

# Scientific Research

Generally, research is a systematic inquiry that uses disciplined methods to answer questions to solve problems.

“A systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.”

# Scientific Research

- Belmont Report Definition of Research  
“Any activity designed to test a hypothesis, permit conclusions to be drawn and thereby to develop or contribute to generalizable knowledge (expressed, for example, in theories, principles, and statements of relationships).”
- Medical research is a *systematic* inquiry designed to develop knowledge about issues of importance to health and illness, including medical practices and medical education.
- **Systematic**: a logically progression through a series of steps according to a specified plan.

# Research characteristics

- Is based on the work of others.
- can be replicated.
- Is generalizable to other settings.
- Is based on some logical rationale and tied to theory.
- Is doable.
- Generate new questions or is cyclical in nature.
- Is incremental (an increase of some amount).
- Is an apolitical activity that should be undertaken for the betterment of society.

# Ways of Knowing

- There are many ways to obtain information, including sensory experience, agreement with others, expert opinion, logic, and the scientific method.
- The scientific method is considered by researchers the most likely way to produce reliable and accurate knowledge.

# Ways of Knowing (continue)...

- The scientific method involves answering questions through systematic data collation and analysis.
- The scientific research uses empirical data (data gathered through the senses) and is a systematic orderly and objective method of seeking information.

# Logical Reasoning

- Is a method of knowing combines experience and formal systems of thought.
- Inductive Reasoning. Is the process of developing generalizations from specific observations.
- Deductive Reasoning. Is the process of developing specific predictions from general principles.

# PHILOSOPHIES OF RESEARCH

- The word “science” means knowledge.
- The word “philosophy” means wisdom.
- All research is based on philosophical beliefs about the world – world view or paradigm.
- The perceived view is the basis of naturalistic (qualitative) research; the received view is the basis of empirical analytical (quantitative) research.

# Paradigms for Scientific Research

- Paradigm: Is a world view; a general perspective on the complexities of the real world, with certain assumptions about reality. Paradigms for human inquiry are characterized in terms of the ways in which they respond to basic philosophical questions?
- Ontology: the nature of reality
- Epistemology: The relationship between inquirer and that being studied
- Axiology: role of values in the inquiry
- Methodology: how to obtain knowledge

# Major Paradigms

## Positivism (also modernism, logical positivism)

- There is a reality out there that can be studied and known
- Phenomenon is not haphazard or random
- Highly objective in pursuit of knowledge
- Rooted in 19<sup>th</sup> century thought.
- Guided by such philosophers as Mill, Newton, & Locke.

## Naturalism (also phenomenologic, constructive)

- Putting structures and ideas in a new ways
- Reality is not fixed
- Subjectivity is the primary way of understanding the phenomenon of interest.
- Began as a countermovement to positivism with writers such as Weber & Kant.

# Assumption: Ontologic “what is the nature of reality”?

- Positivist Paradigm
  - Reality exists; there is a real world driven by real natural causes.
- Naturalistic Paradigm
  - Reality is multiple and subjective, mentally constructed by individuals.

# Assumption: Epistemologic “How is the inquirer related to those being researched”?

- **Positivist Paradigm**
  - The inquirer is independent from those being researched; findings are not influenced by the researcher.
- **Naturalistic Paradigm**
  - The inquirer interacts with those being researched; findings are the creation of the interactive process.

# Assumption: Axiologic “What is the role of values in the inquiry”?

- **Positivist Paradigm**
  - Values and biases are to be held in check; objectivity is sought.
- **Naturalistic Paradigm**
  - Subjectivity and values are inevitable and desirable.

# Assumption: Methodologic “How is knowledge obtained”?

- **Positivist Paradigm**
  - Deductive processes
  - Emphasis on discrete, specific concepts.
  - Verification of researchers’ hunches.
  - Fixed design.
  - Tight controls over contexts.
  - Emphasis on measured, quantitative information; statistical analysis.
  - Seeks generalizations.
- **Naturalistic Paradigm**
  - Inductive processes.
  - Emphasis on entirety of some phenomenon, holistic.
  - Emerging interpretations grounded in participants’ experiences.
  - Flexible design.
  - Context-bound.
  - Emphasis on narrative information; qualitative analysis.
  - Seeks patterns.

