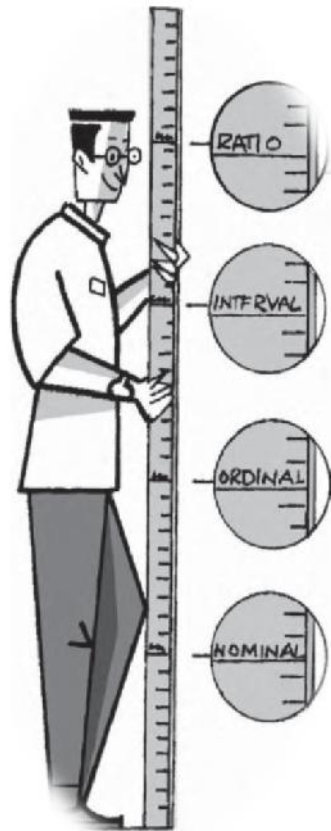


# Level of Measurements



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# Objectives

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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

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## Measurement and Variables

### Levels of Measurement


- Nominal
- Ordinal
- Ratio
- Interval

Norm referenced and criteria referenced measure



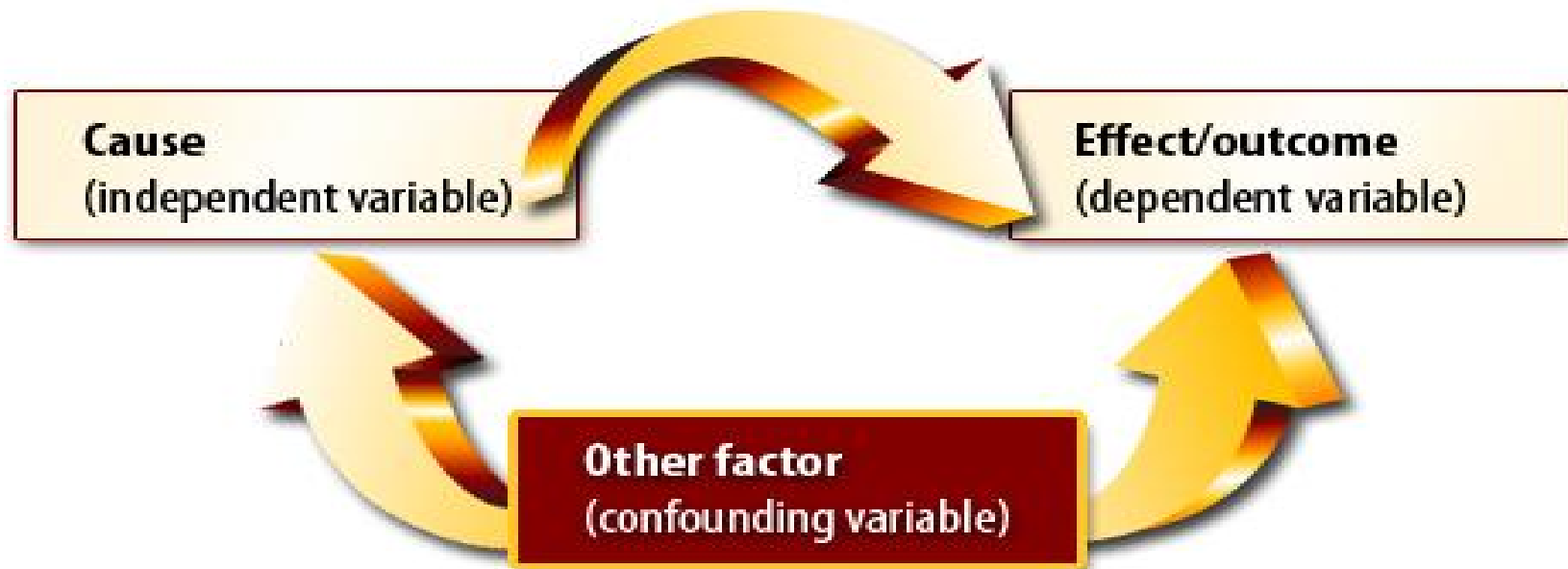
# MEASUREMENT

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- Measuring is undertaken by therapists to ascertain the dimensions (size), quantity (amount) or capacity of a trait, attribute or characteristic of a person that is required by the therapist to develop an accurate picture of the person's needs and problems to form a baseline for therapeutic intervention and/or to provide a measure of outcome.
  - A measurement is obtained by applying a **standard scale** to **variables**, thus translating **direct observations** or **patient/proxy reports** to a numerical scoring system.
- 

# Measured Variables

The data gathered during research are known as variables. It is any factor (e.g. characteristics, trait, or attribute ) that can change in a scientific investigation or experiment



# Independent Variable

It is a variable that can be manipulated by the researcher to **cause an effect** on the dependent variable.

