Level of Measurements

Mohammed TA, Omar, Ph.D. PT, CLT, PGDCR
Rehabilitation Health Science Department
CAMS-KSU,

Objectives

- Identify types of variables in research study

- Differentiate and discuss the mathematical model of nominal, ordinal, ratio, and interval level of measurements.

- Differentiate between norm referenced and criteria referenced measures

Outline

- Measurement and Variables

- Levels of Measurement
  - Nominal
  - Ordinal
  - Ratio
  - Interval

- Measurement erors

Measured Variables

A variable is some characteristic or factor that can have different values and is either subject to change or can be manipulated as an intervention.

A Variable is the data gathered during research

Variables may be independent, dependent, constant, or confounding

Variables

Independent

- [ ] manipulated by researcher
- [ ] cause an effect on the dependent variable.
- [ ] Experimental /Treatment variable
- [ ] one /multiple level independent variable
- [ ] Known factors

Dependent

- [ ] Occurs in response to independent variable.
- [ ] Outcome of researcher interest
- [ ] Outcomes/predictor variable
- [ ] one /multiple dependent variable
- [ ] Unknown factors

Example -1-

- Effects of 12 weeks of aerobic training on autonomic modulation, mucociliary clearance, and aerobic parameters in patients with COPD

Independent Variable   12 weeks of aerobic training

dependent Variable
- ❖ Autonomic modulation,
- ❖ Mucociliary clearance
- ❖ Aerobic parameters

Example -2-

- The effect of aquatic exercise on spasticity, quality of life, and motor function in cerebral palsy

Independent Variable

aquatic exercise

dependent Variable

❖Spasticity,
❖Quality of life,
❖Motor function

Variables

- **Confounding variables** are often defined as the variables correlate (positively or negatively) with both the dependent variable and the independent variable .
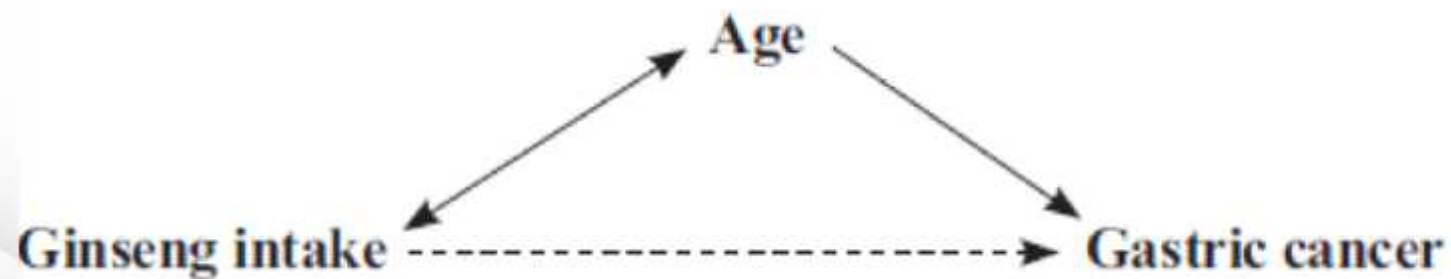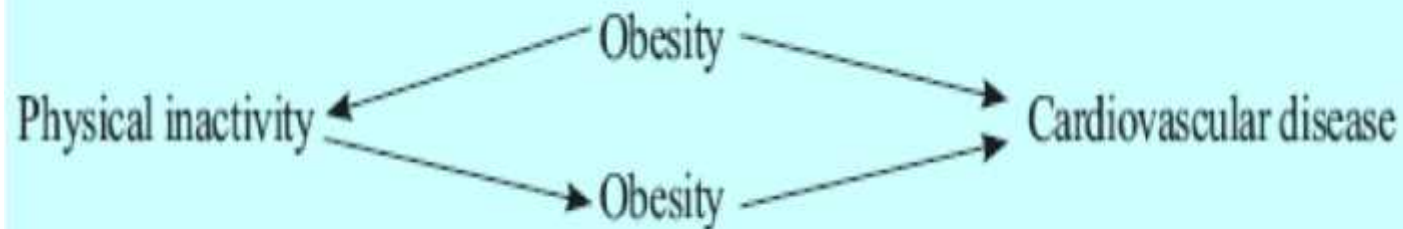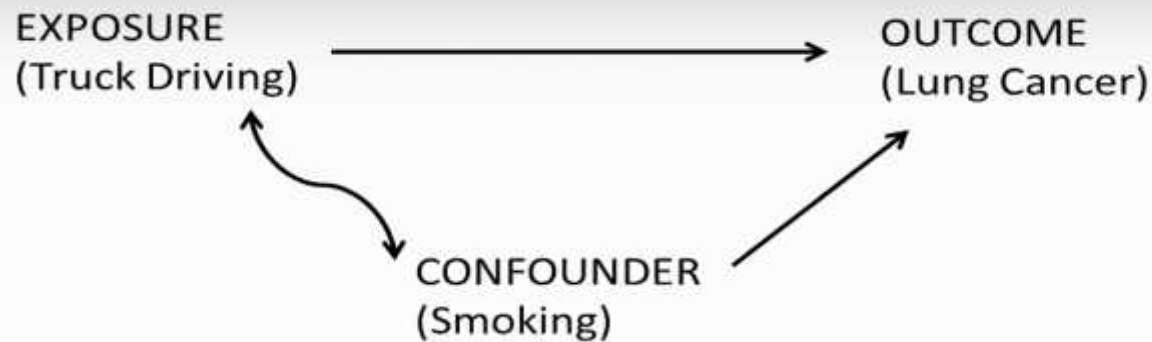
Controlled Variable

