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Abstract

Reliability refers to accuracy and precision of a measurement instrument or scale. Reliability of test scores are estimated through measures of internal consistency has been characterized mathematically in many ways that appear, on the surface at least, to be very different to one another. The coefficient alpha is the most widely used measure of internal consistency for composite scores. In this article, the inferential statistics for three coefficients of internal consistency i.e. alpha coefficient with theta coefficient and omega coefficients are estimated. These indices of reliability are extremely important in health research (medical and oral health). The estimation of alpha, theta and omega coefficients and analytical effects under different sample sizes are examined and described. But computations of these coefficients are easily put forwarded by statistical software programs like SPSS, STATA, SYSTAT, STATISTICA etc. The good quantity of reliability estimates is observed in the sample size of 50 and more. Therefore, the researcher claims that for calculation of reliability coefficient for five points scale or any, the sample size should be at least 50 and more is enough. It is also concluded that with a prescription that every time a researcher reports any one of alpha coefficient, theta coefficient and omega coefficients.

Introduction

Precision of measurement is one of the major issues, which is frequently quantified by the reliability coefficients. The coefficient alpha, developed by Cronbach (1951), is the most commonly used index for estimating the reliability of measurement instruments such as scales, multiple item tests, questionnaires, or inventories (Raykov 1997) in all the fields of research such as psychology, education, statistics, sociology, medicine, counseling, nursing, political science, and economics (Cortina 1993).

Measurement of concrete characteristics required a scale, which must be reliable and valid. But, it is an important problem in the case of measuring conceptual characteristics. There is a great deal of interest in developing sensitive, reliable and valid measure for clinical populations and for aggregates such as organizations and families. It is an appropriate to begin the series with a discussion of reliability of measurement, required some statistical procedures.

Reliability estimates provide essential information regarding one aspect of soundness of the measurement of variables, items or attributes etc. Thus, the reliability coefficients that are suitable in obtaining the reliability of the scale is important. In this article we used three reliability coefficients were introduced and calculated under various sample sizes, in which coefficient of alpha in particular is important, but there are circumstances it is inappropriate and another estimates should be generated.

Further, the sample size is playing an important role on estimation of the reliability level of the measurement scale. Thus, cronbach, theta and omega are as three measures of internal consistency are examined and an example of the calculation of each is provided.

Methods

Analysis of Reliability

It is a property that measurement scale must have, is an indicator of consistency of measurement values obtained from the measurements repeated under the uniform circumstances (Ilker, et al. 2007; Gay, 1985; Carmines and Zeller, 1982; Arkin and Colton, 1970; O' corner, 1993; Carey 1988). It is an important concept when there is no gold standard. Using different ways, the reliability of the scale can be examined by applying the scale once, twice or applying the parallel scales once. The reliability of internal consistency can be examined, when scale is examined once.

The coefficient of reliability takes the range 0 to 1.

Methods of measuring internal consistency

If the reliability can be examined by applying the measurement scale once, the error of the estimated reliability will be smaller than the other estimation procedure of reliability, wrong management, incorrect methodology of scoring, unexceptional or temporary changes in personal performance affect the internal consistency (O' corner, 1993).

The split half method is another method denotes the homogeneity indices of the items in the scales. It pertains to the relationship between the responses of

the items and the total scale score (Oncu, 1994). O'conner, 1993 claimed that an increase in homogeneity in the set of items increases the reliability estimates. The idea that the internal consistency methods depend upon is that every measurement tool is constructed to realize an objective (Karasar, 2000). The methods of internal consistency are widely and frequently preferred (Oncu, 1994). Although there are many estimates of reliability that can be used, but internal consistency is one of the most frequently generated estimates or scales or instruments composed of number of items or variables that will be formed into a linear composite.

