Lecture 5 · July 1, 2024

Research Methodology

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YSEMA
Introduction to Research **Methodology**

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Recap – Mid-Course

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Objectives

- Define research methodology
- List the elements of methodology
- Draw the schematic for selected research designs
- List, define, and discuss the type of analysis for each research design
- List and discuss the types of studies
- Define, identify, and discuss the terms bias, error, reliability, validity, threats to validity, and types of data.

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Methodology

- Should be driven by research objectives
- Two mistakes may distract novice investigators when choosing a methodology:
  - Selecting a familiar methodology without first defining the research objectives
  - Planning to use already available data
- Describes how the research study was conducted. Includes descriptions of:
  - Subjects
  - Instrumentation used
  - Procedures performed
  - Analytic procedures used for evaluating and summarizing the data

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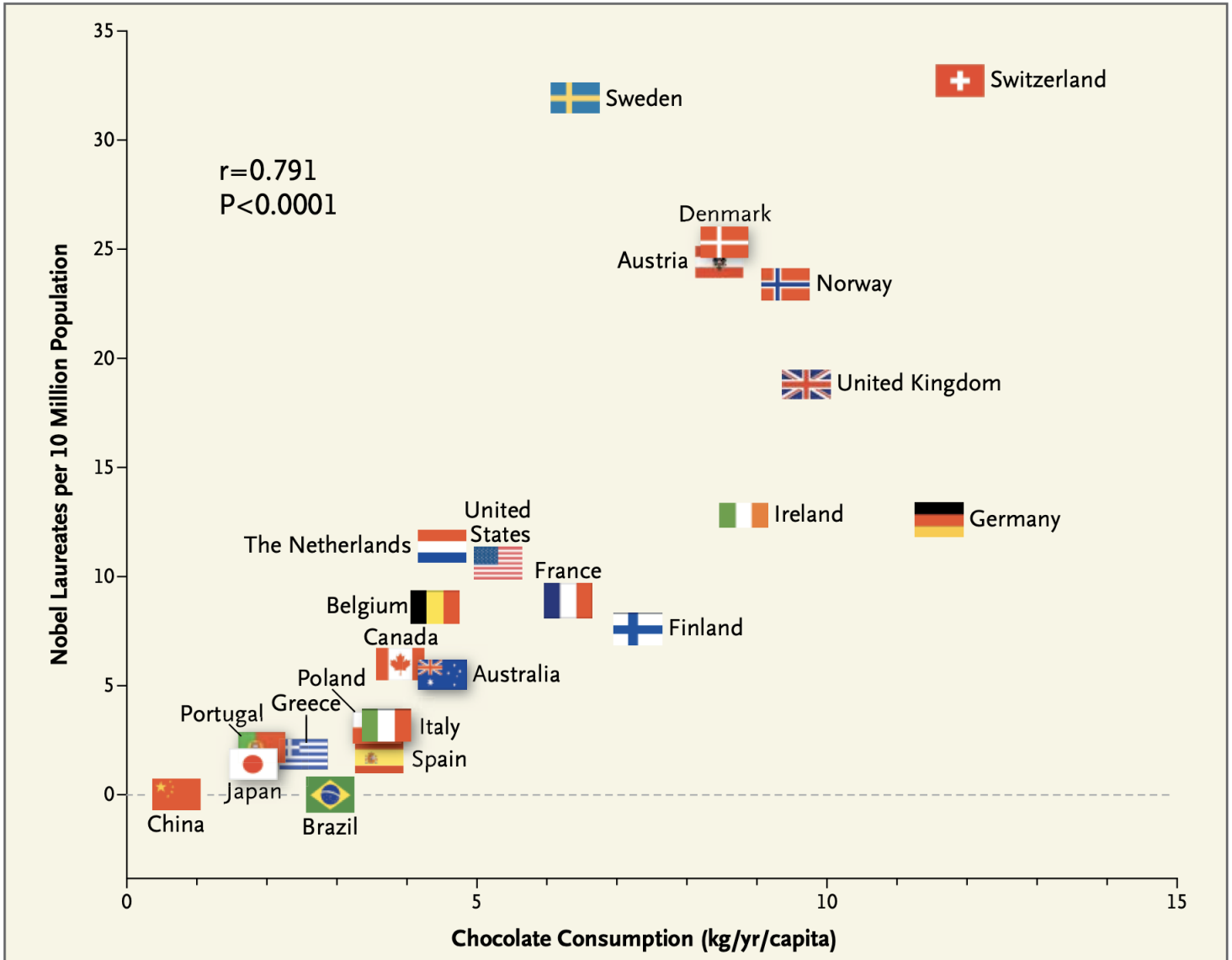