a variable that is not changed not effect the outcome
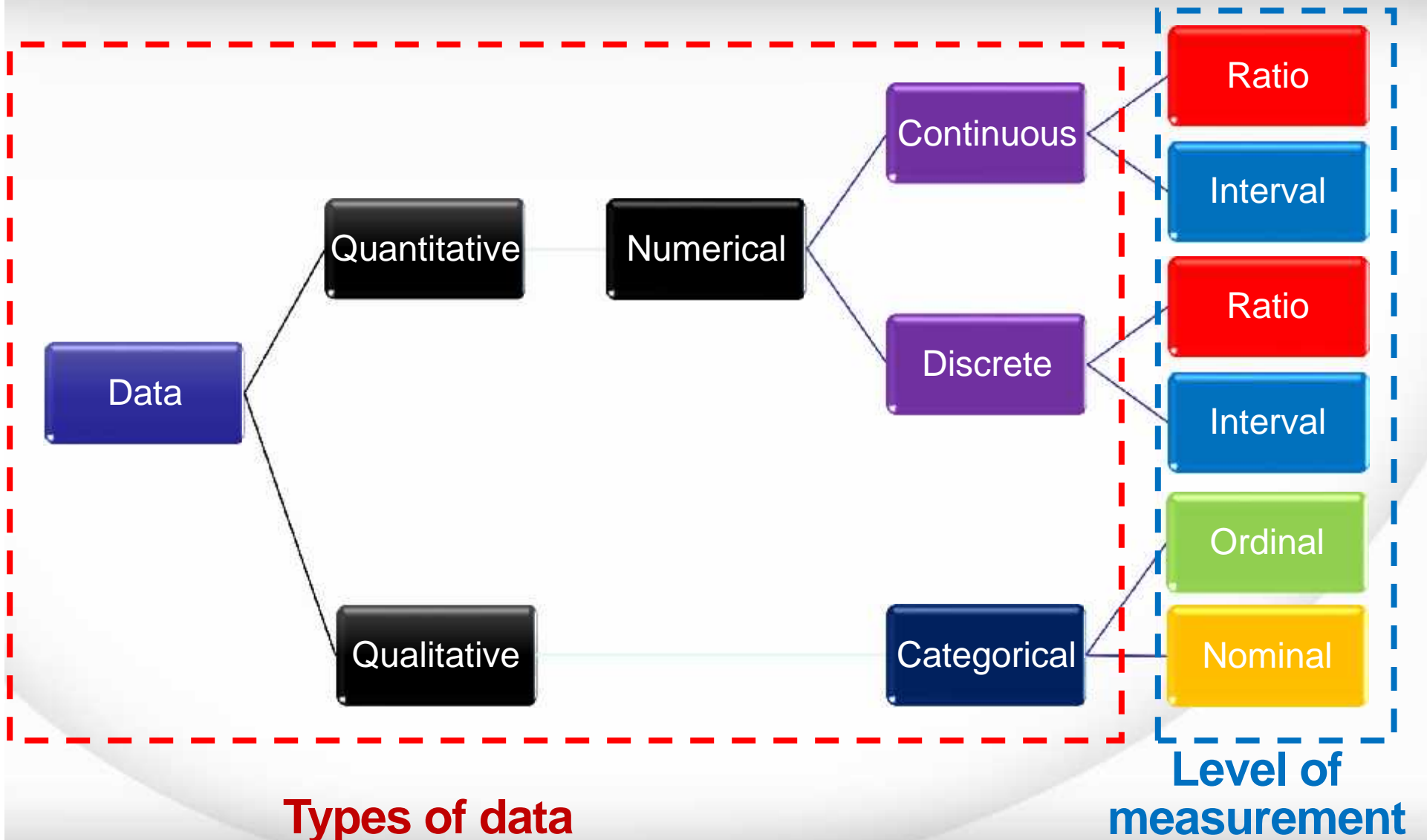
NOT being tested