# Methods of Research

- **Research methods are the techniques used by researchers to structure a study and to gather and analyze information relevant to the research question.**
- **Quantitative research, which is most closely allied with the positivist tradition.**
- **Qualitative research, which is most often associated with naturalistic inquiry.**

# Quantitative Research

- o Associated with positivism.
- o Use a scientific approach.
- o Mainly to understand the phenomenon of interest.
- o Use deductive reasoning to generate hunches that are tested in the real world.
- o Use mechanisms designed to control the study.
- o Researchers gather empirical evidence.
- o Must focus on human beings, who are inherently complex and diverse.

# Qualitative Research

- ✓ Mainly to understand the human experience.
- ✓ Rich and in-depth information.
- ✓ Flexible.
- ✓ Associated with naturalistic paradigm.
- ✓ Use Inductive reasoning.

# Quantitative Methodologies

- Is concerned with objectivity, tight controls over the research situation, and the ability to generalize findings.
- Preference for precise hypotheses stated at the outset.
- Preference for precise definitions stated at the outset.
- Data reduced to numerical scores.

# Quantitative Methodologies

- Much attention to assessing and improving reliability of scores obtained from instruments.
- Assessment of validity through a variety of procedures with reliance on statistical indices.
- Preference for random techniques for obtaining meaningful samples.
- Preference for precisely describing procedures.

# Quantitative Methodologies

- Preference for design or statistical control of extraneous variables.
- Preference for statistical summary of results.
- Preference for breaking down complex phenomena into specific parts for analysis.
- Willingness to manipulate aspects, situations, or conditions in studying complex phenomena.

# Qualitative Methodologies

- Is concerned with the subjective meaning of an experience to an individual.
- Preference for definitions in context or as study progresses.
- Preference for narrative description.
- Preference for assuming that reliability of inferences is adequate.
- Assessment of validity through cross-checking sources of information (triangulation).

# Qualitative Methodologies

- Preference for narrative/literary descriptions of procedures.
- Preference for logical analysis in controlling or accounting for extraneous variables.
- Primary reliance on researcher to deal with procedural bias.
- Preference for narrative summary of results.
- Preference for holistic description of complex phenomena.
- Unwillingness to tamper with naturally occurring phenomena.

# PROCESS OF DESIGNING AND CONDUCTING A RESEARCH PROJECT

- **What**--What was studied
- **What about**--What aspects of the subject were studied

**What for**--What is/was the significance of the study

**What did prior lit./research say**

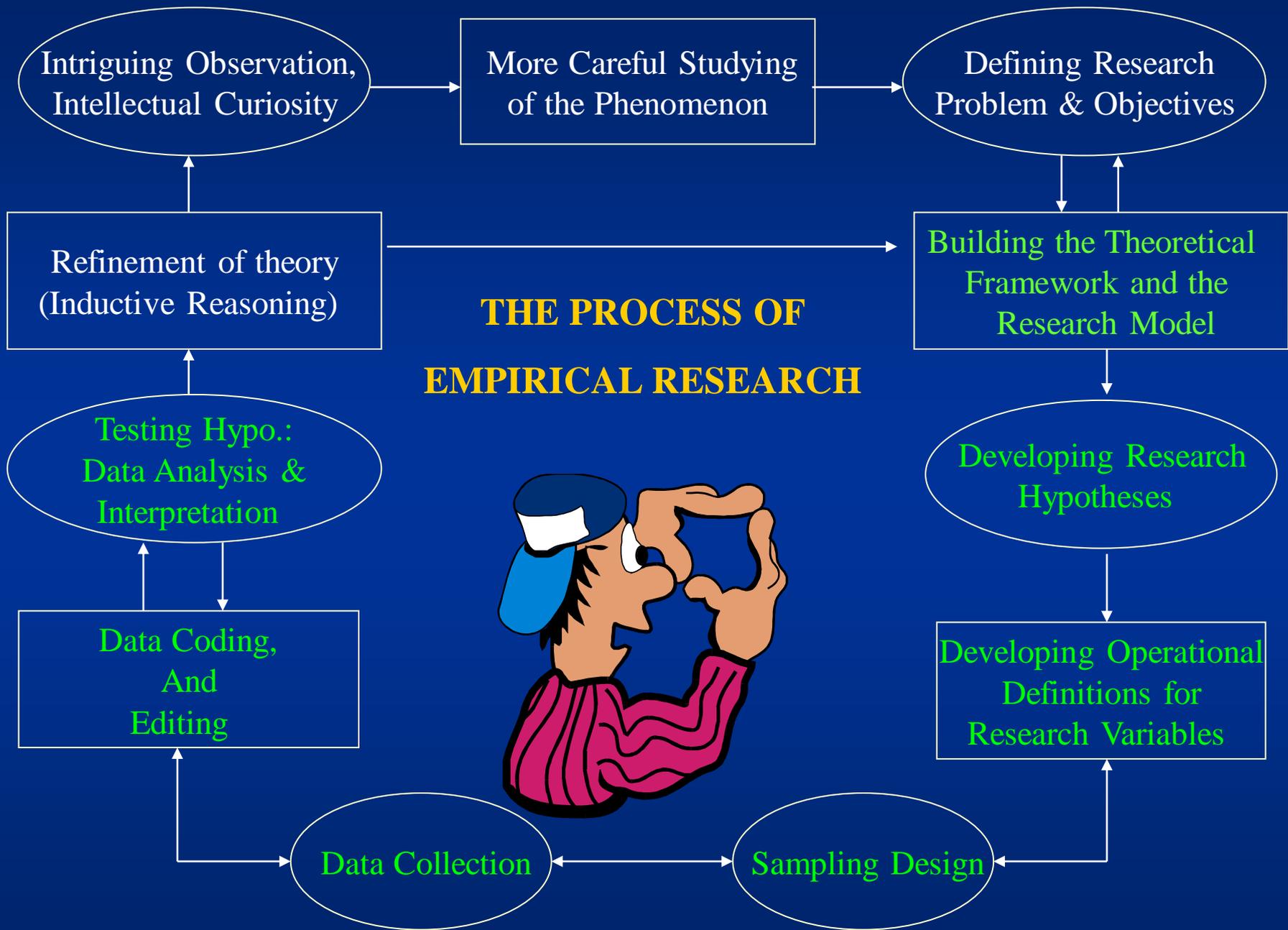
**What was done**--How was the study conducted

