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Document heading **doi: 10.21276/apjhs.2016.3.4.43** **Research article**

A focus on reliability in developmental research through Cronbach's Alpha among medical, dental and paramedical professionals

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ABSTRACT

Background: The purpose of this paper is to demonstrate the quantitative methods used to determine reliability in developmental research. Author represented methods of reliability and emphasizing the technique and conditions for reliability through Cronbach's Alpha that have been utilized in medical, dental and paramedical education. **Materials and Methods:** Validity and reliability of a questionnaire are the basic elements in the development of a measurement instrument. Reliability may be calculated in a number of ways but Cronbach's alpha is widely used measure of internal consistency or reliability of a survey instrument. Calculating alpha has become common practice in medical, dental and paramedical education research when dichotomous and multiple-item measures of a concept are applied. **Results:** Cronbach Alpha can be employed significantly for both binary-type and large-scale data to judge the reliability of the instrument. The study demonstrated the technique of interpreting the reliability by using Chronbach's alpha for one domain of the questionnaire administered among 60 samples was developed by Elango. Cronbach's alpha demonstrates the internal consistency based on average correlation or the co-variances of items in a survey instrument or development of a questionnaire. Unstandardized alpha is based on the covariance matrix while the standardized alpha based on the correlation matrix. Overall, alpha is the most appropriate measure of reliability when the items measure different substantive areas within a single construct. **Conclusion:** This article spread awareness and offers an understanding of use of Chronback's alpha and basic guidelines in reporting the reliability of a survey instrument (questionnaire) in development research studies accurately and scientifically so that the instrument get validation for its use in future.

Key words: Cronbach Alpha, Likert format, Reliability, Validity, Measurement Error

Introduction

The Likert scale format is widely used technique to assess attitudes discovered in 1931 by Rensis Likert. [1] The Likert scale is a valuable and important part of survey research commonly used in public health evaluation. Information gathered in the social sciences, marketing, medicine, and business, relative to attitudes, emotions, opinions, personalities, and descriptions of people's environment involves the use of Likert-type scales [2] which re-described in 1981 by McIver and Carmines. [3] Validity and reliability are two fundamental elements in the evaluation of a measurement instrument to enhance the accuracy of their assessment and evaluations. [4] Cronbach's alpha determines the internal consistency or average correlation of items in a survey instrument to gauge its reliability [5] and is a test reliability technique that requires only a single test administration. Reliability is concerned with the ability of an instrument to measure consistently [6] while the reliability does not depend on validity of an instrument. [7]Cronbach's alpha requires one test administration but frequent use of alpha in the literature, meaning, proper use and interpretation of alpha is not clearly understood. [8-9] It is a marker of internal consistency [4, 10-11] but the standard error of measurement (SEM) must be calculated to judge the effect of measurement error on the observed score of an individual student. [12] While calculating alpha, the underlying assumptions behind alpha must be satisfied in order to promote its more effective use and a sound statistical tool to observe an instrument as a reliable instrument. The theoretical distinction between the two coefficients (Cronbach's alpha: unstandardized alpha,

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based on the covariance matrix, and standardized alpha based on the correlation matrix) are lacking, which can lead to the misconception that the differences between two coefficients are unimportant and to the temptation to report the larger coefficient. [13]The value of alpha significantly depends on correlation among pairs of items in a questionnaire and affected by the length of the test and a high value such as 0.95 doesn't indicated high degree of reliability. More related items testing the same concept should be added to the test to increase the coefficient alpha. [7] It is also important to note that alpha is a property of the scores on a test from a specific sample of testees. Therefore investigators should not rely on published alpha estimates and should measure alpha each time the test is administered. [14] Investigators are frequently using Cronbach's alpha to determine the reliability but many conditions where nature of data triggers the extent of coefficient alpha's underestimation of reliability.

