

Statistics Corner: Measurement Scales

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For Today's Graduate, Just One Word: Statistics¹

REALITY CHECK

"Let us assume that an investigator conducted a randomized trial to compare the effectiveness of yoga and a standard drug on patients with schizophrenia. The trial consisted of 200 participants of age 60–80 years old. Furthermore, the investigator also collected data on variables such as sex, religion, the severity of disease, stress, IQ, temperature, height, and weight of the participants." In the given context can you identify:

- How many variables were captured by the investigator in the trial?
- Which of these were Nominal, ordinal, Interval or Ratio scale variables?
- What was the unit of observation in the trial?
- How many replications were there in the trial?

Statistics has penetrated almost all the domains of life. This is more so with science where measurements and qualifications are a part of the routine of the researchers. Even medical science has not remained untouched with this trend. However, misuse of statistics by medical researchers is also commonplace when they attempt to indulge in 'Do it yourself' analysis. The reason for this can be attributed to the easy availability of user-friendly statistical software and powerful computers in recent decades.² Appropriate statistics helps to convey information from medical data, but first, we need to understand—what is data?

Understanding Data

In the crudest way, data can be defined as the information which is omnipresent. It can be structured, semi-structured or unstructured. It is important to note that not all the available information is required to conduct a study. The relevant information related to the objectives of the study are carefully collected as variables with the help of



Fig. 1: Frequently used terminology in context to data

appropriate tools. Broadly, variables can be segmented as qualitative and quantitative. But, merely this distinction does not help in their analysis and interpretation. There are finer aspects which need to be understood to make sense out of the data. "Word Cloud" displayed in Figure 1 present various terminologies used in context to the data.

This article is an attempt to introduce the fundamentals of the data. Any variable is assigned numerals according to the predefined standards. It may be labeled as nominal, ordinal, interval or ratio scale variable as per the property or a set of properties of the abstract number system (Table 1).

Nominal Variable

A nominal variable represents the categories without natural ordering. Numbers are arbitrarily assigned to the different categories. These numbers do not follow the usual principle of arithmetic (addition, subtraction, multiplication, and division) and follow the property of identity. Different types of religious group such as Hindu, Sikh, Muslim, Christian, etc., can be arbitrarily assigned number 1, 2, 3 and 4 to represent different categories.

Ordinal Variable

An ordinal variable represents the categories having natural ordering and can be expressed in terms of the

Table 1: Four fundamental properties of the abstract number system

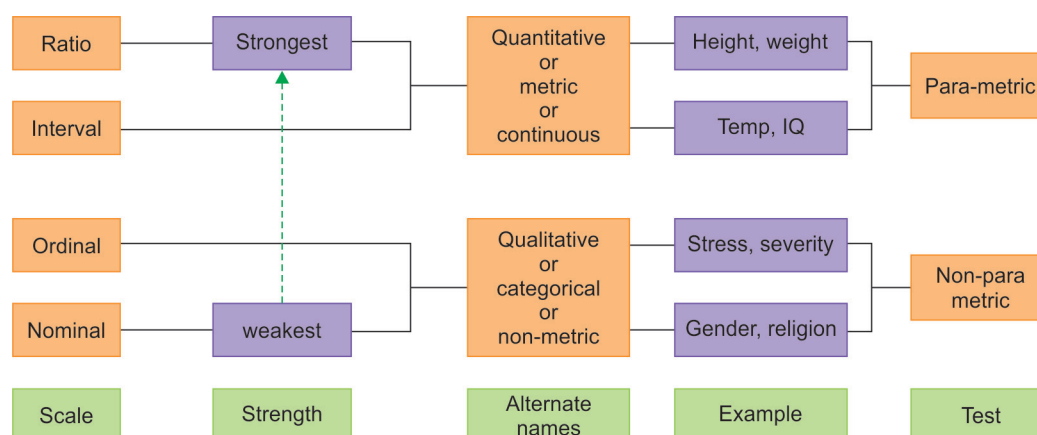
<i>Identity:</i> Different numerals display different classification	<i>Magnitude:</i> Different numerals display different identity and magnitude
<i>Interval:</i> Numerals are meaningful and display property of equidistance	<i>True Zero:</i> Represents the absence of an attribute

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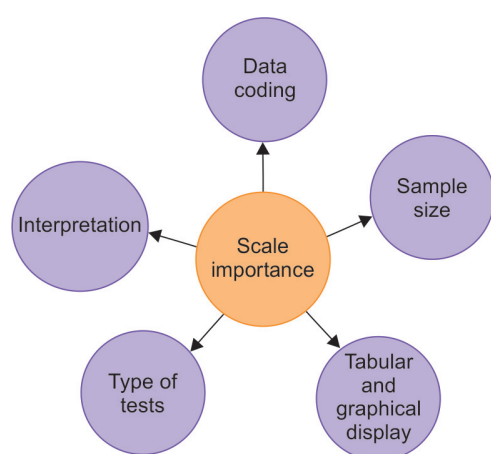
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Flow Chart 1: Properties of Scales



Flow Chart 2: A web of scale and different domain of statistics



ranks. The assigned numbers display properties of identity and magnitude as numbers are assigned in the increasing or decreasing order. Ranking of the severity of disease in categories not severe, mild, moderate and very severe by different patients indicate a hierarchy of order.

Interval Variable

The numbers in the interval variable are meaningful and represent the property of equidistance. Different numerals can be compared in relative terms as compared to absolute terms. Temperature scale and IQ scale displays the property of interval. The difference between 20°C and 30°C is equivalent to 40°C and 50°C, but 40°C is not as twice as hot as 20°C. Moreover, a temperature of 0°C does not mean the absence of the temperature. It only informs about relative hotness or coldness of a body.

Ratio Variable

This type of variable represents all the properties of the abstract number system. It is most sensitive and possesses the characteristics of true zero. Height and weight have meaningful zero, and 40 kg weight is twice the 20 kg. The properties of different scales, alternative names and their hierarchy from weakest to strongest are presented in Flow Chart 1.

Table 2: Definition of important terms

Variable: A characteristics that vary from subject to subject	Measurement: It is defined as an assessment of characteristics of objects/events with numerals according to a certain pre-defined rule
Replication: A replication is a group of units randomly allocated between different interventions	Units: A fundamental entity of observation measured under scientific investigation. It is also known as element, individual, cluster and/or subject

Differentiations between variables in terms of measurement scales are very important. Flow Chart 2 displays different aspects of statistics that demand an understanding of measurement scales. The characteristics of the variable will help in the identification and selection of appropriate descriptive and inferential statistics. Moreover, it also helps in planning a study with a minimum number of sample size required.

It is important to know that besides knowing about the four types of variables: knowledge of variable, measurement, replication, and units in context to data are important. The definitions of these terms are presented in Table 2.

Solutions

- There are 10 variables in the study (type of intervention, age, sex, religion, the severity of disease, stress, height, weight, IQ, and temperature).
- Nominal (type of intervention, sex, religion), ordinal (stress, the severity of disease), interval (IQ, temperature), ratio (age, height, weight).
- A schizophrenia patient is the unit of observation.
- There are 200 replications or participants in the study.

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