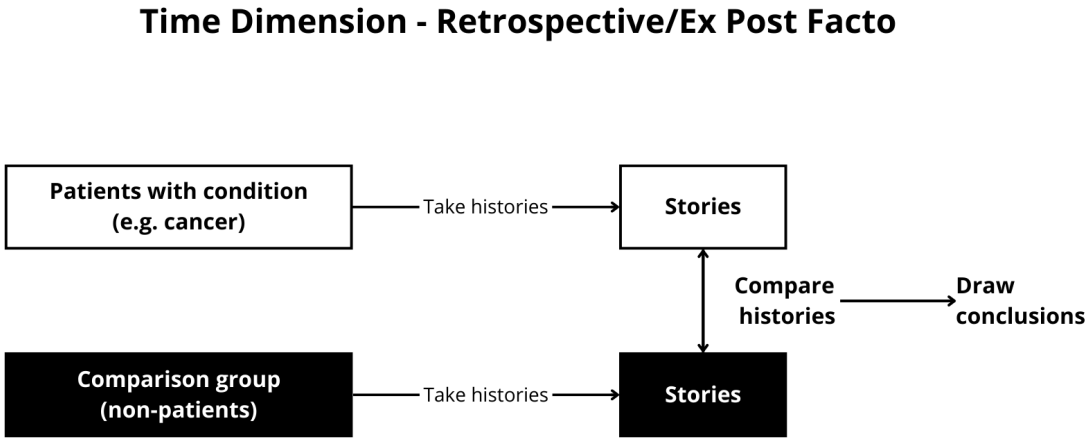


Figure 9. *Retrospective (Ex Post Facto) studies.*
Adapted from University of Minnesota, Driven for Discover Libraries.

Additional terms to consider when reading research

Learners may find it difficult when reading research to identify the Research Design used. Please consult the table below for more information on terms frequently used in research.

Table 1. Frequently Used Terms in Quantitative Research

Terms in Design	Definitions
Descriptive	To accurately portray characteristics of persons, situations, groups and/or frequency of phenomena
Exploratory	To explore dimensions of a phenomenon or develop/redefine hypotheses about relationships between phenomena.
Comparative	Seeks to find relationships between independent and dependent variables after an action or event has already occurred
Correlational	Explores the interrelationship among variables of interest without any active intervention by the researcher
Ex post facto	Research conducted after variations in the independent variable have occurred naturally or “after the fact”
Retrospective	Begins with examination of the dependent variable in the present, then searches for presumed cause occurring in the past
Prospective	Begins with examination of presumed causes, then goes forward in time to observe presumed effects
Cross-sectional	Data collected at one point in time, immediate present
Longitudinal	Data collected, from the same group, at more than one point in time

Source: *Polit & Beck (2021); Singh & Thirsk (2022)*

3. Selecting the most appropriate Research Design

The Research Design is selected to answer the research question. The following flowcharts are useful when trying to decide which design to use in relation to the researcher's question they are trying to answer:

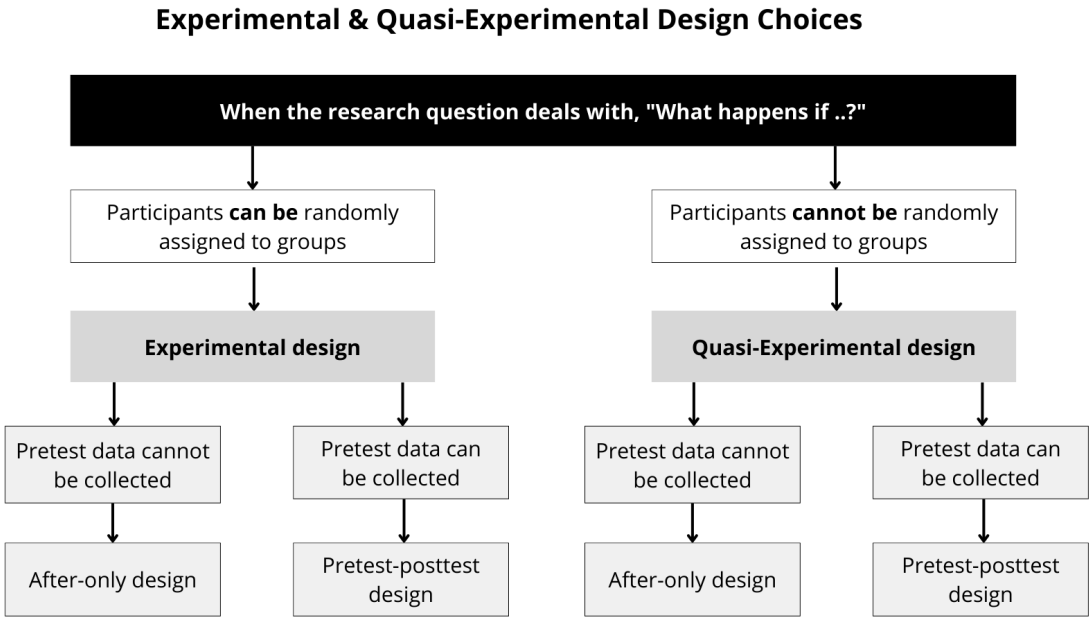


Figure 10. *Experimental & Quasi-Experimental Design Choices.*
From Singh et al. (2022), Elsevier Canada, a division of Reed Elsevier Canada Ltd.