Various studies documented significant use of Cronbach's alpha in medical, dental and paramedical education to assess and improve upon the reliability of a survey instrument or a questionnaire. The author hypothesized that help from biostatistician will be more fruitful for those who are willing to carry out reliability and validity of an instrument especially in the field of biological sciences. Therefore, Medical, Dental and Para-medicals have been taught methods for selecting and appropriate method of statistical reliability. Overall, they needed to understand the intricacies of the statistical methods. [15] In this article, the author aimed to create awareness about the statistical reliability in developmental research through Cronbach's Alpha among medical, dental and paramedical professionals. Reliability of an instrument may be judged accurately and the article allows understanding the meaning of Cronbach's alpha.

Materials and methods: Data collected and compiled from experimental work, records and surveys should be accurate and checked for accuracy and adequacy before processing further. [15] Perhaps the greatest difficulty in conducting research in organizations is assuring the accuracy of measurement of the constructs under examination. [16] A researcher wants to confirm that the data gathering instrument being used will measure what it is supposed to measure and will do this in a consistent manner and can only be identified by establishing the validity and reliability of the research instrument. In general, there are four ways to determine the reliability or consistency of a measurement device (survey, test, questionnaire, etc.). (1)-Inter-Rater/Observer Reliability: The degree to which different raters/observers give consistent answers or estimates. (2)-Test-Retest Reliability: The consistency of a measure evaluated over time. (3)-Parallel-Forms Reliability: The reliability of two tests constructed the same way, from the same content and (4)-Internal Consistency Reliability: The consistency of results across items, often measured with Cronbach's Alpha.Reliability may be calculated in a number of ways, but the most commonly accepted measure in field studies is internal consistency reliability using Cronbach's alpha. [17] Likert scales used to assess the attitude about a particular topic, belief, or behavior items, and are a valuable and important part of survey research commonly used in public health evaluation, is an ordered scale from which respondents choose one option that best aligns with their view. Generally, Likert scales used to measure respondents' attitudes by asking the extent to which they agree or disagree with a particular question or statement. A classical scale might be "Strongly disagree, Disagree, Neutral, Agree, Strongly agree." Two versions of Cronbach's alpha are available in literature and in various statistical software are unstandardized alpha and standardized alpha. The knowledge of theoretical distinction between the two coefficients leads to misconception. To report of larger coefficient misleads the verification of reliability of an instrument. However, the unstandardized alpha is based on the covariance matrix while the standardized alpha based on the correlation matrix. Overall selection of an appropriate reliability coefficient based on theoretical considerations will confirm the significance of reliability. The details of reliability using Cronbach's alpha presented in result section.

Results

Choosing the appropriate reliability of an instrument with relevant statistical analysis technique is largely dependent on the complexity of the aim and objectives of the proposed research in medical and paramedical research. Cronbach Alpha coefficient is invented by Professor Cronbach, and is a measure of squared correlation between observed scores and true scores.

What is Cronbach alpha?

Alpha was firstly employed in 1951 by Lee Cronbach [18] which presented a measure of the internal consistency of a test or scale and numerically treated between 0 and 1. The basic classical test theory indicated that the reliability of test scores can be expressed as the ratio of the true-score and total-score (error plus true score) variances. Definition of Cronbach alpha suggested as: Suppose that we measure a quantity which is a sum of K components (K-items):

$X = Y_1 + Y_2 + \ldots\ldots\ldots + Y_K$ than unstandardized Cronbach's alpha is defined as $\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K}\sigma^2_{Y_i}}{\sigma^2_X}\right)$

Where σ^2_X is the variance of the observed total test scores, and $\sigma^2_{Y_i}$ the variance of component *i* for the current sample of persons.[19] If the items are scored 0 and 1, a shortcut formula is [20] $\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K}P_i\,Q_i}{\sigma^2_X}\right)$ where P_i is the proportion scoring 1 on item *i*, and Q_i =1-P_i. Alternatively, Cronbach's alpha can be defined as $\alpha = \frac{K\bar{c}}{(\bar{v} + (K-1)\bar{c})}$ where K is as above, $\bar{v}$ the average variance of each component (item), and the average of all covariance's between the components across the current sample of persons (that is, without including the variances of each component).