**What was found**

**So what**

**What now**

- 1. Introduction, Research Problems/ Objectives & Justification, purpose, & significance**
- 2. Literature Review**
- 3. Methodology**  
(Research sample, data collection, measurement, data analysis)
- 4. Results & Discussion**
- 5. Implications**
- 6. Conclusions and Recommendations for Future Research**



# Phases in a Quantitative Study

- Phase 1: Conceptual Phase
- Phase 2: Design and Planning
- Phase 3: Empirical Phase
- Phase 4: Analytic Phase
- Phase 5: Dissemination Phase

# Major Steps in a Quantitative Study

- Phase 1: Conceptual Phase
  1. Formulating the problem
  2. Reviewing related literature
  3. Undertaking clinical fieldwork
  4. Defining the framework and developing conceptual definitions
  5. Formulating hypotheses

# Major Steps in a Quantitative Study (cont.)

- Phase 2: Design and Planning Phase
6. Selecting a research design
  7. Developing intervention protocols
  8. Identifying the population
  9. Designing the sample plan

# Major Steps in a Quantitative Study (cont.)

- Phase 2: Design and Planning Phase  
(cont.)
10. Specifying methods to measure research variables and collect data.
  11. Developing methods to protect human/animal rights.
  12. Finalizing and reviewing the research plan.

# Major Steps in a Quantitative Study (cont.)

- Phase 3: Empirical Phase

13. Collecting data

14. Preparing data for analysis

# Major Steps in a Quantitative Study (cont.)

- Phase 4: Analytic Phase

15. Analyzing the data

16. Interpreting results

# Major Steps in a Quantitative Study (cont.)

- Phase 5: Dissemination Phase
  17. Communicating the findings
  18. Utilizing findings in practice

# Topic

- Use intuition, creativity, and imagination
- First, we need to put down, and generally, the areas of interest without using any critical thought
- It is not important how specific or abstract these ideas.
- Then, sort the ideas based on your knowledge about the topic, and interest
- Select the most fruitful topics or ideas
- Start asking some questions such as:
  - Why is this important to me..?
  - What is involved with that?
  - How effective is that...?
-

# The Research Problem

- This is a critical and first step
- A clear problem gives direction for the study
- It helps the reader evaluate the research article.
- Should identify the nature, context, and significance of the problem being addressed
- Should be broad enough to include central concerns
- Should be narrow enough to serve as a guide to study design.

# Sources of Research Problems

- Experience and clinical fieldwork
- Medical literature
- Quality improvement initiatives
- Social issues
- Theory
- External suggestions

# Problem Statement

- It articulates the nature, context, and significance of a problem.
- It includes several components:
  - Problem Identification.
  - The background.
  - Scope and consequences of the problem.
  - Knowledge gaps.
  - Possible solutions to the problem.

