Levels of Measurement | Nominal, Ordinal, Interval and Ratio

Levels of measurement, also called scales of measurement, tell you how precisely variables are recorded. In scientific research, a variable is anything that can take on different values across your data set (e.g., height or test scores).

There are 4 levels of measurement:

- **Nominal:** the data can only be categorized
- **Ordinal:** the data can be categorized and ranked
- **Interval:** the data can be categorized, ranked, and evenly spaced
- **Ratio:** the data can be categorized, ranked, evenly spaced, and has a natural zero.

Depending on the level of measurement of the variable, what you can do to analyze your data may be limited. There is a hierarchy in the complexity and precision of the level of measurement, from low (nominal) to high (ratio).

Nominal, ordinal, interval, and ratio data

Going from lowest to highest, the 4 levels of measurement are cumulative. This means that they each take on the properties of lower levels and add new properties.

Nominal level	Examples of nominal scales
You can categorize your data by labelling them in mutually exclusive groups, but there is no order between the categories.	• City of birth • Gender • Ethnicity • Car brands • Marital status
Ordinal level	**Examples of ordinal scales**
You can categorize and rank your data in an order, but you cannot say anything about the intervals between the rankings. Although you can rank the top 5 Olympic medallists, this scale does not tell you how close or far apart they are in number of wins.	• Top 5 Olympic medallists • Language ability (e.g., beginner, intermediate, fluent) • Likert-type questions (e.g., very dissatisfied to very satisfied)
Interval level	**Examples of interval scales**
You can categorize, rank, and infer equal intervals between neighboring data points, but there is no true zero point. The difference between any two adjacent temperatures is the same: one degree. But zero degrees is defined differently depending on the scale – it doesn't mean an absolute absence of temperature. The same is true for test scores and personality inventories. A zero on a test is arbitrary; it does not mean that the test-taker has an absolute lack of the trait being measured.	• Test scores (e.g., IQ or exams) • Personality inventories • Temperature in Fahrenheit or Celsius
Ratio level	**Examples of ratio scales**
You can categorize, rank, and infer equal intervals between neighboring data points, and there is a true zero point. A true zero means there is an absence of the variable of interest. In ratio scales, zero does mean an absolute lack of the variable. For example, in the Kelvin temperature scale, there are no negative degrees of temperature – zero means an absolute lack of thermal energy.	• Height • Age • Weight • Temperature in Kelvin

Why are levels of measurement important?

The level at which you measure a variable determines how you can analyze your data.

The different levels limit which descriptive statistics you can use to get an overall summary of your data, and which type of inferential statistics you can perform on your data to support or refute your hypothesis.

In many cases, your variables can be measured at different levels, so you have to choose the level of measurement you will use before data collection begins.

Example of a variable at 2 levels of measurementYou can measure the variable of income at an ordinal or ratio level.

- **Ordinal level:** You create brackets of income ranges: $0–$19,999, $20,000–$39,999, and $40,000–$59,999. You ask participants to select the bracket that represents their annual income. The brackets are coded with numbers from 1–3.
- **Ratio level:** You collect data on the exact annual incomes of your participants.

Participant	Income (ordinal level)	Income (ratio level)
A	Bracket 1	$12,550
B	Bracket 2	$39,700
C	Bracket 3	$40,300

At a ratio level, you can see that the difference between A and B’s incomes is far greater than the difference between B and C’s incomes.

At an ordinal level, however, you only know the income bracket for each participant, not their exact income. Since you cannot say exactly how much each income differs from the others in your data set, you can only order the income levels and group the participants.

Which descriptive statistics can I apply on my data?

Descriptive statistics help you get an idea of the "middle" and "spread" of your data through measures of central tendency and variability.

When measuring the central tendency or variability of your data set, your level of measurement decides which methods you can use based on the mathematical operations that are appropriate for each level.

The methods you can apply are cumulative; at higher levels, you can apply all mathematical operations and measures used at lower levels.

Data type	Mathematical operations	Measures of central tendency	Measures of variability
Nominal	• Equality (=, ≠)	• Mode	• None
Ordinal	• Equality (=, ≠) • Comparison (>, <)	• Mode • Median	• Range • Interquartile range
Interval	• Equality (=, ≠) • Comparison (>, <) • Addition, subtraction (+,−)	• Mode • Median • Arithmetic mean	• Range • Interquartile range • Standard deviation • Variance
Ratio	• Equality (=, ≠) • Comparison (>, <) • Addition, subtraction (+,−) • Multiplication, division (×, ÷)	• Mode • Median • Arithmetic mean • *Geometric mean	• Range • Interquartile range • Standard deviation • Variance • **Relative standard deviation

*Arithmetic mean is the most commonly used type of mean. A **geometric mean** is a method used for averaging values from scales with widely varying ranges for individual subjects. You can then compare the subject level means with each other. While an arithmetic mean is based on adding values, a geometric mean multiplies values.**__Relative standard deviation__** is simply the standard deviation divided by the mean. If you use it on temperature measures in Celsius, Fahrenheit and Kelvin, you'd get 3 totally different answers. The only meaningful answer is the one based on a scale with a true zero, the Kelvin scale.