The standardized Cronbach's alpha can be defined as $\alpha_{standardized} = \frac{K\bar{r}}{(1 + (K-1)\bar{r})}$ where K is as above and $\bar{r}$ the mean of the [K(K-1)/2] non-redundant correlation coefficients (i.e., the mean of an upper triangular, or lower triangular, correlation matrix). Reliability of an instrument should be observed before employing relevant statistical analysis in research to confirm validity. Reliability indicates the amount of measurement error and mutual dependence among paired items in a test. The measurement error calculated by squaring the correlation and subtracting from numeric one produces the index. For example, if a test has a reliability of 0.80, there is 0.36 error variance (random error) in the scores (0.80×0.80 = 0.64; 1.00 – 0.64 = 0.36). [21]

Use of Cronbach's alpha

Cronbach Alpha can be employed significantly for both binary-type and large-scale data. The number of test items, item interrelatedness and dimensionality affect the value of alpha. [22] Low value of alpha could be due to a low number of questions and consequently the low correlations among pairs and hence some items may be deleted. If alpha is too high very close to one then it may suggest that some items are redundant as they are testing the same question but in a different guise. A maximum alpha value of 0.90 has been recommended. [14]

Table 1: Selection of coefficient of alpha to observe the extent of reliability of instrument

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Table 1 reveals the ranges of coefficient of alpha to observe the extent of reliability of instrument. As the value of coefficient of alpha increase the instrument tends to be more reliable. There are different reports about the acceptable values of alpha, ranging from 0.70 to 0.95. [7, 23].

A commonly accepted rule for describing internal consistency using Cronbach's alpha is as follows [24-25] though a greater number of items in the test can increase the value of alpha [22] and a sample with a narrow range can deflate it, so this rule should be used with caution.

How to calculate Cronbach's Alpha

A questionnaire developed by Elango JK *et al*. in 2009 to measure the awareness of oral cancer, its risk factors and to estimate the prevalence of risk factors in a high-risk semi-urban population in India. [26] For instance, the study illustrated one domain of the questionnaire was presence of symptoms of oral cancer among 60 samples were administered the questionnaire and analyzed the reliability by using Chronbach's alpha.

Table 2: Dichotomous statements to measure the awareness of oral cancer

Q. No.	Presence of symptoms	Yes	No
1	Have you ever visited a dentist?	Yes	No
2	Have you ever examined your oral cavity?	Yes	No
3	Do you have difficulty in opening the mouth?	Yes	No
4	Do you have burning sensation on eating normal food/ hot and spicy food?	Yes	No
5	Do you have any red or white patches in your oral cavity?	Yes	No
6	Do you have any sharp tooth that hurt your cheek?	Yes	No
7	Do you have any ulcer that has not healed for more than 3 weeks?	Yes	No
8	Have you noticed a change in voice in the last 2-3 weeks or before that?	Yes	No
9	Do you continuously suffer from earache?	Yes	No
10	Do you have difficulty in swallowing food?	Yes	No
11	Have you noticed any swelling in your neck?	Yes	No

Dichotomous statements were presented in table 2. Single domain of the questionnaire was designed to measure the presence of symptoms of oral cancer among studied subjects.

Table 3: Inter-Item Correlation Matrix

	Correlation among pairs of questions									
Q. No.	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	.644	-.421	-.194	-.241	-.020	-.206	-.331	-.251	-.251	-.331
2	-	-.254	-.019	-.254	-.200	-.144	-.254	-.281	-.183	-.075
3	-	-	.465	.400	.250	.395	.400	.351	.614	.520
4	-	-	-	.361	.323	.270	.361	.340	.453	.465
5	-	-	-	-	.597	.534	.760	.219	.614	.520
6	-	-	-	-	-	.365	.597	.321	.574	.366
7	-	-	-	-	-	-	.673	.468	.621	.395
8	-	-	-	-	-	-	-	.482	.745	.520
9	-	-	-	-	-	-	-	-	.567	.351
10	-	-	-	-	-	-	-	-	-	.745

Table 3 shows the correlation matrix which projects clearly that question number one and two had an inverse relationship with rest questions. Rest pairs showed significant relationship. Henceforth, to delete either question number one or two from the questionnaire may increase the value of coefficient of alpha and may be verified precisely by next table four.