Used for Comparison
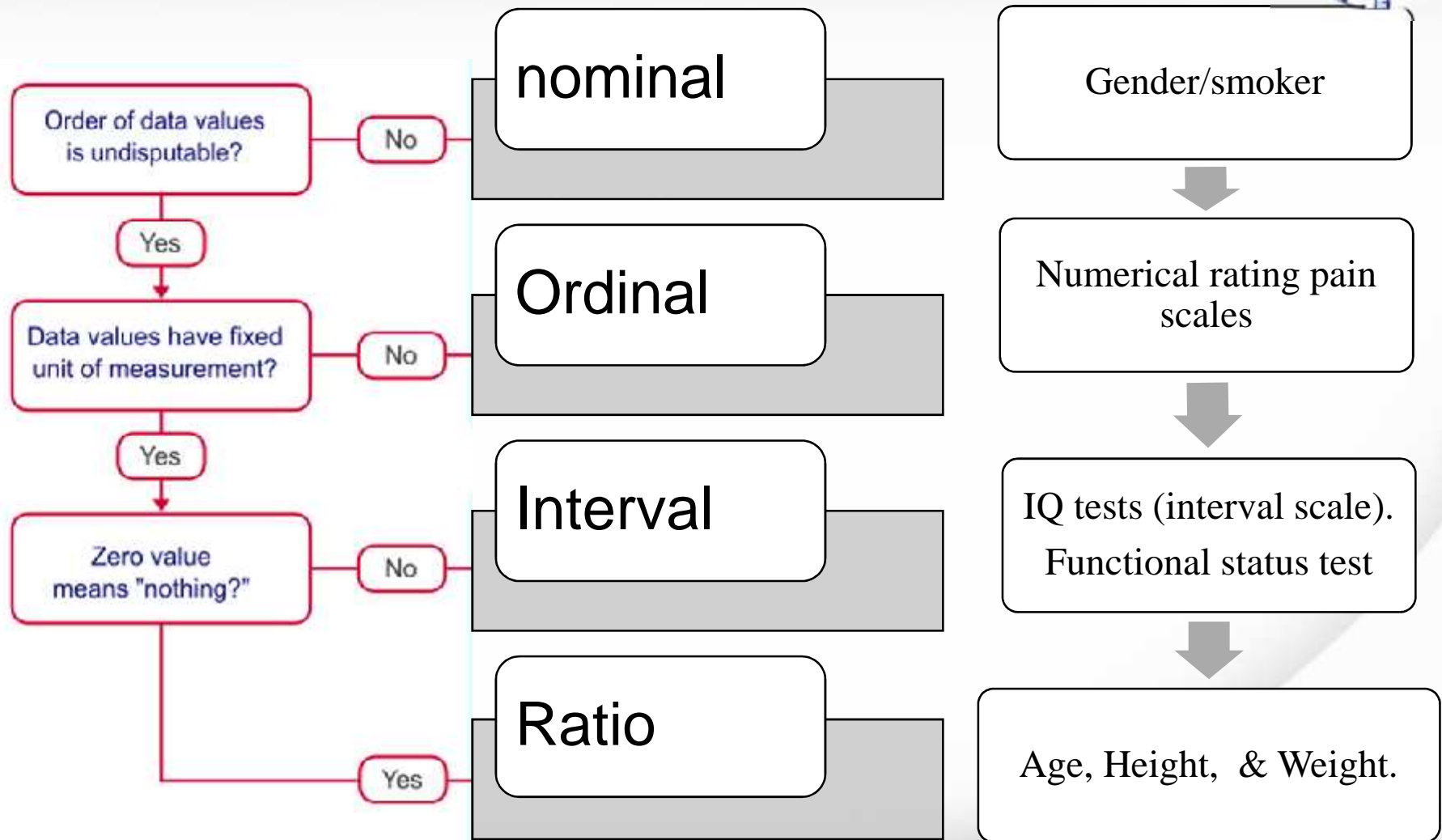
How to Reduce Confounding Variables?