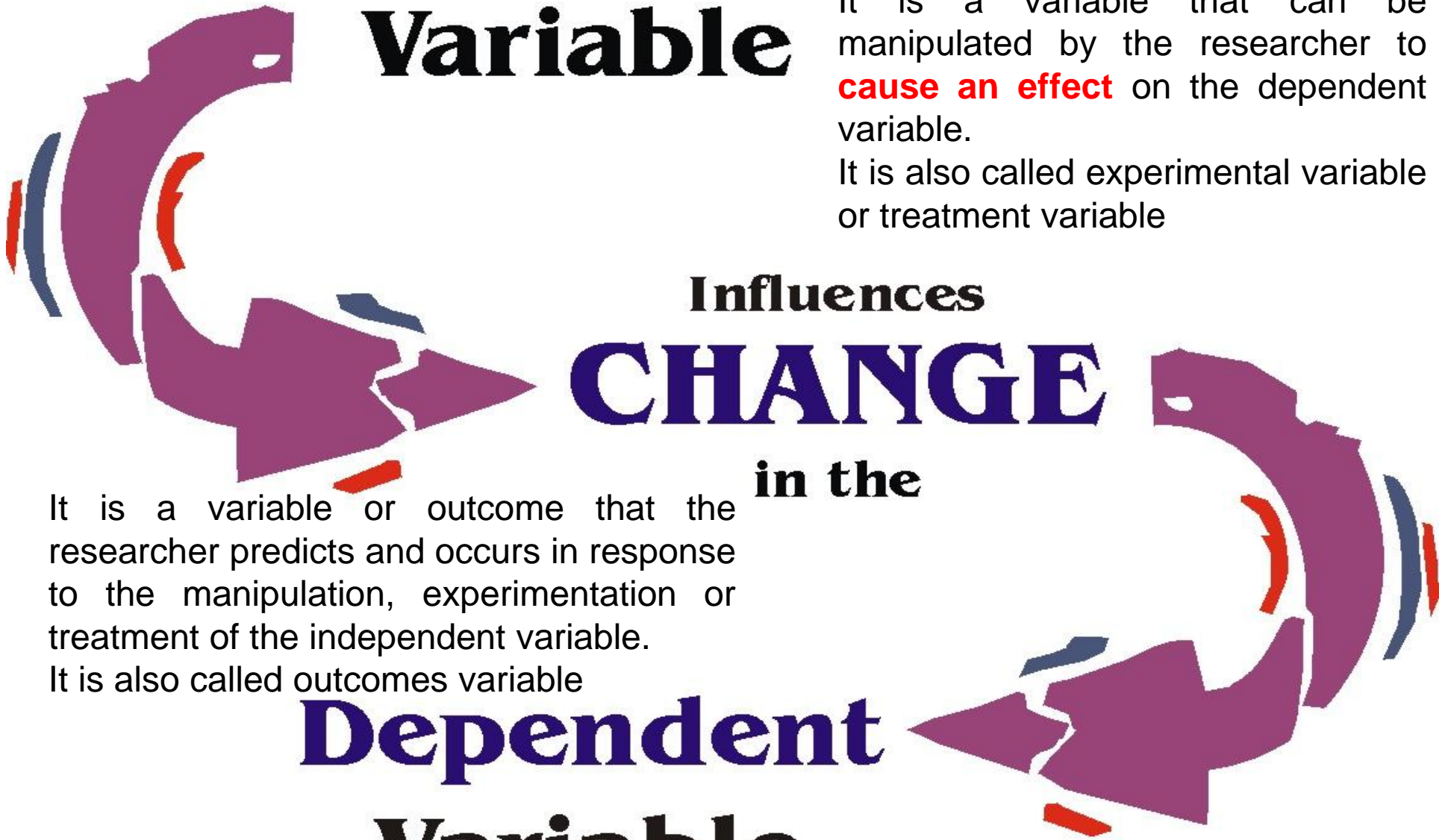
It is also called experimental variable or treatment variable

Influences  
**CHANGE**  
in the

It is a variable or outcome that the researcher predicts and occurs in response to the manipulation, experimentation or treatment of the independent variable.