Figure 1. **Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.**

https://www.nejm.org/doi/pdf/10.1056/NEJMon1211064

A Methods Scheme

- Researcher must first decide whether the approach will be analytic or descriptive by answering the question: Is there a comparison between groups in the study?

TABLE 6.1 Selected Research Designs

Name	Design	Statistical Test
One-shot case study	X O	None
One group pretest–posttest	O X O	Dependent or paired *t*-test Wilcoxson matched pairs, signed ranks
Static group comparison	X O O	Independent *t*-test Chi-squared Mann-Whitney *U*
Posttest-only control group	R X O R O	Independent *t*-test or ANOVA Mann-Whitney *U* Kruskal-Wallis ANOVA
Nonequivalent control group	O X O O O	ANCOVA or ANOVA
Pretest–posttest control group	R O X O R O O	ANCOVA or ANOVA
Solomon four-group	R O X O R O O R X O R O	ANCOVA or ANOVA
Counterbalanced	X_1 O X_2 O X_3 O X_2 O X_3 O X_1 O X_3 O X_1 O X_2 O	ANOVA
Time series	O O O O X O O O O	ANOVA, trend analysis

X = experimental treatment or intervention; O = observation, measurement, or evaluation; R = randomization of a large number of subjects; ANOVA = analysis of variance; ANCOVA = analysis of covariance.

Intervention?

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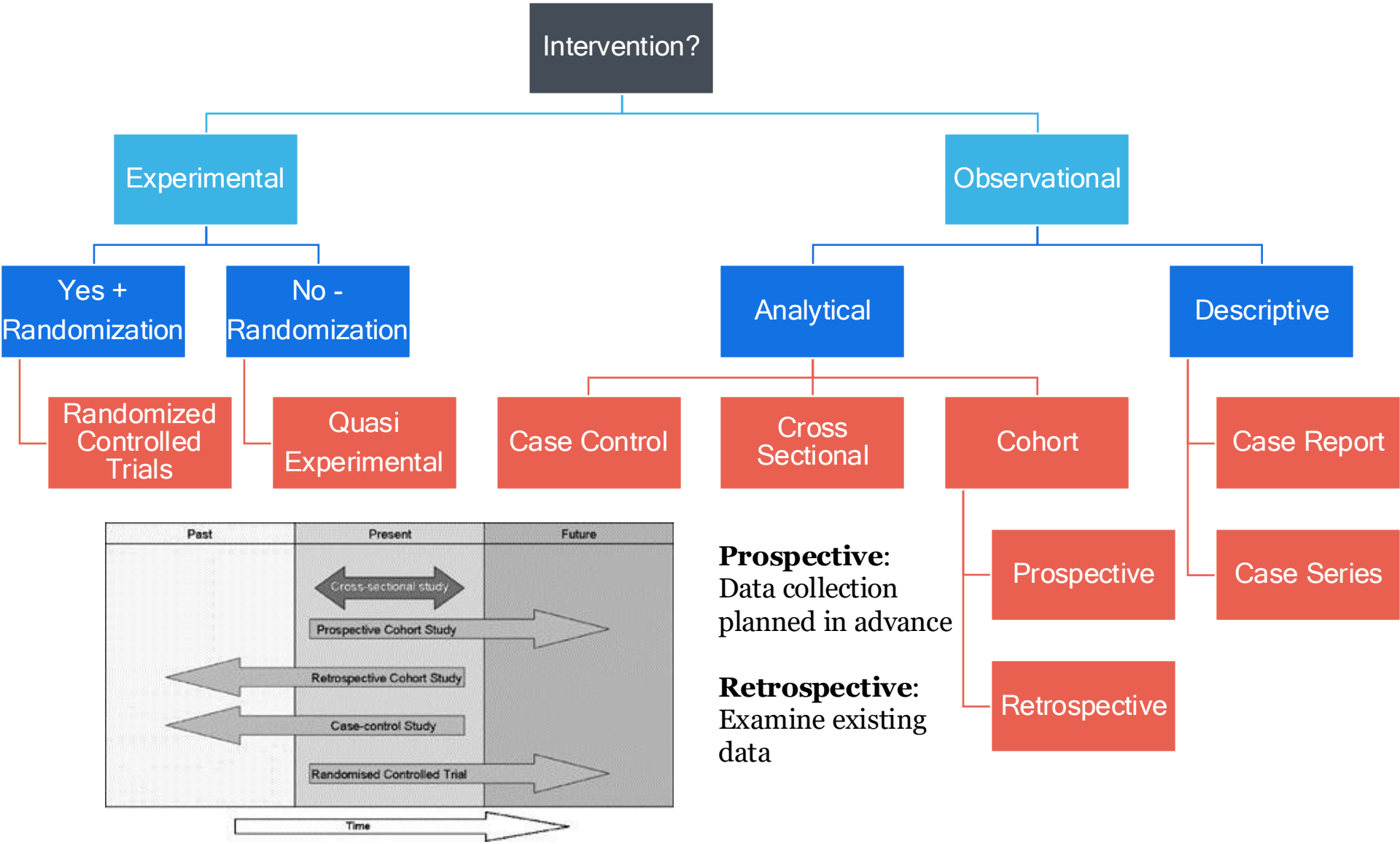