Example -3-

EXPOSURE
(Truck Driving)

OUTCOME
(Lung Cancer)

CONFOUNDER
(Smoking)

Physical inactivity

Obesity

Obesity

Cardiovascular disease

Age

Ginseng intake

Gastric cancer

Types of data

Properties of Measurement Scales

Order of data values is undisputable? — No → **nominal** → Gender/smoker

Yes

Data values have fixed unit of measurement? — No → **Ordinal** → Numerical rating pain scales

Yes

Zero value means "nothing?" — No → **Interval** → IQ tests (interval scale). Functional status test

Yes → **Ratio** → Age, Height, & Weight.

Importance of Measurement Level

- Decide what statistical analysis is appropriate on the values that were assigned

- Decide how to interpret the data from that variable

Measurement level: Nominal

❖ Lowest of the four levels of measurement

❖ Categories/classification

❖ No order or ranking

❖ Mutually exclusive & exhaustive

❖ May be Dichotomous/Multichotomous

Statistics:
Descriptive:
  Frequency, Percentage, Mode,
Graphs:
  Bar Charts and Pie Charts
Inferential
  Non-parametric

Practice in Therapy and Rehabilitation

- Gender; (Male=1 and Female= 0)

- Ethnicity (Hispanic=1 Indian = 0)

- Marital Status (Married =1, Divorce= 0, Unmarried =2)

- Hand dominance (Left =2, Right =1).

- Smoking (Smoking =1, Ex-smoker 2, Non-smoker =0)

- Stroke classification according to side (right=0, left=1, both=2)

- Types of pain (aching, burning, stabbing)

- Occupation, and Educational level

- Blood groups (A, B, AB. O)

Measurement level: Ordinal

❖ Next up power level of measurement.

❖ Classifies data into categories/ ranked/ order

❖ Distances between attributes do not have any meaning.

❖ Does not make sense to do calculations

Statistics:
Descriptive:
       Frequency, Percentage, Mode, Median, Quartiles
Graphs:
       Bar Charts and Pie Charts
Inferential
       Non-parametric

Practice in Therapy and Rehabilitation

❖ Five point scales for manual muscle test

❖ Manual muscles test (MMT)

❖ Numerical rating pain scales

❖ Functional Independence Measure (FIM)

❖ Barthel Index(BI)

Ability to perform ADL
1 = completely dependent
2 = needs human assistance
3 = needs mechanical assistance
4 = completely independent

Functional assessment scales
0 = Dependent,
1 = need Physical assistance
2=independence

Measurement level: **Interval**

❖ Same rules as ordinal (ranked & ordered)

❖ Assume equal distances between values,

❖ No absolute zero (zero point is arbitrary)

❖ Differences make sense, but ratios do not.

❖ Mathematical operations (subtraction, multiplication & division).