# Statement of Purpose

- It establishes the general direction or the nature of the inquiry
- The word purpose or goal always appears in the purpose statement
- It should include the keys study variables and their possible interrelationships, and the nature of the population.
- It's the manner that seeks solution of the problem.
- Statement of purpose is the researcher's summary of the overall goal of the study

# Statement of Purpose—Quantitative Studies:

- Identifies key study variables
- Identifies possible relationships among variables
- Indicates the population of interest
- Suggests, through use of verbs, the nature of the inquiry (e.g., to test..., to compare..., to evaluate...)

# Research Question

- It a rewording of the purpose of the study.
- The specific queries the researcher wants to answer in addressing the research problem
- It interrogative rather than narrative
- Its direct and simple
- Attract attention to focus on of the study and the kind of data that would have to be collected.
- Is statement of a specific query the researcher wants to answer to address the research problem.
- More question mean more simplicity.

# Characteristics of Good Research Questions

- The question is feasible (i.e., it can be investigated without an undue amount of time, energy, or money).
- The question is clear (i.e., most people would agree as to what the key words in the question mean).

# Characteristics of Good Research Questions

- The question is significant (i.e., it is worth investigating because it will contribute important knowledge about the human condition).
- The question is ethical (i.e., it will not involve physical or psychological harm or damage to human beings, or to the natural or social environment of which they are a part).

# Research Hypothesis

- A tentative prediction or explanation of the relationship between two or more variables
- It's a translation of research question into a precise prediction of the expected outcomes
- In some way it's a proposal for solution/s
- In qualitative research, there is NO hypothesis

# Research Hypothesis

- States a prediction
- Must always involve at least two variables
- Must suggest a predicted relationship between the independent variable and the dependent variable
- Must contain terms that indicate a relationship (e.g., more than, different from, associated with)

# Hypotheses Criteria

- Written in a declarative form.
- Written in present tense.
- Contain the population
- Contain variables.
- Reflects problem statement or purpose statement.
- Empirically testable.

# Directional Versus Nondirectional Hypotheses

## **Directional hypothesis**

Predicts the direction of a relationship

## **Nondirectional hypothesis**

Predicts the existence of a relationship, not its direction

# Research Versus Null Hypotheses

## **Research hypothesis**

States the actual prediction of a relationship

## **Statistical or null hypothesis**

Expresses the absence of a relationship  
(used only in statistical testing)

# Importance of Reviewing Literature

- It helps the investigator to examine previous and allied work in his proposed area of study to familiarize oneself with the subject
- Provide theoretical/conceptual framework for the study
- Helps refine the research topic/problem
- To identify knowledge gaps in order to avoid re-inventing the wheel.
- To identify weaknesses and pitfalls other researchers have fallen into.
- To compare methodologies used by others in relation to those one intends to use
- To identify other researchers in the subject for possible areas of collaboration
- Provides strong arguments for the necessity and feasibility of your research

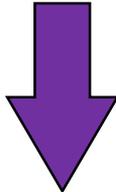
# Ethical Issues for Human Subjects Research

- The right of the researcher to know vs. participants rights - privacy, dignity and self-determination.
- Research should be conducted in a manner that balances the biases and subjectivities of the researcher and protects the dignity and welfare of the researched.

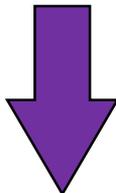
*Increasing Knowledge of  
Disease/Exposure*



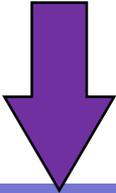
*Descriptive Studies*



*Case-control Studies*



*Cohort Studies*



*Clinical trials*

*Develop  
hypothesis*

*Investigate it's  
relationship to  
outcomes*

*Define it's meaning  
with exposures*

*Test link  
experimentally*

# *Research Design*

*Analytical Research*

*Experimental Research*

*Meta Analyses*

*Pre-designs*

*Descriptive Research*

*Quasi-designs*

*Case Study*

*Survey*

*True-designs*

*Cohort Studies*

*Cross-Sectional*

*Longitudinal*

*Case-control Studies*

*Correlational*

# Clinical Trial Designs

**Randomized  
Controlled Clinical Trials  
"True Experimental"**

**Pretest-posttest  
control group**

**Post-test Only  
Control Group**

**Crossover trial**

**Solomon four-group**

**Non-randomized  
Controlled Clinical Trials  
"Quasi"**

**Nonequivalent  
Control Group  
Design**

**Time Series  
Design**

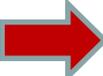
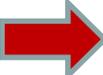
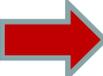
**Non-Controlled  
Clinical Trials**