Cronbach Alpha

Of the measures of internal consistency, the most frequently preferred is cronbach alpha (cronbach, 1951), can be used for three, four, or five point likert scale items. But Oncu (1994) claimed that, it is not limited to the true-false or correct-incorrect format of scale. It is equivalent of the average of all split-half correlations that could be generated for the scale 2N items long, where N equals the number of indicants (Novick and Lewis, 1967) and where each item is scored on more than two points (Nunnally, 1978). Alpha is easily interpreted and ranges from 0 to 1 gives low to very high internal consistency. At the lower extreme, the inter-item correlations are zero; and at the upper extreme, there is a perfect correlation among the items. Many researchers consider an alpha coefficient at least 0.070 or more to be adequate for the scale (Nunnally, 1978).

When interpreting alpha as a measure of internal consistency, every researcher should needed to understand several key factors. Initial and most basic thing is that there is an assumption that internal consistency is expected. Secondly, although the estimate is labeled internal consistency, that is not completely accurate. The nature of increase of alpha coefficient is depends on change in number of items while holding the average correlation among the items constant (Nannually, 1978). Finally, alpha is a best estimate of reliability given the assumption that the items are parallel. Otherwise it is a lower bound estimate of reliability. Parallel items are items that have identical true scores.

Although cronbach alpha is easily obtained from several packaged statistical programs, it is worthwhile understanding the formula. It becomes clear that alpha uses the average inter item correlation as part of the formula. When the items have equal variances, averaging presents no problem. The formula according to Carmines and Zeller (1979). If the items are standardized, the alpha is estimated by using the items "correlation mean or variance-co variances" mean is (Carmines and Zeller 1983; Ozdamar 1999a). Alpha due to the correlation mean is and alpha coefficient due to the variance-co variance mean is . If the correlation between the items is negative alpha coefficient will be negative because this will spoil the scales additive property, it also causes a spoil in the reliability model and scale is no more additive (Ozdamar, 1999a).

Theta coefficient

Because alpha coefficient may not be a optimal estimator of reliability, when the items are heterogeneous or when the number of items is small. The other two measures of scale should be interested (i.e. theta and omega). The theta is based on a principle components model analysis, in which components are in descending order due to the variances of each of constructions (Carmines and Zeller, 1982). Theta coefficient depends on the property like; the first component is the linear component with the maximum variance. The second component is the linear component with the second maximum variance. Components can be explained by percentage values to explain the variance of the original data set in order. The theta is computationally much simple, takes into account the eigen value that maximum explains the event than that of alpha coefficient.

Omega coefficient

Heise and Bohrnstedt (1970) introduced the third estimate of internal consistency i.e. omega (W). It is based on the factor analysis model. Factor analysis is a computationally complex approach to examining the inter relationships among the items and substes of items. In this type of modeling, in calculating the coefficient, before factoring '1' values on diagonal in the correlation matrix are replaced with the communality values.

Methodology

To know the efficiency of three reliability coefficients of internal consistency, the data set has been used from dental environment stress scale with five points developed by Garbee (1980) to measure stress of dental professionals including graduates, interns and postgraduate from SDM College of Dental Sciences and Hospital, Dharwad, Karnataka, India. The example that follows is based on analysis of a 33 item scale administered to 316 dental health professionals, on convenient basis. The response rate was 98.74% (n=312). After receiving the scale from each professional, the response of each item is scored and entered in MS office-2003, then converted into SPSS 16.00 format. The three reliability coefficients i.e. alpha coefficient, theta coefficient and omega coefficient were calculated under different sample sizes starting

from n=33 (because of total number of items are 33) and so on. In order to obtain theta and omega coefficients, the eigen values were calculated from a principle component analysis and communalities were estimated from a factor analysis. The mean item correlation and Split-half reliability coefficient were calculated to know the reliability of dental environment stress scale under different sample size. Further, the three reliability coefficients for internal consistency were compared under different sample size.

