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Case Report

USE OF CRONBACH'S ALPHA IN DENTAL RESEARCH

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Abstract:
Cronbach's alpha is commonly used in statistics to measure reliability of tests. Reliability of any measuring instrument/questionnaire refers to the extent to which it measures consistently. Cronbach's alpha is one of the way of measuring the strength of that consistency. This article is intended to highlight its use in dental research by creating an understanding of Cronbach's alpha by giving suitable example.

Keywords: Cronbach's alpha, Epidemiology, Experimental design, Reliability, Statistics

Introduction:

Cronbach's alpha was originally derived by **Kuder & Richardson** (1937) for dichotomously scored data (0 or 1) and later generalized by **Cronbach** (1951) to account for any scoring method. [1]

People know that a high alpha is good, but it is important to have a deeper knowledge to use it properly.

The reliability of any given measurement refers to the extent to which it is a consistent measure of a concept, and Cronbach's alpha is one way of measuring the strength of that consistency. [2]

A measure is said to be highly reliable if it produces similar results repeatedly. If a person weights 50kg and on repeated measurements, his weight comes out to be the same i.e. 50kg, this means that the measuring device is reliable. If the device gives different weight of a person on repeating the procedure during the course of a day, it is not reliable instrument.

In research field, there has to be accuracy in evaluation then only the result is of any use. Hence reliable and valid tests/questionnaire are created to enhance the accuracy in evaluations.

Reliability and validity are two main elements for evaluating any measuring device. Example, Survey questionnaires, measuring instrument. Reliability is related to repeatability whereas validity is concerned with the extent to which a measure what it is intended to measure. For example, if an instrument is used to detect/ measure caries, it should measure caries and not enamel hypoplasia.

Reliability and validity are important aspect of any instrument for the result to be accurate. It should be noted that reliability of an instrument is closely associated with

its validity. An instrument has to be reliable for it to be valid. If it is not reliable, then it is not valid. However, the reliability of any instrument does not depend on Validity.[3] An instrument can be reliable even if it is not valid. Example, A weight consistently the same value 45kg instead of actual value 50kg. So, although the instrument is reliable but its validity is compromised.

A correlation coefficient is used to assess the degree of reliability. High positive correlation indicates high degree of reliability.

Reliability estimates show the amount of measurement error in a test. Interpretation of reliability is the correlation of test with itself. Subtracting square of correlation from one gives the index of measurement error. For example, if a test having reliability of 0.80, then by squaring 0.80 and then subtracting this value from 1.00, gives measurement error of 0.36. [3].

Types of reliability: [4-6]

Different types of reliability as shown in table 1.

Table 1: Showing types of reliability

1. Internal reliability	Average inter-item correlation	Mean of all correlation of a construct.
	Average item total correlation	Mean of total correlation of each item.
	Split half correlation	Correlation between split half scores of a construct.
	Cronbach's alpha	Correlation between all possible split half scores of a construct.
2. External reliability	Test-retest reliability	Correlation between measures of one test at two different times.
	Parallel form reliability	Correlation between two tests at same point of time
	Inter-Rator reliability	Correlation of results of Different observer doing same test.

1. **External Reliability**: Between the tests. It refers to the extent to which a measure varies from one use to another.

Do we get same results time after time using same test or doing same investigation?

(a) Test-Retest Reliability

An assessment or test of a person should give the same results whenever you apply the test. Test-retest reliability evaluates reliability across *time*. Suppose we trying to weight things at time 1 and doing same test at time 2 and comparing the results of these two tests. Comparison by simple correlation and if there is high correlation, the test is reliable.

(b) Parallel-Form Reliability

Conducting two tests at same point of time (fig.1) and if there is stability across the results of both tests, then it is reliable.

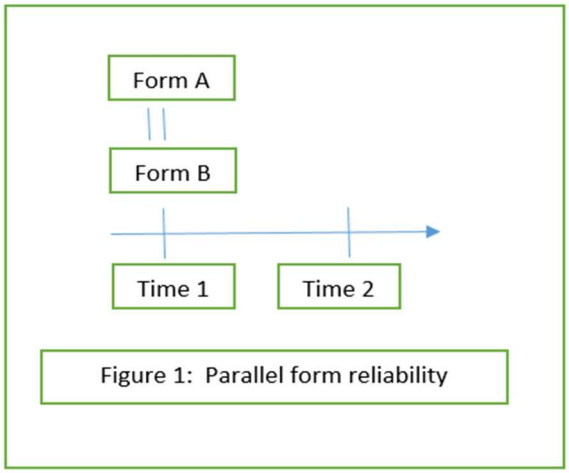


Figure 1: Parallel form reliability

(c) Inter-Rater Reliability:

Also known as *inter-observer reliability* or *inter-coder reliability.*

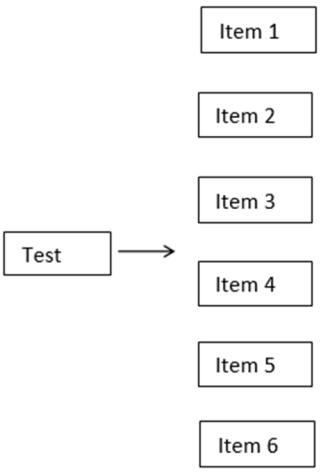
Different people or observer doing same test and their results are highly correlated then the test is reliable.