**One-Group  
Pretest-Posttest**

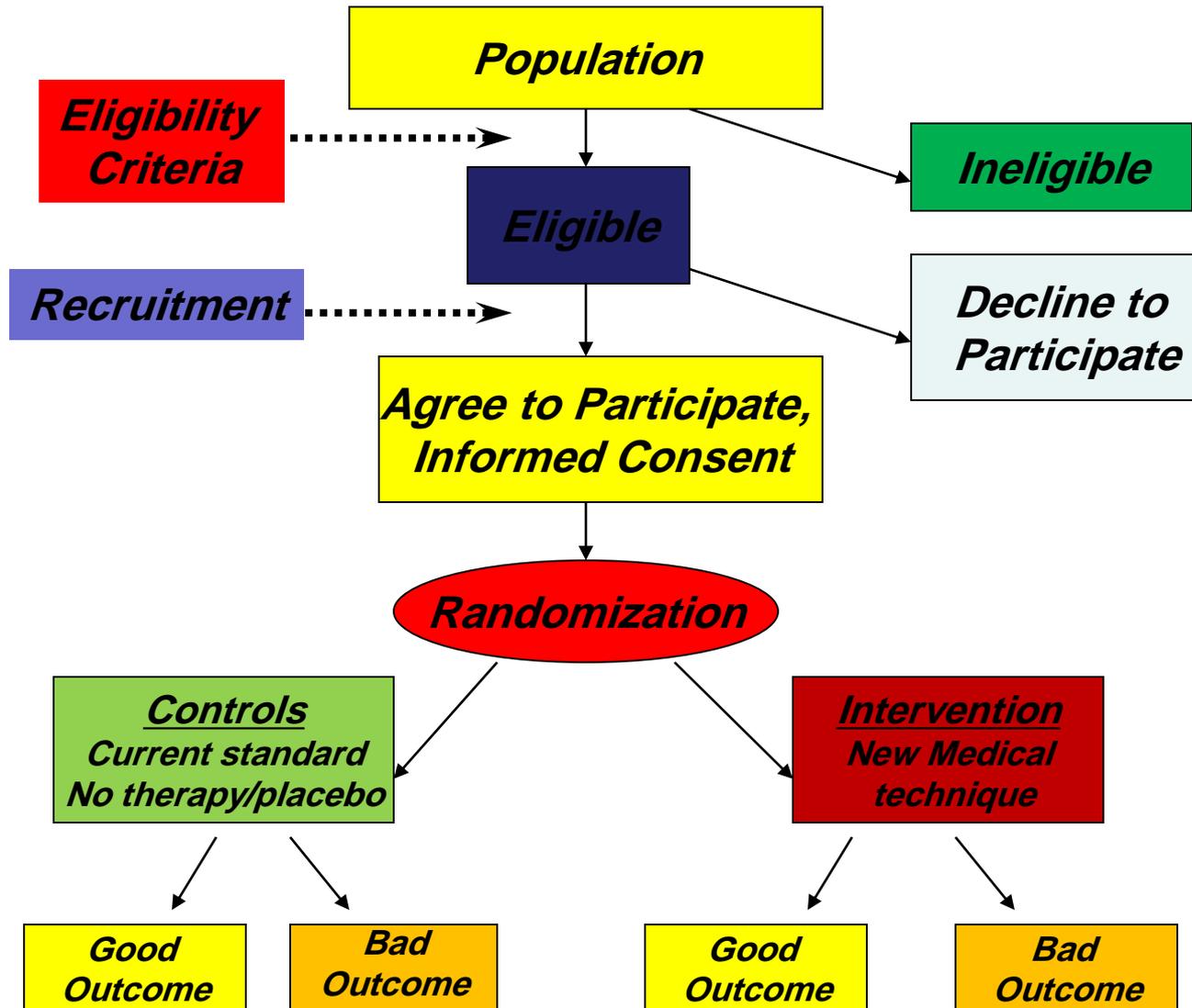
**One-Shot Case  
Study**

# Design Options

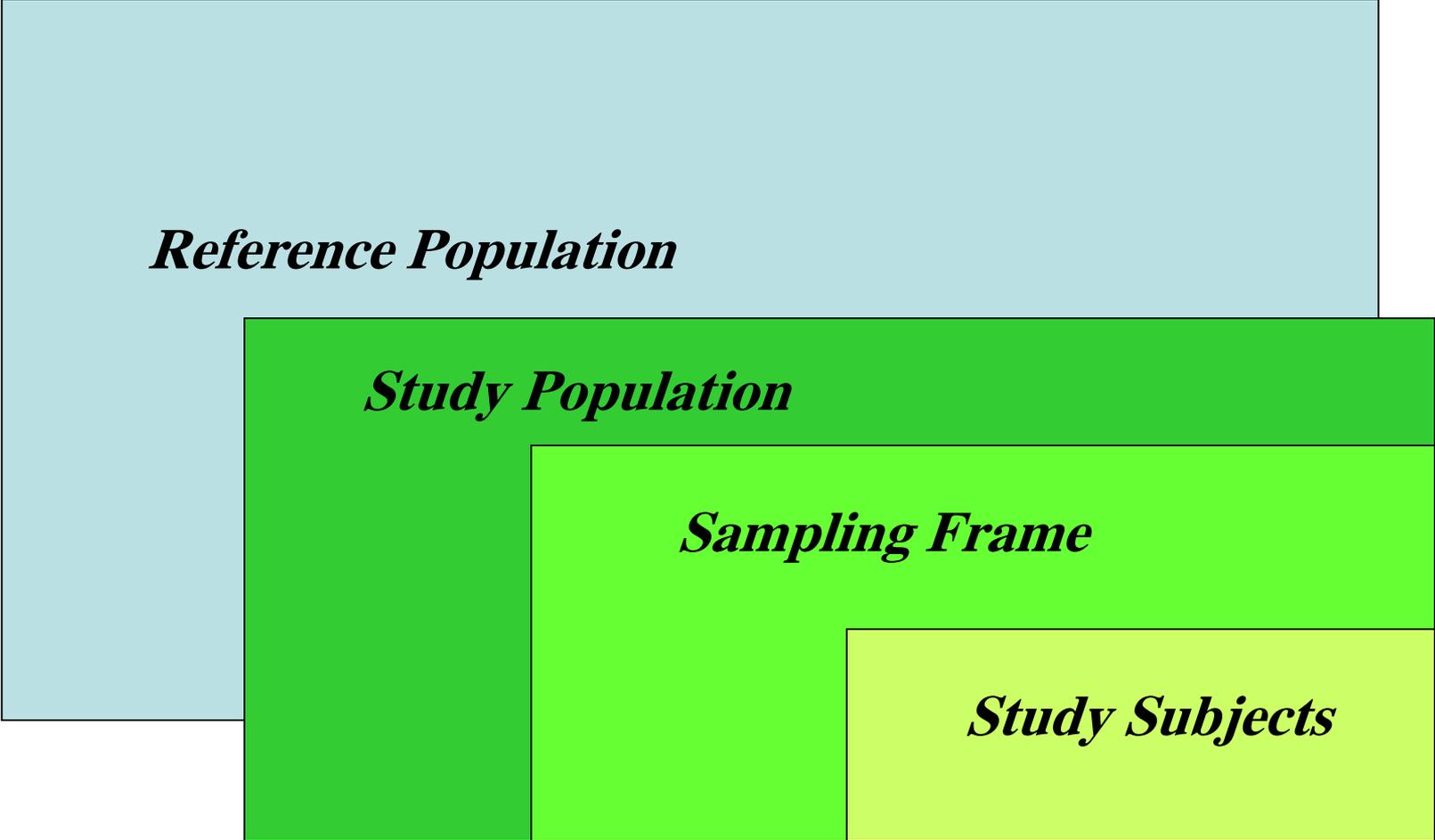
1. Controls: Use of a comparison or control group.
2. Randomization: the random (by chance) assignment of participants into exposure groups.
3. Manipulation: Manipulation of the independent variable
4. Blinding:

Sponsor's Clinician / Analysis Team	Investigator	Patient		
No	No	No		open/unblinded
No	No	Yes		single blinded
No	Yes	Yes		double blinded
Yes	Yes	Yes		triple blinded