Table 4: Item Analysis

Reliability Statistics		**Cronbach's Alpha**		**Cronbach's Alpha Based on Standardized Items**		**N of Items**
		0.734		0.786		11
Scale Statistics		**Mean**	**Variance**		**Std. Deviation**	**No. of Items**
		13.53	5.270		2.296	11
Summary of Item Statistics	**Variable**	**Mean**	**Minimum**	**Maximum**	**Range**	**Variance**
	Item Means	1.230	1.117	1.567	0.450	0.023
	Item Variances	0.159	0.105	0.254	0.149	0.003
	Q. No.	**Scale Mean if Item Deleted**	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Squared Multiple Correlation**	**Cronbach's Alpha if Item Deleted**
Item-Total Statistics	**1**	11.97	5.524	-0.215	0.630	0.809
	2	12.05	5.303	-0.123	0.566	0.797
	3	12.37	4.440	0.435	0.529	0.708
	4	12.28	4.206	0.487	0.355	0.699
	5	12.37	4.202	0.601	0.698	0.685
	6	12.35	4.231	0.552	0.527	0.691
	7	12.42	4.383	0.577	0.527	0.694
	8	12.37	4.101	0.676	0.789	0.675
	9	12.40	4.549	0.413	0.481	0.712
	10	12.40	4.041	0.807	0.830	0.662
	11	12.37	4.202	0.601	0.666	0.685

Table four highlights the item-analysis to measure the presence of symptoms of oral cancer among samples. For interpretation, a description of the sections and related terms are presented in this article. Summary statistics for the eleven items comprising the scale shown in table entitled "scale statistics". The summated item scores had range (0.450) from 1.117 to 1.567. The descriptive statistics for items such as mean, standard deviation and variance are presented in summary of item statistics. The "Reliability Statistics" presents two different values for Cronbach's Alpha. The value of alpha in the second column of table four is 0.734 which is treated as raw or unstandardized value of alpha based upon item covariance that measured the distributions of two variables. The value of alpha is little higher in the third column is 0.786 is treated as standardized value of alpha based upon item correlation, and the stronger the items are inter-related, the more likely the test is consistent. The choosing of alpha must be based on statistical tool either covariance or correlation but not as to show the larger value.The section entitled Item-total Statistics have to analyze carefully can provide fruitful results as one can select item(s) to delete and consequently the value of coefficient of alpha may increase. First two columns indicated the scale mean and variance if item deleted. In table 4, the mean and variance of the summated scores excluding item 1 is 11.97 and 5.524 respectively. The caption "Corrected Item-Total Correlation" were designed to identify the correlation of the item designated with the summated score for all other items. A rule-of-thumb is that these coefficients of correlation should be at least 0.40, indicating the correlation is fair. Next caption is "Squared Multiple Correlation" is the predicted square of multiple correlation coefficient obtained by regressing the identified individual item on all the remaining items. In table 4, the predicted squared multiple correlation is 0.630 by regressing item 1 on item 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11.The last column captioned "Cronbach's Alpha if Item Deleted is the most significant column shows the reliability coefficient (Cronbach's alpha) for internal consistency of a scale (instrument) if an individual item is deleted from the scale. Cronbach's alpha would be 0.809 if item 1 in table 4 were deleted from the scale. This value is then compared to the value of alpha (0.734 for unstandardized items) at the top of the table to see if researcher wants to delete the

item. Using the above information the deletion of item one resulted in an increase in Cronbach's alpha from 0.734 to 0.809.