Two major ways in which inter-rater reliability is used are (a) testing how similarly people *categorize* items, and (b) how similarly people *score* items.

2. Internal reliability: Within one test

It assesses the consistency of results across items within a test. If we divide the test into two parts, if they show similar result or not. Four types of internal consistency:

(a) Average inter-item correlation calculates mean from all intercorrelations between questions. (fig.2)



	Item1	Item 2	Item 3	Item 4	Item 5	Item 6
Item 1	1					
Item 2	0.89	1				
Item 3	0.91	0.92	1			
Item 4	0.88	0.93	0.95	1		
Item 5	0.84	0.86	0.92	0.85	1	
Item 6	0.88	0.91	0.95	0.87	0.85	1

Figure 2: Showing correlation between items

Average inter-item correlation = 13.41/15=0.90

Average item total correlation=4.43/5=0.886

(b) Average item total correlation takes the average inter-item correlations and calculates a total score for each item, then averages these (fig.2). Calculates total score of correlation between all pair of question of each item and then average these.

(c) Split-half correlation divides items into two halves, which are tested on the same group of people and then the correlation between the two total scores is calculated (fig.3).

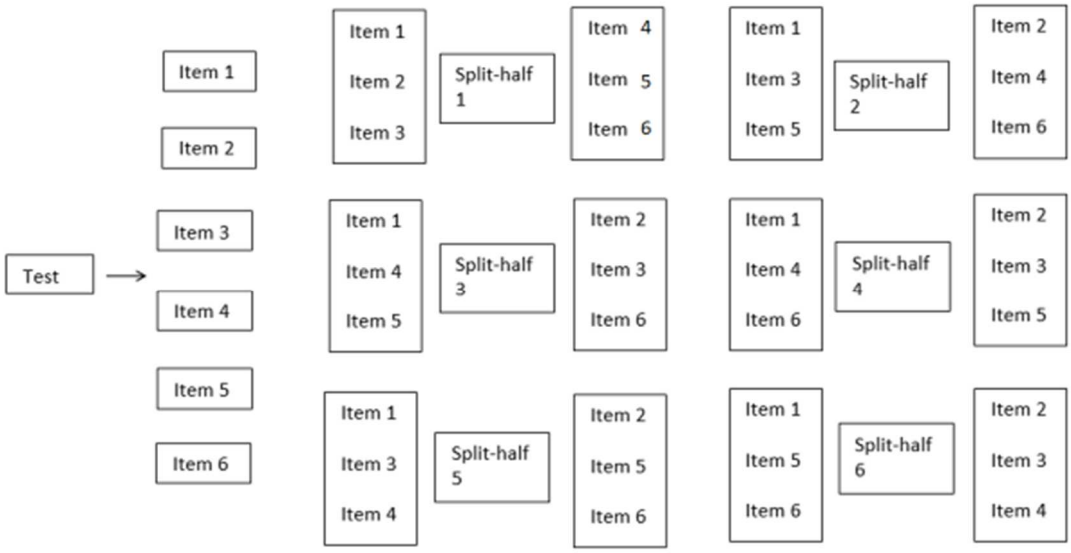


Figure 3: Showing 6 Split halves and Cronbach's alpha (average of all possible split halves)

(d) Cronbach's alpha calculates an equivalent to the average of all possible split-half correlations (fig.3) and is calculated by formula: $\alpha = (N. \text{r-bar}) / (1 + (N-1). \text{r-bar})$

Where N is the number of components, and r-bar is the average of all Pearson correlation coefficients i.e. (1+2+3+4+5+6) split halves/6.

Describes the extent to which all the items in a test measure the same concept or construct and so it is connected to the inter-relatedness of the items within the test. Internal consistency should be determined before a test to be used for research or examination purposes to ensure validity. [3] Cronbach's alpha provides a measure of the internal consistency of a test or scale; it is expressed as a number between 0 and 1.

A commonly accepted rule for describing internal consistency using Cronbach's alpha is, a greater number of items in the test can artificially inflate the value of alpha and a sample with a narrow range can deflate it, so this rule should be used with caution.

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

Cronbach's basic equation for alpha

$\alpha = n / n-1[1- (\Sigma Vi/ Vtest)]$

n = number of questions

Vi = variance of scores on each question

Vtest = total variance of overall scores (not %'s) on the entire test

The resulting α coefficient of reliability ranges from 0 to 1 in providing this overall assessment of a measure's reliability. Zero value indicates that all the items of a scale

are not correlated i.e. they are independent; and, if all of the items have high covariances, then α will approach 1 as the number of items in the scale approaches infinity. [2]

A low value of alpha could be due to less questions, or if the items are partly related with each other or diversity in the construction of questionnaire.