It is also called outcomes variable

# Dependent Variable



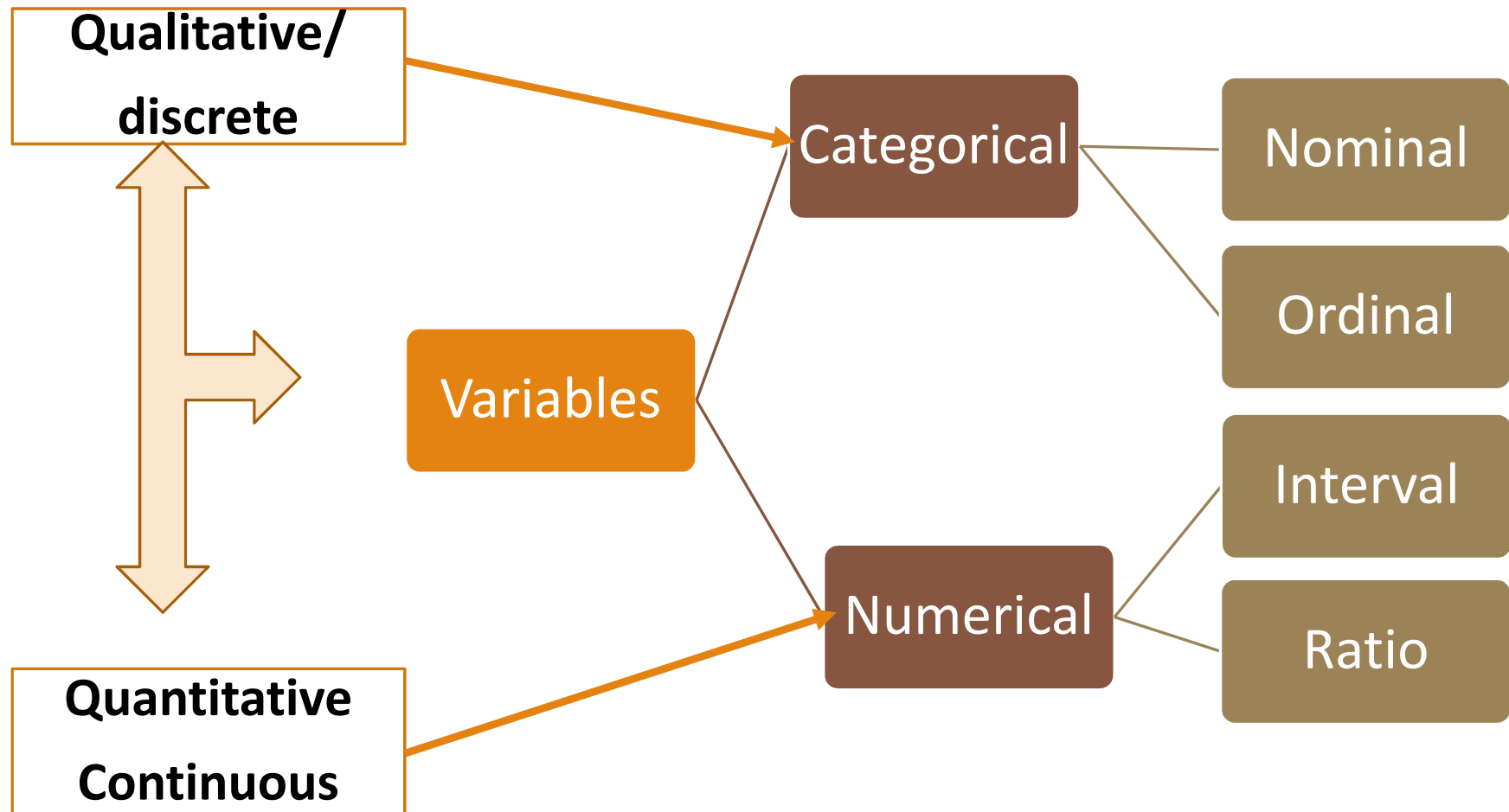
# Extraneous and confounding variables

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It is a characteristic or feature of objects, individuals, or environmental conditions, other than the factors of interest, that may influence the outcome of the study.

- ❖ Variables other than independent variables  
(e.g. personal, situational, experimenter)
- ❖ Must be carefully and systematically controlled across the in experiment

# Kinds of data measured





# Properties of Measurement Scales

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**Identity.** Each value on the measurement scale has a unique meaning.

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**Magnitude.** Values on the measurement scale have an ordered relationship to one another. That is, some values are larger and some are smaller.

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**Equal intervals.** Scale units along the scale are equal to one another. This means, for example, that the difference between 1 and 2 would be equal to the difference between 19 and 20.

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**A minimum value of zero.** The scale has a true zero point, below which no values exist.

