Mathematics and Biostatistics

Variables and Measurements

1st Semester 2021

Lecture 2

Review

- **Statistics** is the branch of mathematical science that is focused on the collection, organization, and interpretation of numerical information.
- **data = numerical information = measurements = observations**
- **Biostatistics** is a specialized discipline of statistics that deals with statistical applications in the biological and health sciences.
- The design of health surveys, clinical trials, vital statistics, cancer survivorship studies and biological field studies are some specific biostatistical applications.
- Inference is making a generalization from a few specific measurements (sample) to a larger set of measurements (population).

Measurement

- Measurement is the assignment of a **numerical value** to some property or characteristic of a person or object.

- This simple definition covers the assignment of numeric codes for properties like gender, spoken languages or other non-quantitative properties.

Note: (These codes do not support arithmetic or numerical computation)..

Properties of Measurements

- identity, is the ability to identify differences between items regarding the property of the item being measured.
- order is the ability to rank the items based on the measurement. The ordering depends on whether one item has more or less of the property than another item.
- A scale of measurement allows one to not only say one item has more of a characteristic, but how much more or less in terms of units on a scale.

Quantitative Types Of Variables

- **Discrete:** The variable and it's measurement or value assignment has 'isolated' values.

- There are no fractional values between any two values, measurements or codes.

- Examples: number of patients, number of siblings, rankings on a scale of 1 to 5,
- categories of spoken languages coded with numbers.

Say 1=Arabic, 2=English, 3=French, 4=Chinese, etc.

Quantitative Types Of Variables

- **Continuous:** The measurement scale can be viewed as a one-to-one correspondence with a part of the real number line.
- There are no 'breaks' in the set of possible measurements. Between any two possible values there always can be found another value,
- Examples: Distance, mass, height.

Notes:

1. Most actual measurements are discrete.
2. The issue is to what degree of accuracy do required to carry out the work.

Qualitative Types Of Variables

- **Nominal:** A variable with value assignments for a characteristic which only has the property of identity.
- A ‘measurement that has this property allows items to be identified as different
- Example: Blood types, female vs. male, Green vs. Red.

Note:

1. There is no quantitative aspect to such a ‘measurement’ or coding assignment.
2. Such variables are always discrete categories.

Qualitative Types Of Variables

- **Ordinal:** A variable with a coding which has the property of identity, and order indicating more or less of an attribute.
- An example is patient prognosis*: Poor, Fair, Good, Excellent. University Graduation degrees : Bachelor, Master, Doctorate.
- Note:

1. all of these reduce to a ranking.
2. also, that such rankings are discrete.

*prognosis : an opinion, based on medical experience, of the likely course of a medical condition.

Other Types of Variables

- Interval: A variable with properties of identity, order and a scale of measurement. The scale quantitatively indicates how much more or less of a characteristic one item has relative to another.
- An interval measurement or variable does not have a true zero point. A value of zero does not mean a complete absence of the characteristic.
- Example: temperature in Celsius or Fahrenheit scale, where 0° does not correspond to an absence of heat (no true zero).

Other Types of Variables

- Ratio: A variable with measurements which holds identity, order, scale of measurement, and has an absolute or true 'zero' (distance, time, mass).
- Ratio is the most advanced level of measurement, which can handle most types of mathematical operations.

Ratio examples

1. Range of motion, no movement corresponds to zero degrees
2. The interval between 10 and 20 degrees is the same as between 40 and 50 degrees
3. Weight-lifting capacity, a person who is unable to lift scores zero. A person who lifts 30 kg can lift twice as much as one who lifts 15 kg.

Rounding of Numbers

- How we round is related to the level of precision in the measurement. A question that has to be answered is: to what nearest digit have these numbers been measured? Is it the nearest whole number, nearest, 10^{th}, nearest 100^{th} etc.

- When we report data in tables, or as statistics, then we only report to the level of precision in the measurements. So if you had values measured to the nearest 100^{th} you could only report values to two decimal places: ex: 123.45

Rounding of Numbers

- When rounding for this course follow this rule:

- If the ‘extra’ digit is a 0,1,2,3 or 4 do not round up. While if the extra digit is a 5, 6, 7, 8 or 9 round up.

Ex: Values to nearest 10^{th}: 12.45, 16.12 are rounded to 12.5 and 16.1.

Rounding of Numbers

- A further annoyance is that if you report a weight like 80.0 kg, that value lies in an interval of 79.5 up to 80.4 inclusive.
- You may recall intervals in mathematics given as: [139.5, 140.4] or [139.5, 140.5).
- The square bracket implies the endpoint is in the interval, while the rounded bracket indicates the value is not, but that every value up to but not including 140.5 is included.
- Every now and then this type of issue pops up and can be annoying.

End of Lecture 2