Prospective: Data collection planned in advance

Retrospective: Examine existing data

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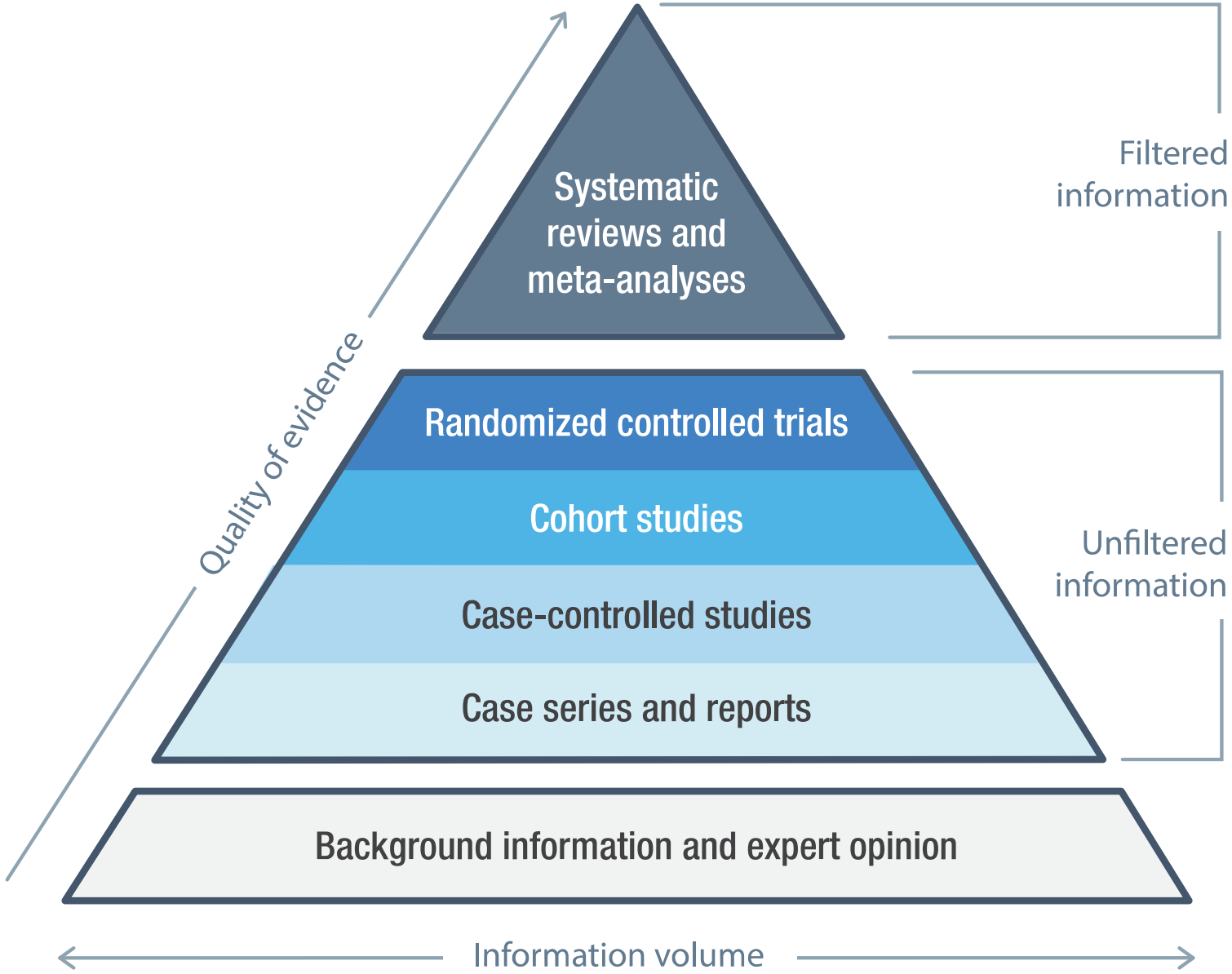