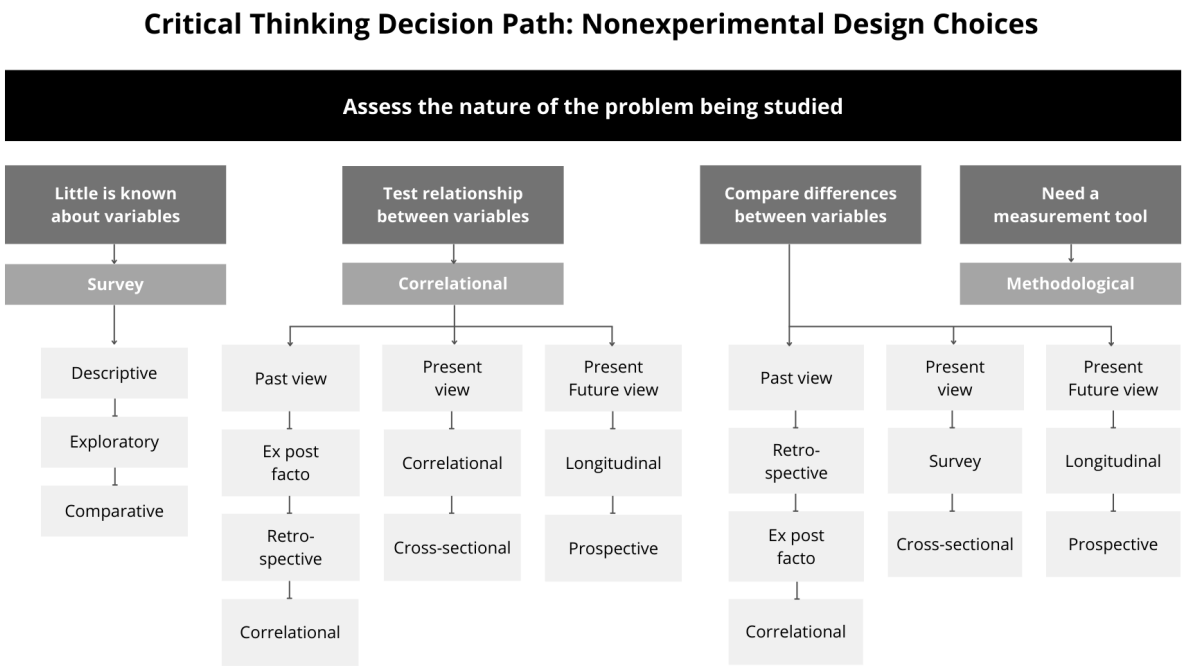


Figure 11. *Critical Thinking Decision Path: Non-experimental Design Choices. From Singh et al. (2022), Elsevier Canada, a division of Reed Elsevier Canada Ltd.*

The matrix below provides an overview of Research Design and key features of designs, and may be useful when critically appraising the choice of design.

Table 2. Key Features of Research Designs

Design Feature	Experimental	Quasi-Experimental	Non-Experimental
Randomization	Yes	No	No
Control Group	Yes	Maybe	No
Manipulation of the Independent Variable	Yes	Yes	No
Desired Results	Cause and Effect	Cause and Effect	Descriptive, Exploratory, Correlational, Comparative

4. Levels of Evidence

While researchers need to consider the most appropriate design to use to answer their research question, they also need to assess the strengths and weaknesses of their chosen design for the purposes of testing hypotheses. One helpful tool is the levels of evidence ranking the types of studies from level I (providing the strongest evidence) to 7 (weakest evidence).

Level I	Systematic review or meta-analysis of randomized controlled trials (RCTs) Evidence-informed clinical practice guidelines based on systematic reviews
Level II	A well-designed RCT
Level III	Controlled trial without randomization (quasiexperimental study)
Level IV	Single nonexperimental study (case-control, correlational, cohort studies)
Level V	Systematic reviews of descriptive and qualitative studies
Level VI	Single descriptive or qualitative study
Level VII	Opinion of authorities and/or reports of expert committees

Figure 12.*Levels of Evidence*

Another type of level of evidence pyramid is useful when searching for evidence. The video entitled *6S Pyramid* provides a tool that helps you find evidence quickly and efficiently (National Collaborating Centre for Methods and Tools, n.d.), helps researchers conduct a search to answer practice-based questions.

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As demonstrated in the image and in the video, the type of Research Design used in a study is linked to the level of evidence, and in turn, the contribution of a study's findings is linked to evidence-informed practice!

Knowledge Check

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://ecampusontario.pressbooks.pub/quantativeresearchdesigninhealthsciences/?p=72#h5p-1

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