Statistics:
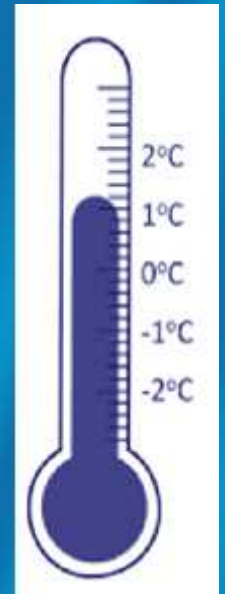**Descriptive**
      Mean & standard deviation (SD)
Graphic:
    Histograms , Stem-and-Leaf plots
    Dot Plots, Box plots
    XY Scatter Plots (2 variables).
Inferential
    Parametric

2°C
1°C
0°C
-1°C
-2°C

Practice in Therapy &Rehabilitation

Temperature : The distance, for example, between a joint angle of 10° and 18° is the same as the difference between 25° and 33°.

IQ tests (interval scale).

Functional status test

Measurement level: Ratio

❖ Highest level for measurement

❖ Meets all rules of interval level,

❖ Absolute zero point

❖ Can construct a meaningful ratio (fraction)

Statistics:
Descriptive
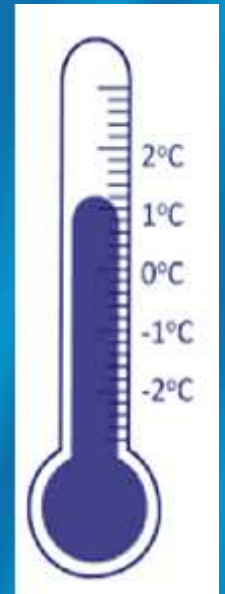 Mean & standard deviation (SD)
Graphic:
  Histograms , Stem-and-Leaf plots
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Practice in Therapy &Rehabilitation

❖ Walking distance in meter

❖ Force of muscle contraction in Newton-meter.

❖ Age, Height, & Weight.

❖ Temperature in Kelvin

❖ Speed ,volume.

❖ Isokeintic

❖ Pulmonary function test

Comparison between 4 Levels of measuremen

Type of Scale	Data Characteristics	Numerical Operation	Descriptive Statistics	Examples
Nominal	Classification	Counting	Frequency & Percent	Gender (1=Male, 2=Female)
Ordinal	Classification and order	Rank ordering	Median Range Percentile ranking	Academic status (1=Freshman, 2=Sophomore, 3=Junior, 4=Senior)
Interval	Classification, order, and distance	Arithmetic operations that preserve order and magnitude	Mean Standard deviation Variance	Temperature in degrees
Ratio	Classification, order, distance and unique origin	Arithmetic operations on actual quantities	Geometric mean Coefficient of variation	Age in years Income in Saudi riyals

Practice -1-

Please reading carefully the assigned paper and then apply the concept related to
1-Different types of variables
   ❖ Independent variable,
   ❖ Depended variables ,
   ❖ Control variables
   ❖ Confounding variables