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# *1-Nominal*

- ❖ Lowest of the four levels of measurement
- ❖ Categories that are not more or less (no order or ranking)
- ❖ Mutually exclusive (**no overlapping**) and exhaustive categories (**every one being measured**).
- ❖ Classifies data into names, labels or categories

Dichotomous  
multichotomous

## ***1-Nominal: 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)
- Answer to a questioner (YES=1, NO=2)
- Stroke classification according to side (right=0, left=1, both=2)
- Types of pain (aching, burning, stabbing)
- Occupation, and Educational level
- Blood groups

### **Statistics:**

Non-parametric using frequency, percentage, mode,  
Cross-tabulation and with chi-square)

## 2-Ordinal

- ❖ *Next up the list in terms of power of measurement.*
- ❖ *Classifies data into categories that can be ordered or rank*
- ❖ *No objective distance between any two points on the scale.*
- ❖ *Does not make sense to do calculations*
- ❖ *The simplest ordinal scale is a ranking.*



## *2-Ordinal: Practice in Therapy and Rehabilitation*

- ❖ Five point scales for manual muscle test
- ❖ Numerical rating pain scales
- ❖ Functional Independence Measure (FIM)
- ❖ Barthel Index(BI)
- ❖ Functional assessment scales

### **Statistics:**

non-parametric statistics using Median , Mode, Rank and Correlation

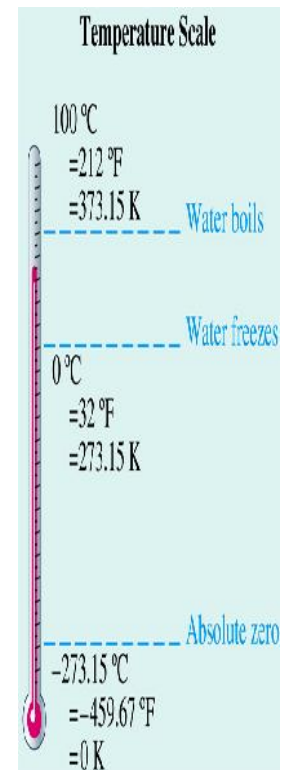
## 2-Ordinal: Practice in Therapy and Rehabilitation

Table 1 The Barthel Index of activities of daily living

Domain assessed	Score			
	0	5	10	15
Feeding	Unable	Requires assistance	Independent	
Bathing	Dependent	Independent		
Grooming	Needs help	Independent		
Dressing	Dependent	Needs some help	Independent	
Bowels	Incontinent	Occasional accident	Continent	
Bladder	Incontinent or catheterized	Occasional accident	Continent	
Toilet use	Dependent	Needs some help	Independent	
Transfers (bed to chair and back)	Unable	Major help	Minor help	Independent
Mobility (on level surface)	Immobile	Wheelchair independent > 50 yards	Walks with help of one	Independent
Stairs	Unable	Needs help	Independent	

## 3-Interval

- ❖ Interval scales are metric scales that have constant, equal distances between values, but the zero point is arbitrary.
- ❖ An interval scale is truly quantitative.




## *3-Interval: Practice in Therapy & Rehabilitation*

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The distance, for example, between a joint angle of  $10^{\circ}$  and  $18^{\circ}$  is the same as the difference between  $25^{\circ}$  and  $33^{\circ}$ .

**Statistics:** Interval scale data would use parametric statistic:

- Mean & standard deviation (SD)
  - Correlation and Analysis of variance
  - Factor analysis
  - Regression analysis
- 



# 4-Ratio

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- ❖ Highest for measurement
- ❖ A truly quantitative scale
- ❖ Absolute zero point:
- ❖ A ratio scale has the properties of order, equal distance between units and a fixed origin or absolute zero point.
- ❖ Parametric statistics can be used to analyze ratio scales.

## *4-Ratio: Practice in Therapy & Rehabilitation*

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The length (walking distance in meter )

Force exerted by a concentric muscle contraction in Newton-meter.

Age, Height, and Weight.

Temperature in Kelvin

Speed ,volume.

Isokeintic

**Statistics :** The same as for Interval data.



# Characteristics of 4 Levels of Scale Measurement

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

# Quick Test

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## Nominal, Ordinal, Interval or Ratio?

- Blood lactate concentration ( $\text{mmol.l}^{-1}$ )
- Profile of Mood States (scale 1-7)
- Heart Rate ( $\text{beats.min}^{-1}$ )
- Blood Group
- Bench Press 1RM (kg)
- Year of Birth (AD)
- Atmospheric Pressure (mmHg)

# Practice -1-

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Please reading carefully the following paper and then apply the concept related to

1-Different types of variables (e.g. Independent variable, Depended variable(s) , extraneous variables )

2- Different scales/Level of measurements (e.g. nominal , ordinal, ratio, interval)

**Effectiveness of Virtual Reality Using Wii Gaming Technology in Stroke Rehabilitation A Pilot Randomized Clinical Trial and Proof of Principle. *Stroke*. 2010;41:1477-1484.)**

# Practice -1-

1-Different types of variables (e.g. Independent variable, Dependent variable(s) , extraneous variables )

independent variables	Dependent variables	Extraneous variables

2- Different scales/Level of measurements (e.g. nominal , ordinal, ratio, interval)

Dependent variables and their level of measurements		
Variables	Level/scale	Statistical description/test