# The Basic design of randomized Controlled Clinical Trial



# Sampling - Populations



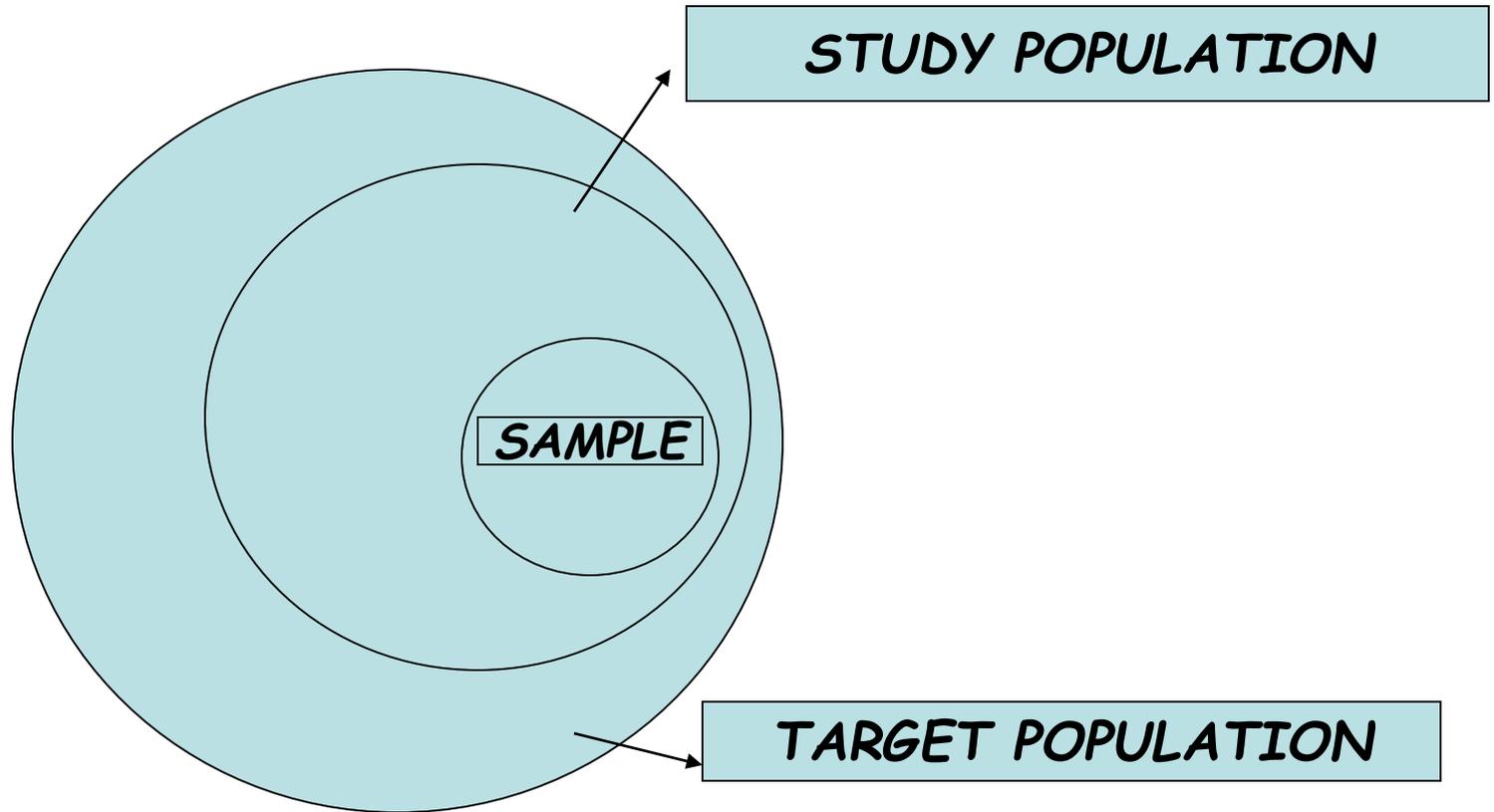
*Reference Population*

*Study Population*

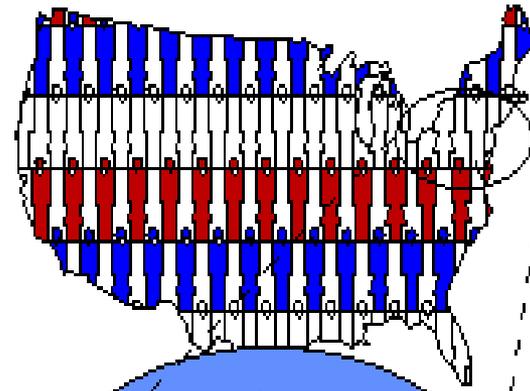
*Sampling Frame*

*Study Subjects*

# SAMPLING

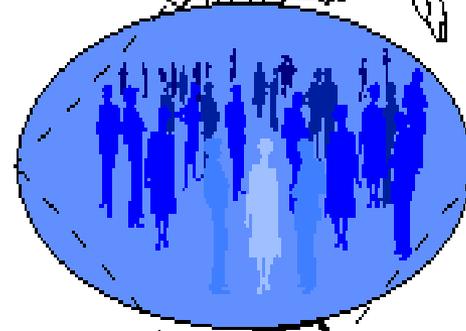


Who do you want to generalize to?