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Bias

When selecting a research design, the investigator must:

- Consider the expectation
- Create a means of controlling biases that may result from this expectation

The investigator must design the research to eliminate bias, thus allowing the results of the study to represent the true effect of the independent variable.

Error

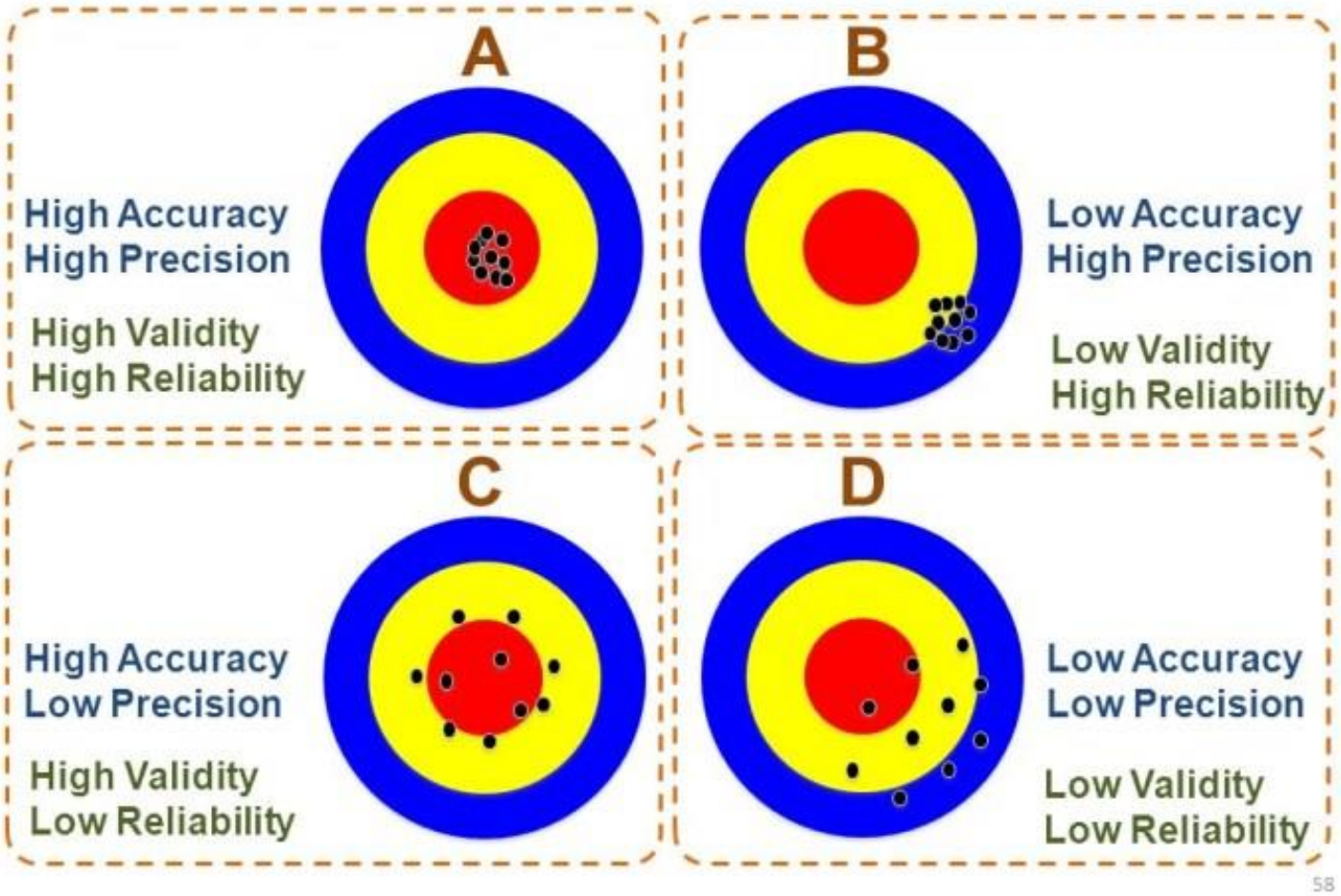
True measurement = Observed measurement + Error

As the concept of “error” decreases, the observed measurement begins to approximate the true measurement.

Two Types of Error:

- Random error: Occurs strictly because of chance
- Systematic error: Series of consistent biases affecting a measurement. May be related to poor technique or to inappropriate research designs, inappropriate measures, or incorrect statistical applications

Accuracy vs. Precision



Precision is a lack of random error.

Validity refers to a lack of systematic error.

Reliability

Consistency with which a measurement is taken

- If a measurement lacks reliability, then the data obtained may be useless because of error.
- If a clinician does not gather reliable data, then there is no way of knowing whether apparent changes in the patient are the result of actual physiological changes or poor technique.

Validity

Indicates usefulness or appropriateness of the data being gathered

- **Measurement or test validity:**
  - Does the test or measure do what it is intended to do?
- **Design or experimental validity:**
  - **Internal validity:** Concerned with limiting or controlling factors and events other than the independent variable
  - **Experimental validity:** Concerned with factors that may affect the generalizability of the conclusions drawn from the study

Threats to Internal Validity

Unintended factors and conditions that can affect the results

Temporal or time-based effects: History, maturation, or attrition

Measurement effects: Testing, instrumentation, sampling, and statistical regression to the mean

Threats to External Validity

Factors and conditions that affect the ability to generalize the results of a study

Two categories:

- Threats related to the populations used
- Threats related to the environment in which the study takes place

Uses of Statistics

- To describe and summarize group information
- To infer or generalize sample results to the larger population
- To test for significant relationships or differences between groups

Types of Data

Non-numerical

- Nominal or ordinal

Numerical

- Interval or ratio
- Preferred to non-numerical data

When numerical data is not possible, nonparametric statistical tests must be used.

Questions

Read

Chapter 9: Assembling Reasons and Evidence

Chapter 10: Acknowledgments and Responses

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*"Observation, reason, and experiment make up what we call **the scientific method.***

- Richard P. Feynman