2- Different Level of measurements and statistical tests
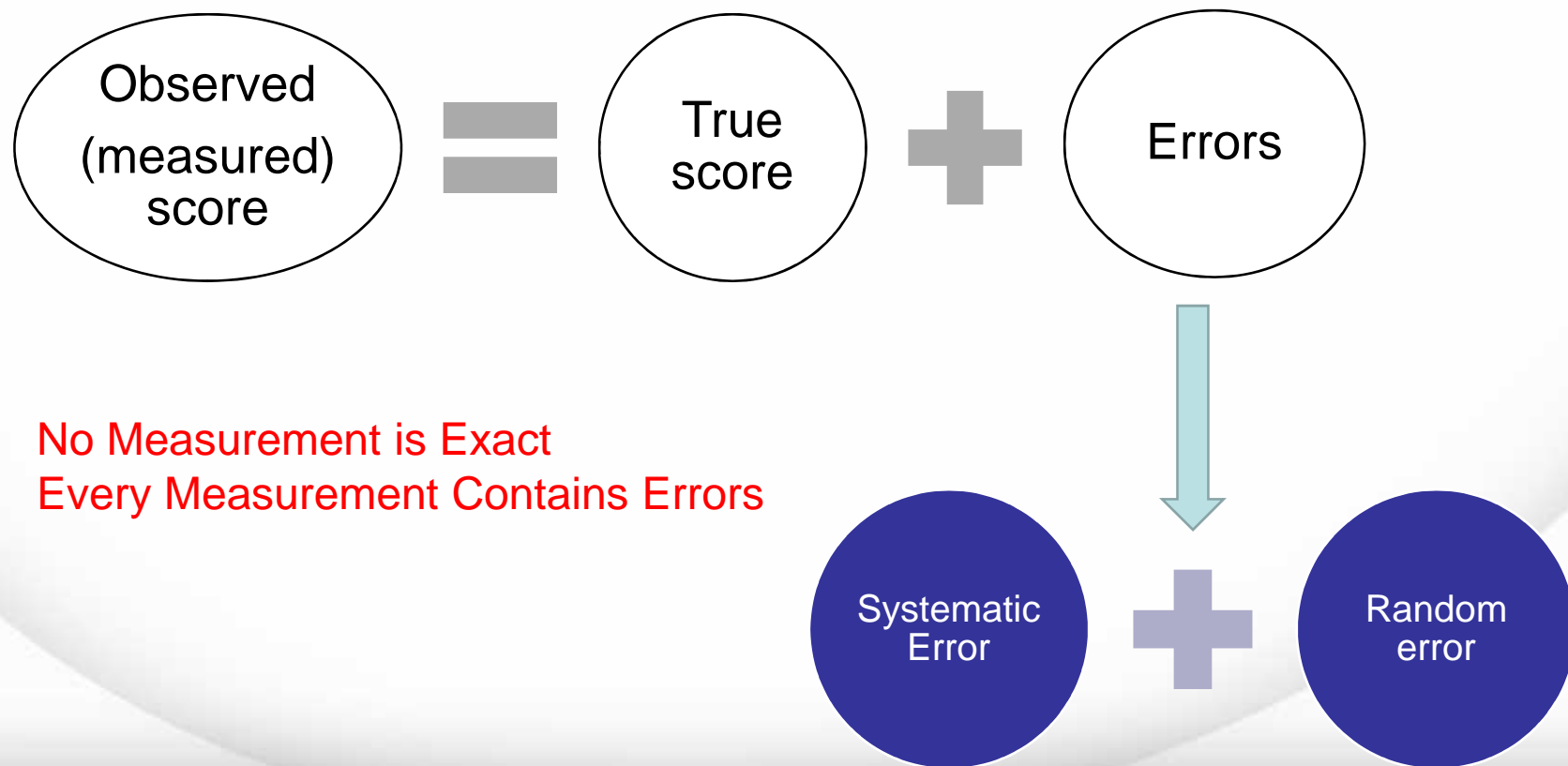   (nominal , ordinal, ratio, interval)

Practice -1-

- Higher versus Lower Positive End-Expiratory Pressures in Patients with the Acute Respiratory Distress Syndrome N Engl J Med 2004;351:327-36.

- Immediate effect of a functional wrist orthosis for children with cerebral palsy or brain injury: A randomized controlled trial Available online 28 October 2017 In Press, Corrected Proof

Data Collection Strategies

- The strategy for data collection depends on research design

  - Qualitative study *vs.* Quantitative study

  - Established reliability & validity

  - Methods of data collection

        surveys, measures, questionnaires, interviews, scales

Measurement error

The term 'ERROR' does not necessarily mean that something is being done INCORRECTLY; rather it refers to the variability in the technique of the person operating the instrument or making the measurement.