Discussion

This research article offers an in-depth understanding of use of an appropriate reliability method to enhance the chance of validation of a developmental research in medical, detal and paramedical science. However, the decisive instrumental (i.e., applied) knowledge is expressed together with some statistical degree of confidence. [15] Problems with the reliability and validity of measures used on survey questionnaires continue to lead to difficulties in interpreting the results of field research. When using Likert-type scales it is imperative to calculate and report Cronbach's alpha coefficient for internal consistency reliability for any scales or subscales. [2] In a medical research Aisha MAl-Osail et al. used Cronbach's alpha, Spearman's rank correlation and R2 coefficient determinants to observe the stability of the stations on the three examinations and Cronbach's alpha indicated good internal consistency in increased manner as compared to rest two. [27]Coefficient alpha, the most commonly used estimate of internal consistency, is often considered a lower bound estimate of reliability, though the extent of its underestimation is not typically known. [28] Many researchers are unaware that coefficient alpha is based on the essentially tau-equivalent measurement model. It is the violation of the assumptions required by this measurement model that are often responsible for coefficient alpha's underestimation of reliability. Coefficient alpha, is based on the essentially tau-equivalent measurement model, a measurement model that requires a number of assumptions to be met for the estimate to accurately reflect the data's true reliability observed by Raykov in 1997 [29] which was in agreement with Tavakol M, Dennick R [4] revealed that alpha is affected by the test length and dimensionality. Alpha as an index of reliability should follow the assumptions of the essentially tau-equivalent approach. Tavakol and Dennick showed that the understanding of the associated concepts of internal consistency, homogeneity or unidimensionality can help to improve the use of alpha. If the items in a test are correlated to each other, the value of alpha is increased. However, a high coefficient alpha does not always mean a high degree of internal consistency. [4]Reliability tests are especially important when derivative variables are intended to be used for subsequent predictive analyses. If the scale shows poor reliability, then individual items within the scale must be re-examined and modified or completely changed as needed. One good method of screening for efficient items is to run an exploratory factor analysis on all the items contained in the survey to weed out those variables that failed to show high correlation. [5]There is a distinction between the coefficients of unstandardized and standardized alpha and is lacking can lead to the misconception. To select an appropriate coefficient will be fruitful for betterment of an instrument in term of reliability and avoid the habit to report the larger coefficient. Falk and Savalei clarify in 2011 that the theoretical meaning of each coefficient and conclude that researchers should choose an appropriate reliability coefficient based on theoretical considerations. [13]Cronbach's alpha projects the internal consistency based on average correlation or the co-variances of items in a survey instrument or development of a questionnaire to measure its reliability. As a result, alpha is most appropriately used when the items measure different substantive areas within a single construct but when the set of items measures more than one construct, coefficient omega hierarchical is more appropriate. [30-32]. An integrated approach by undertaking the statistical concept of reliability of an instrument in-depth would ensure the more reliable instruments to measure the construct, and a more effective instrument (scale) to measure patient's awareness, perception, and attitude towards the diseases for the promotion of medical and paramedical research may established. Lastly, author do hope that this article will provide clinicians, denticians and other paramedical specialists with hands-on experience to promote the use of Chronback's alpha to observe the reliability of an instrument to make educated decisions whenever there is a need of developmental research.

Conclusion

This article dedicated to an understanding of use of Chronback's alpha and basic guidelines in reporting the reliability of a survey instrument (questionnaire) in development research studies accurately and scientifically so that the instrument get validation for its use in future.The main objective of reporting the reliability of a survey instrument (questionnaire) deals with the extent to which the instrument yields the same results on repeated trials. Provided guidelines in the article may contribute to an improvement in the employment of reliability statistics and consequently the research instrument get valid. Author do hope that this research article will enable clinicians, dietician and paramedical to enhance their statistical skills and experience essential to carry out an appropriate

technique of statistical reliability of an instrument in a clear and objective manner.

Implication of the study: This paper has demonstrated the statistical aspect of getting reliability of a survey instrument (questionnaire) use in development research studied among medical, dental and paramedical that motivates for more training in the use of advanced and basic statistical methods of reliability. The technique provided in article described with adequate detail to allow a reader who has to report the reliability of a survey instrument. Collateral reading of the article will be helpful for researchers to improve the standard of employing techniques of reliability includes in professional education and therefore awareness regarding assumptions underlying the calculation of alpha and more critics in the improvement of reliable and valid instrument in research studies may be created.

