Level of Measurements

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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

Norm referenced and criteria referenced measure
• 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**

**Dependent Variable**

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.
Extraneous and confounding variables

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

Qualitative/discrete

Variables

Categorical

Numerical

Quantitative/Continuous

Nominal

Ordinal

Interval

Ratio
Properties of Measurement Scales

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

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

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.

A minimum value of zero. The scale has a true zero point, below which no values exist.
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
<table>
<thead>
<tr>
<th>Domain assessed</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
<td>Unable</td>
<td>Requires assistance</td>
<td>Independent</td>
<td></td>
</tr>
<tr>
<td>Bathing</td>
<td>Dependent</td>
<td>Independent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grooming</td>
<td>Needs help</td>
<td>Independent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dressing</td>
<td>Dependent</td>
<td>Needs some help</td>
<td>Independent</td>
<td></td>
</tr>
<tr>
<td>Bowels</td>
<td>Incontinent</td>
<td>Occasional accident</td>
<td>Continent</td>
<td></td>
</tr>
<tr>
<td>Bladder</td>
<td>Incontinent or catheterized</td>
<td>Occasional accident</td>
<td>Continent</td>
<td></td>
</tr>
<tr>
<td>Toilet use</td>
<td>Dependent</td>
<td>Needs some help</td>
<td>Independent</td>
<td></td>
</tr>
<tr>
<td>Transfers (bed to chair and back)</td>
<td>Unable</td>
<td>Major help</td>
<td>Minor help</td>
<td>Independent</td>
</tr>
<tr>
<td>Mobility (on level surface)</td>
<td>Immobile</td>
<td>Wheelchair independent &gt; 50 yards</td>
<td>Walks with help of one</td>
<td>Independent</td>
</tr>
<tr>
<td>Stairs</td>
<td>Unable</td>
<td>Needs help</td>
<td>Independent</td>
<td></td>
</tr>
</tbody>
</table>
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.
The distance, for example, between a joint angle of 10° and 18° is the same as the difference between 25° and 33°.

**Statistics:** Interval scale data would use parametric statistic:
- Mean & standard deviation (SD)
- Correlation and Analysis of variance
- Factor analysis
- Regression analysis
4-Ratio

- 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

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

Nominal, Ordinal, Interval or Ratio?
- Blood lactate concentration (mmol.l$^{-1}$)
- Profile of Mood States (scale 1-7)
- Heart Rate (beats.min$^{-1}$)
- Blood Group
- Bench Press 1RM (kg)
- Year of Birth (AD)
- Atmospheric Pressure (mmHg)
Practice -1-

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

<table>
<thead>
<tr>
<th>independent variables</th>
<th>Dependent variables</th>
<th>Extraneous variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Dependent variables and their level of measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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</table>