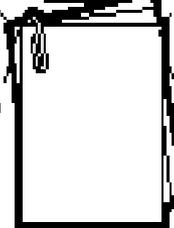
The Theoretical Population

What population can you get access to?



The Study Population

How can you get access to them?



The Sampling Frame

Who is in your study?



The Sample

*SAMPLING BREAKDOWN*

# Types of Sampling Methods

- Probability Sampling Methods. Involves the use of random selection process to select a sample from members or elements of a populations.
  - Simple Random Sampling
  - Systematic sampling.
  - Stratified sampling.
  - Multistage sampling.
  - Cluster sampling.

# Types of Sampling Methods

- Nonprobability Sampling Methods:
  - Convenience sampling.
    - Snowball sampling.
  - Quota sampling.
  - Purposive sampling.

# Descriptive Statistics

- **Measures of Location**
  - **Measures of Central Tendency:**
    - Mean
    - Median
    - Mode
  - **Measures of noncentral Tendency-Quantiles:**
    - Quartiles.
    - Quintiles.
    - Percentiles.
- **Measure of Dispersion (Variability):**
  - Range
  - Interquartile range
  - Variance
  - Standard Deviation
  - Coefficient of variation
- **Measures of Shape:**
  - Mean  $>$  Median-positive or right Skewness
  - Mean = Median- symmetric or zero Skewness
  - Mean  $<$  Median-Negative of left Skewness

# Summary Table of Statistical Tests

Level of Measurement	Sample Characteristics					Correlation
	1 Sample	2 Sample		K Sample (i.e., >2)		
		Independent	Dependent	Independent	Dependent	
Categorical or Nominal	$\chi^2$ or binomial	$\chi^2$	Macnarmar's $\chi^2$	$\chi^2$	Cochran's Q	
Rank or Ordinal	$\chi^2$	Mann Whitney U	Wilcoxin Matched Pairs Signed Ranks	<b>Kruskal Wallis H</b>	<b>Friedman's ANOVA</b>	Spearman's rho
Parametric (Interval & Ratio)	z test or t test	t test between groups	t test within groups	<b>1 way ANOVA between groups</b>	<b>1 way ANOVA (within or repeated measure)</b>	Pearson's r
		<b>Factorial (2 way) ANOVA</b>				

# Presentation, discussion, and Utilization

# Presentation of the findings

- Findings are presented in the form of empirical data or facts
- Findings are presented in the past tense
- Findings come from the analysis of data which is either descriptive or inferential analyses.
- Findings are presented in narrative forms
  - Tables and figures

# Discussion of study hypotheses

- Discussion of study hypotheses by using inferential statistics to test hypotheses
- Possibilities:
  - The null hypothesis is rejected and the research hypothesis is supported
  - The null hypothesis is not rejected
- Conclusions of the study
- Implications of the study
- Recommendations:
  - Extensions of the research study
  - Replication of the research study
  - Consideration of study limitations.

# Discussion

- From numbers to words
- From theory and abstract to practical meaningful data
- *Making the numbers a live*
- Telling what do numbers indicate and why (for both significant and nonsignificant results)
- Some conclusions

# Discussion

- A good discussion should comply with the following:
  - Present principles, relationships and generalizations shown by results. Discuss and not recapitulate the results
  - Point out any exceptions or any lack of correlations and define unsettled points. Never try to cover up or fudge data that do not quite fit
  - Demonstrate how results and interpretations agree (or contrast) with previously published work
  - Don't be shy; discuss theoretical implications of your work, as well as any possible practical applications

## Conclusion/Implications/Summary

- Making a summary of the discussion
- What is learned from the study
- What do other researchers need to do to perfect the findings .

## *References*

*Use a specific style*

*Consistent*

*Using most recent*

- Conclusions

- It should stand alone, presenting no new material but drawing together all the threads of argument from the report and the discussion in a clear and logical manner
- Conclusions must be clearly stated and for each conclusion you should summarize the evidence

- References

- References in text can be numbered in the sequence in which they appear and then can be listed in this order in the list of references. Another possibility is the Harvard System of listing the authors' names in the text followed by the date of the publication in brackets for example (Chimbari *et al*)

- Chimbari, M.J., Chirebvu, E. and Ndlela, B. (2008) *Acta Tropica* 109, 200-213.

# SHOKRAN



*I Welcome your Comments & Questions*