References

1. Raykov, T. (1997). Scale reliability, Cronbach's coefficient alpha, and violations of essential tau-equivalence with fixed congeneric components. Multivariate Behavioral Research, 32, 329-353.
2. Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. Journal of Applied Psychology, 78 (1), 98-104.
3. Ercan Ilker et al. (2007). Examining Cronbach Alpha, Theta, Omega, Reliability Coefficients According to the Sample Size, Vol. 6, No. 1, 2-354
4. Gay, L. R. (1985). Educational evaluation and measurement. London: A Bell & Howell.
5. Carmines, E. G., & Zeller, R. A. (1982). Reliability and validity assessment. Beverly Hills: Sage Publications.
6. Arkin, H., & Colton, P. R. (1970). Statistical methods. New York: Barnes & Noble Books.
7. O'Connor, R. (1993). Issues in the measurement of health-related quality of life, working paper 30. Melbourne: NHMRC National Centre for Health Program Evaluation ISBN: 1-875677-26-7.
8. Carey, L. M. (1988). Measuring and evaluating school learning. London: Allyn and Bacon.
9. Oncu, H. (1994). Egitimde olcme vedegerlendirme (Measurement and evaluation in education). Ankara: Matser Basim.
10. Karasar, N. (2000). Bilimsel arastirma yontemleri (Research methods in science). Ankara: Nobel Yayin Dagitim.
11. Cronbach, (1951). Coefficient alpha and the Internal Structure of tests. Psychometrika--VOL. 16, NO. 3, pp.297-334.
12. Novick, M. R., & Lewis, M. R. (1967). Coefficient alpha and the reliability of composite measurements. Psychometrika, 32, 1-13.
13. Nunnally, J. C. (1978). Psychometric theory (2nd ed.). New York: McGraw-Hill
14. Carmines, Edward G., and Richard A. Zeller (1979). Reliability and Validity Assessment. Newbury Park, CA: Sage Publications
15. Carmines, E. G., & Zeller, R. A. (1982). Reliability and validity assessment. Beverly Hills: Sage Publications.
16. Thorndike, R. M., Cunningham, G. K., Thorndike, R. L., & Hagen, E. P., (1991). Measurement and evaluation in psychology and education (5th ed.). New York: Macmillian Publishing Co.
17. Rosenthal, and Rubin (1996). Comparing Correlated but Non-overlapping Correlation Coefficients, , Psychological Methods, 1, 178-183
18. Mendoza, J. L., Stafford, K. L., & Stauffer, J.M. (2000). Large-sample confidence intervals for validity and reliability coefficients. Psychological Methods, 5, 356–369.
19. Van Zyl, J.M., Neudecker, H. and Nel, D.G. (2000). On the distribution of the maximum likelihood estimator of Cronbach's alpha, Psychometrika 65(3), 271-280.
20. Ozdamar, K. (1999a). Paket programlarla istatistiksel veri analizi-1 (Statistical data analysis by custom softwares-1). Eskisehir: Kaan Kitabevi.
21. Heise, D. R., & Bohrnstedt, G. W. (1970). Validity, invalidity, and reliability. Sociological Methodology, 2, 104–129.

