



# Roots of Scientific Inquiry

RHS 481


Lecture 2

Dr. Einas Al-Eisa

# Research design

- = the process in which the investigators determine how they can best answer their research questions
- Research problem   
Research design   
Data analysis

# Quantitative research

- Gathering counts or measurements
- If a phenomenon can be measured  It can be understood

# Quantitative research

- **Objective :**
  - to exist independent of thought or outside the mind
  - unanimous agreement
- **Subjective:**
  - to be dependent on thought or to exist in the mind
  - varying degrees of agreement

# Quantitative research

- Science is concerned with *truth* or *reality*
- *Quantitativeness is OBJECTIVITY*

# Quantitative research

- If you have quantitative data, you can use statistics to describe and interpret your data
- **Statistics** = applied mathematics by which you can make conclusions with increased assurance of being correct (a valuable tool for helping us to make correct decisions)

# Basics of Data

- Datum = single observation, single value, or single measurement
- Data = more than one datum (collections of single observations)
- Science deals with data (not with single isolated observation that does not provide sufficient evidence)

# Basics of Data

- Data are dependent on the research question and the measuring instrument
- Vary from one study to the other
- Can be quantitative or qualitative



# Basics of Data

- **A variable:**
  - measurable characteristic, trait, or property
  - some characteristic that takes different forms within a study (opposite to a ***constant*** which takes only one form)

# Example

- If differences between ROM values for men and women are studied, then gender is a **variable**
- If ROM values are measured for women only (or men only), then gender is a **constant**

# Variables

```
graph TD; A[Variables] --> B[Independent variable = Presumed cause (factor)]; A --> C[Dependent variable = Presumed effect (outcome)];
```

**Independent** variable =  
Presumed cause  
(factor)

**Dependent** variable =  
Presumed effect  
(outcome)

# Example

- Research **question**: “how effective is ultrasound in the treatment of knee pain?”
- **Independent** variables: ultrasound parameters
- **Dependent** variable: knee pain (visual analogue pain scale)

# Research purposes

1. Description of a phenomenon  
(**descriptive** research)
2. Analysis of **relationships**
3. Analysis of **difference** between groups  
or treatments

# Example

- **Topic:** functional recovery after total knee replacement (TKR), so the **purpose** can be one of three:
  1. To ***describe*** the functional status of patients at various intervals after TKR

# Example

2. To examine the ***relationship*** between preoperative factors (gait velocity, quadriceps strength) and functional status at intervals after TKR
3. To examine the ***differences*** in functional recovery between a group of patients who received individualized postoperative exercise program versus another group who participated in a group exercise program

# Timing of Data Collection

- **Retrospective:** in which the researcher uses data collected before the research question was developed
- **Prospective:** in which the researcher completes data collection after the research question is developed



# Example

- Research **Purpose**: to describe the functional status of patients after TKR
  - **Retrospective**: by extracting functional recovery data from medical records
  - **Prospective**: by setting up a data collection protocol to gather functional recovery data at specific intervals after TKR

# Research manipulation

- **Experimental** research: involves controlled manipulation of subjects.  
Example:
  - Analysis of difference with manipulation
- **Non-experimental** research: does not involve any manipulation. Example,
  - Descriptive research
  - Analysis of relationships

# Experimental research

- Truly experimental research (***Randomized clinical trials***): research that is with high level of control
- Quasi-experimental research:
  - Less control (subjects act as their own control)Or:
  - Multiple groups where subjects are not randomly assigned

# Example

- Measuring pain before and after real ultrasound (treatment) or sham (placebo) in 2 groups of patients
  - Manipulation: true ultrasound versus sham
  - Randomization: assignment of subjects into groups (1- treatment group, 2- control group)
  - Control: standardized ultrasound variables



# Types of control in research

- Five types of control are common:
  1. Control of the implementation of the independent variable:
    - The investigator must have a rationale to govern the implementation of the variable and a mechanism to monitor the implementation

# 1. Control of the implementation of the independent variable:

## Example

- Problem: effect of heat on R.O.M of the low back  $\longrightarrow$  The use of heat must be standardized:
  - Does heat mean hot pack, ultrasound, or other modality?
  - If hot pack, should all hot packs be the same size, or adjusted to the size of the patient?
  - If ultrasound, what is the duration and frequency? Area of application?

## 2. Control of subject selection

- **Inclusion / exclusion criteria:** for admission of subjects to the study
  - Example: age, gender, pain (chronic or acute)
- ***Homogeneous sample:*** tight selection criteria reducing the variability between subjects
- ***Heterogeneous sample:*** broad selection criteria increasing the variability between subjects



# 3. Control of extraneous variables

- **Extraneous** or **confounding** variables = factors that may influence the dependent variable (other than the independent variable)
  - Example: temperature, time of the day for testing, lighting
- You must rule out the effect of the confounding variables (related to the setting & subjects)

# 4. Control of measurement

- **Reliability** (consistency) = the degree to which test scores are free from error
  - ***Instrument reliability*** = measurement error
  - ***Intra-rater reliability*** = consistency with which one rater assigns scores to the same thing on two occasions
  - ***Inter-rater reliability*** = consistency among different raters in assigning scores to the same thing
  - ***Intra-subject reliability*** = related to change in subject performance from time to time

# 4. Control of measurement

- **Validity:**

- the appropriateness and usefulness of the specific inferences made from test scores

- the extent to which the conclusions of research are believable and useful

## 5. Control of information given to subjects & researchers

- **Incomplete information:** about the purpose of the study to control the effect of expectations (BUT be aware of ethics)
- **Subject blinding:** to withhold information about which of several treatments the patient is receiving (not applicable to physical therapy)
- **Researcher blinding:** to the treatment received by the patients, to control the effect of the researcher expectations

# 5. Control of information given to subjects & researchers

- **Single-blind study:** either the subject OR the researcher is blind to the treatment or group assignment
- **Double-blind study:** both subject and researcher are blind