

Frequently Asked Question:

I feel like the Cronbach Alpha measure of reliability lowers down the reliability for my binary data set. Is there another measure of reliability especially for binary data? And what is the cut off value for such a measure?

Reliability is the correlation of an item, scale, or instrument with a hypothetical one which truly measures what it is supposed to. Since the true instrument is not available, reliability is estimated in one of four ways:

1. *Internal consistency*: Estimation based on the correlation among the variables comprising the set (typically, Cronbach's alpha)
2. *Split-half reliability*: Estimation based on the correlation of two equivalent forms of the scale (typically, the Spearman-Brown coefficient)
3. *Test-retest reliability*: Estimation based on the correlation between two (or more) administrations of the same item, scale, or instrument for different times, locations, or populations, when the two administrations do not differ on other relevant variables (typically, the Spearman Brown coefficient)
4. *Inter-rater reliability*: Estimation based on the correlation of scores between/among two or more raters who rate the same item, scale, or instrument (typically, intraclass correlation, of which there are six types discussed below).

These four reliability estimation methods are not necessarily mutually exclusive, nor need they lead to the same results. All reliability coefficients are forms of correlation coefficients, but there are multiple types discussed below, representing different meanings of reliability and more than one might use in single research setting.

Cronbach's alpha is the most common form of internal consistency reliability coefficient. Alpha equals zero when the true score is not measured at all and there is only an error component. Alpha equals 1.0 when all items measure only the true score and there is no error component.

- *Interpretation*: Cronbach's alpha can be interpreted as the percent of variance the observed scale would explain in the hypothetical true scale composed of all possible items in the universe. Alternatively, it can be interpreted as the correlation of the observed scale with all possible other scales measuring the same thing and using the same number of items.
- *Cut-off criteria*. By convention, a lenient cut-off of .60 is common in exploratory research; alpha should be at least .70 or higher to retain an item in an "adequate" scale; and many researchers require a cut-off of .80 for a "good scale." Cronbach's alpha is discussed further in the section on standard measures and scales, along with other coefficients such as Cohen's kappa.

- *The Kuder-Richardson (KR20) coefficient is the same as Cronbach's alpha when items are dichotomous.*

Kuder-Richardson Formula 20 (From Wikipedia, the free encyclopedia)

In statistics, the **Kuder-Richardson Formula 20** (KR-20) is a measure of internal consistency reliability for measures with dichotomous choices, first published in 1937. It is analogous to Cronbach's α , except Cronbach's α is used for non-dichotomous (continuous) measures. A high KR-20 coefficient (e.g., >0.90) indicates a homogeneous test.

Values can range from 0.00 to 1.00 (sometimes expressed as 0 to 100), with high values indicating that the examination is likely to correlate with alternate forms (a desirable characteristic). The KR20 is impacted by difficulty, spread in scores and length of the examination.

In the case when scores are not tau-equivalent (for example when there is not homogeneous but rather examination items of increasing difficulty) then the KR-20 is an indication of the lower bound of internal consistency (reliability).

$$\alpha = \frac{K}{K - 1} \left[1 - \frac{\sum_{i=1}^N p_i q_i}{\sigma_X^2} \right]$$

Note that variance for KR-20 is

$$\sigma_X^2 = \frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N}$$

If it is important to use unbiased operators then the Sum of Squares should be divided by degrees of freedom ($N - 1$) and the probabilities are multiplied by

$$\frac{N}{N - 1}$$

Since Cronbach's α was published in 1951, there has been no known advantage to KR-20 over Cronbach. KR-20 is seen as a derivative of the Cronbach formula, with the advantage to Cronbach that it can handle both dichotomous and continuous variables.