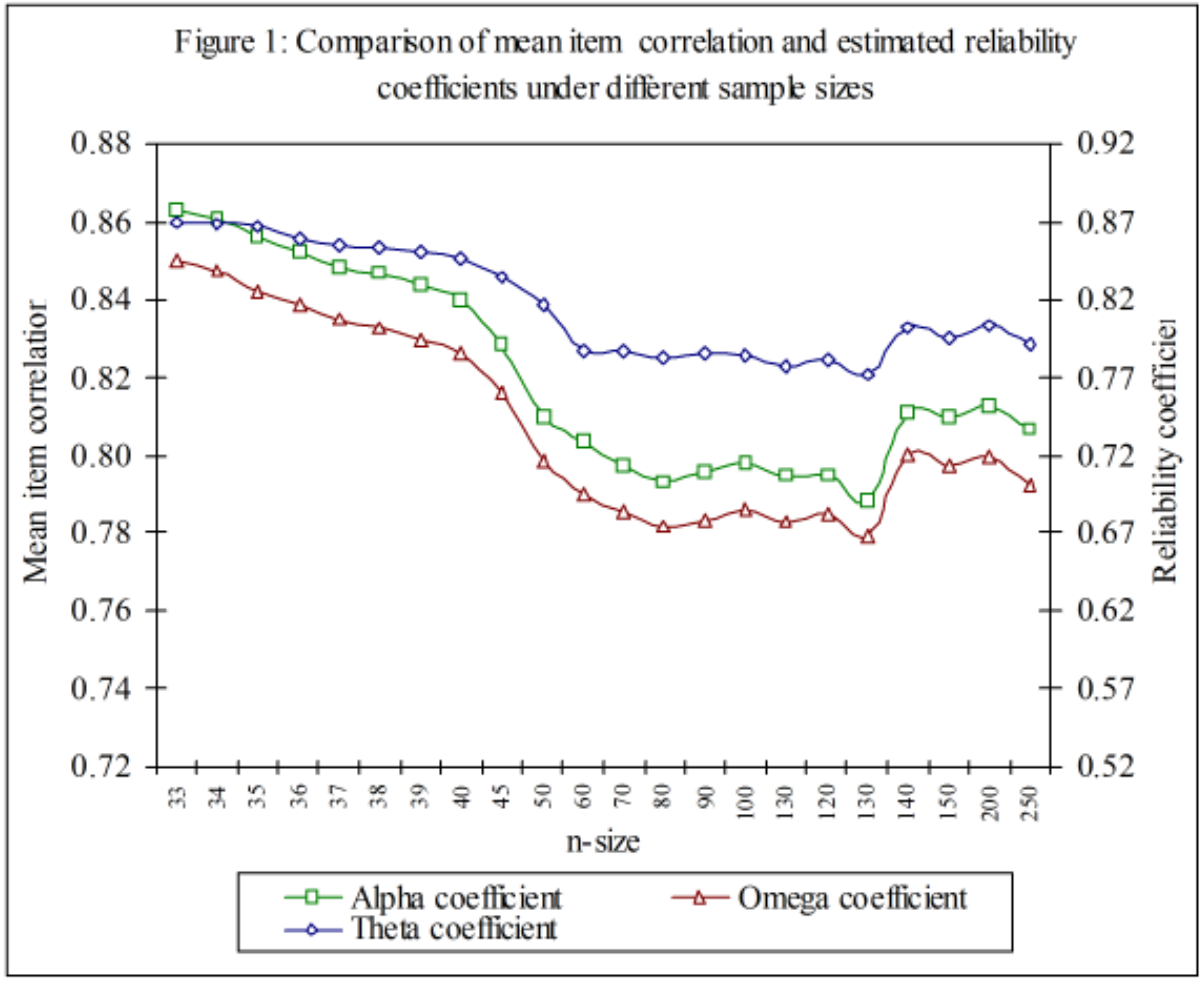
Illustrations

Illustration 1

Table and Figure

Table 1: Estimated reliability coefficient in varying samples sizes

Samples size (n)	Mean item correlation	Split-half reliability	Alpha coefficient (α)	Theta coefficient (τ)	Omega coefficient (Ω)
33	0.3780	0.8408	0.8631	0.8703	0.8500
34	0.3746	0.8445	0.8609	0.8684	0.8475
35	0.3657	0.8304	0.8559	0.8668	0.8419
36	0.3605	0.8269	0.8526	0.8591	0.8386
37	0.3547	0.8288	0.8487	0.8552	0.8348
38	0.3521	0.8310	0.8471	0.8531	0.8329
39	0.3479	0.8297	0.8436	0.8505	0.8297
40	0.3428	0.8242	0.8398	0.8469	0.8261
45	0.3276	0.8177	0.8283	0.8346	0.8160
50	0.3087	0.7777	0.8099	0.8169	0.7988
60	0.3023	0.7818	0.8035	0.7877	0.7899
70	0.2980	0.7486	0.7976	0.7877	0.7857
80	0.2940	0.7458	0.7930	0.7836	0.7818
90	0.2981	0.7574	0.7959	0.7860	0.7836
100	0.2998	0.7648	0.7983	0.7844	0.7862



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