References

1. Likert R. A technique for the measurement of attitudes. Archives of Psychology. New York: Columbia University Press. 1931.
2. Joseph AG, Rosemary RG. Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, The Ohio State University, Columbus, OH, 2003;82-88
3. McIver JP, Carmines EG. Unidimensional scaling. Thousand Oaks, CA: Sage. 1981.
4. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53–55
5. Reynaldo J, Santos A. Cronbach's Alpha: A Tool for Assessing the Reliability of Scales. Ext Information Tech 1999;37(2):4432101
6. Tavakol M, Mohagheghi MA, Dennick R. Assessing the skills of surgical residents using simulation. J Surg Educ. 2008;65(2):77-83
7. Nunnally J, Bernstein L. Psychometric theory. New York: McGraw-Hill Higher, INC; 1994
8. Schmitt N. Uses and abuses of coefficient alpha. Psychol Assessment 1996;8:350-3
9. Cortina J. What is coefficient alpha: an examination of theory and applications. J Appl Psychol. 1993;78:98-104
10. Minion DJ, Donnelly MB, Quick RC, Pulito A, Schwartz R. Are multiple objective measures of student performance necessary? Am J Surg. 2002;183:663–5.
11. Eberhard L, Hassel A, Bäumer A, Becker F, Beck-Mußotter J, Bömicke W, et al. Analysis of quality and feasibility of an objective structured clinical examination (OSCE) in preclinical dental education. Eur J Dent Educ. 2011;15:172–8
12. Tavakol M, Dennick R. post-examination analysis of objective tests. Med Teach. 2011;33:447-58
13. Falk CF, Savalei V. The relationship between unstandardized and standardized alpha, true reliability, and the underlying measurement model. Jour Person Ass. 2011;11:445-453
14. Streiner D. Starting at the beginning: an introduction to coefficient alpha and internal consistency. J Pers Asses. 2003;80:99-103
15. Sharma BK. Statistical aspect in medical and paramedical research articles. International J Health Sci & Res 2014; 4(10):268-276.
16. Barrett GV. New research models of the future for industrial and organizational psychology. Pers Psychol. 1972;25:1-17
17. Price JL, Mueller CW. Handbook of organizational measurement. Marshfield, MA: Pitman. 1986
18. Cronbach L. Coefficient alpha and the internal structure of tests. Psychomerika. 1951;16:297-334
19. Develles RF. Scale Development. Sage Publications. 1991. 24–33.
20. Cronbach LJ. Essentials of Psychological Testing. Harper & Row. 1970. p. 161.
21. Kline P. An easy guide to factor analysis New York: Routledge; 1994.
22. Cortina J. What is coefficient alpha: an examination of theory and applications. J Appl Psychol. 1993;78:98-104
23. DeVellis R. Scale development: theory and applications: theory and application. Thousand Okas, CA: Sage. 2003
24. George D, Mallery P. SPSS for Windows step by step: A simple guide and reference. 11.0 update (4th ed.). Boston: Allyn & Bacon. 2003
25. DeVellis RF. Scale development: Theory and applications. Los Angeles: Sage. 2012;109-110.
26. Elango JK, Sundaram KR, Gangadharan P, Subhas P, Peter S, Pulayath C et.al. Factors affecting oral cancer awareness in a high-risk population in India. Asian Pac J Cancer Prev. 2009;10(4):627-30.
27. Al-Osail AM, Al-Sheikh MH, Al-Osail EM, Al-Ghamdi MA, Al-Hawas AM, Al-Bahussain AS et al. Is Cronbach's alpha sufficient for assessing the reliability of the OSCE for an internal medicine course? BMC Res Notes 2015;8:582.
28. Graham JM. Congeneric and (Essentially) Tau-Equivalent Estimates of Score Reliability What They Are and How to Use Them. Educational and Psychological Measurement 2006; 66(6):930-944.

29. Raykov, T. Estimation of composite reliability for congeneric measures. Appl Psychol Meas. 1997;21:173-184.
30. McDonald RP Test Theory: A Unified Treatment. Erlbaum 1999:90-103.
31. Zinbarg R, Revelle W, Yovel I, Li W. Cronbach's , Revelle's , and McDonald's:Their relations with each other and two alternative conceptualizations of reliability. Psychometrika. 2005;70:123-133.
32. Dunn TJ, Baguley T, Brunsden, V. From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation. Brit J Psychol 2014;105(3):399-412.

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