Observed (measured) score = True score + Errors

No Measurement is Exact
Every Measurement Contains Errors

Systematic Error + Random error
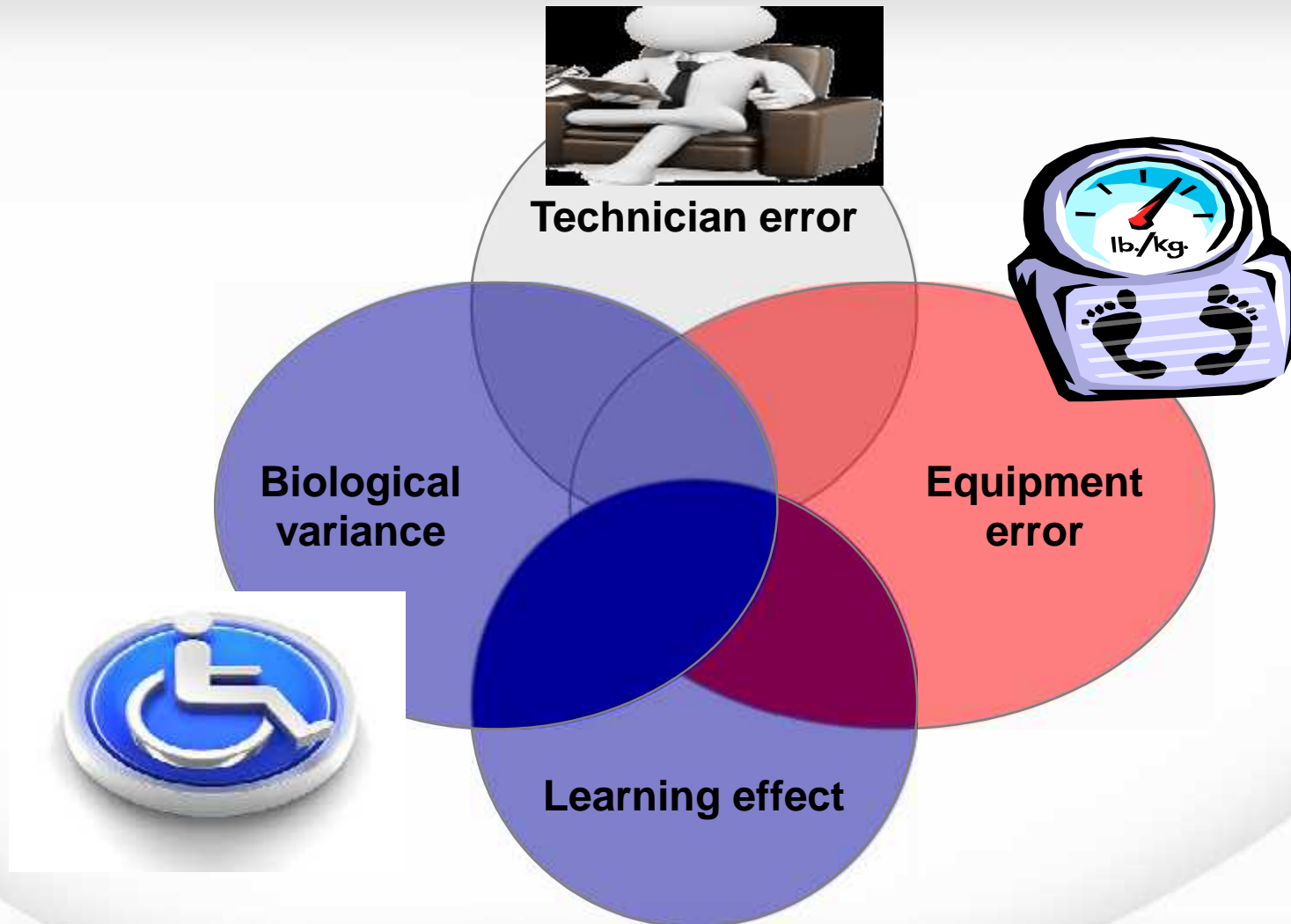
Measurement error

Random errors

Are due to chance and unpredictable, thus they are the basic concern of reliability.

Systematic errors

Systematic errors are predictable errors, occurring in one direction only, constant and biased

Sources of Measurement Errors

Technician error

Biological variance

Equipment error

Learning effect

Sources of Measurement Errors

Conditions of Test Administration and Construction

- Changes in time limits
- Changes in directions
- Different scoring procedures
- Interrupted testing session
- Qualities of test administrator
- Time test is taken
- Sampling of items
- unclearness in wording of items/questions
- Climate of test situation
- (heating, light, ventilation, etc.)
- Differences in observers

Conditions of the Person Taking the Test

- Reaction to specific items
- Health
- Motivation
- Mood
- Fatigue
- Luck
- Memory and/or attention fluctuations
- Attitudes
- Test-taking skills (test-wiseness)
- Ability to understand instructions
- Anxiety