For example, if a low alpha is due to poor correlation between items then some should be revised or discarded. If alpha is too high it may suggest that some items are redundant as they are testing the same question but in a different way.

A maximum alpha value of 0.90 has been recommended. [3]

The length of the test also affects the value of alpha. The value of alpha gets reduced for short length. Thus, to increase alpha, more related items testing the same concept should be added to the test. [3]

Example of using Cronbach alpha in dentistry:

Example1: A self-designed questionnaire with a 5-degree ranked scale was used for assessing the impact of periodontal diseases on individuals' quality of life in Bulgaria. [7]

Internal consistency of questionnaire was tested using Cronbach alpha and average inter-item correlation coefficient. Results after first interview with questionnaire containing 11 questions: Cronbach's coefficient (α=0.882),
Spearman-Brown coefficient (r sb=0.998),
Average inter-item correlation coefficient (R=0.426) (table 2).

Two questions with a low level of inter-item correlation (Q number 6 and 11 shown in bold numbers) with rest of items were excluded. Final version of questionnaire contained 9 questions. Results after the second interviews with these questions:
Cronbach's coefficient (α=0.883),
Spearman-Brown coefficient (r sb=0.998),
Average inter-item correlation coefficient (R=0.507)

Validation proved that developed scale is sufficiently reliable and will be used in final research. Table 2. Correlation coefficients between the items (initial version - 11 questions).

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Table 2: Showing Correlation coefficients between the items (initial version - 11 questions).

Question	1	2	3	4	5	6	7	8	9	10	11
1	1										
2	0.869	1									
3	0.851	0.775	1								
4	0.445	0.487	0.513	1							
5	0.440	0.435	0.415	0.786	1						
6*	**0.273**	**0.288**	**0.273**	**0.495**	**0.564**	**1**					
7	0.394	0.373	0.296	0.633	0.747	0.784	1				
8	0.459	0.542	0.359	0.459	0.271	0.153	0.323	1			
9	0.467	0.576	0.382	0.288	0.113	-0.112	0.121	0.780	1		

10	0.705	0.779	0.500	0.289	0.124	0.199	0.280	0.662	0.672	1	
11*	**0.252**	**0.306**	**0.098**	**0.327**	**0.373**	**0.031**	**0.428**	**0.396**	**0.368**	**0.249**	**1**
total	5.155	4.561	2.738	3.277	2.192	1.055	1.152	1.838	1.04	0.249	0

*Excluded in final version.
Total of all items scores = 23.255
Average value of the inter-item correlations. Average inter-item correlation coefficient R= 23.255/55=0.425.

Example 2: A study was designed to evaluate reliability and validity of seven different types of questionnaires/measures used in assessing different aspects of dental anxiety. [8]

By using Cronbach alpha coefficient, the highest value was obtained for the Dental Anxiety Inventory (short version) (S - DAI), Children's Fear Survey Schedule-Dental Subscale (CFSS - DS) and the Parent Corah Dental Anxiety Scale (PDAS) (Table 3). Pearson's correlations regarding validity represented significant correlations between them (table not shown here).

Table 3. Cronbach's alpha representing reliability.

Dental anxiety Questionnaires	Cronbach's alpha coefficient
1. Parent Corah Dental Anxiety Scale (PDAS)	**0.8732****
2. Dental anxiety Inventory (short version) (S-DAI)	**O.8606****
3. Children's Fear Survey Schedule-Dental Subscale (CFSS-DS)	**0.8348****
4. Child's Corah Dental anxiety scale(CDAS)	0.7896*
5. Overt Aggression Scale (OAS)	0.7836*
6.Broome's Child Medical Fear Questionnaire(CMFQ)	0.7294*
7. Dental Visit Satisfaction Scale-Swedish Version (DVSS-SV)	0.7195*
**highly reliable * reliable	

Conclusion:

Cronbach's alpha is commonly used method for evaluation reliability but while interpreting it, the factors which affect its value should be kept in mind which may inflate or decrease the values of Cronbach's alpha. Greater number of items in a test can inflate the value of alpha, while a scale with less number of items in a test can deflate its value. Alpha is affected by length of test and dimensionality. We hope this article will help in understanding the concept of Cronbach's alpha in dental research work.

References:

1. Allen K. Explaining Cronbach's Alpha. Presentation presented at; University of Oklahoma Dept. Of Industrial Engineering [Internet].kcallen@ou.edu. Available from: http://www.scridbd.com/document/209124558/Explaining Cronbach's Alpha.

2. Goforth C. Using and Interpreting Cronbach's Alpha [Internet]. statlab@virginia.edu. 2015. Available from:http://data.library.virginia.edu/using-and-interpreting-cronbach's-alpha/
3. Tavakol M, Dennick R. Making Sense of Cronbach's Alpha. International Journal of Medical Education. 2011; 2:53-55
4. Examrace. Are your tests reliable? 4 types of reliability [Internet]. 2015. Available from: http://www.youtube.com/watch?v=9L40_dFWr6o
5. Trochim W. Types of Reliability [Internet]. Socialresearchmethods.net. 2006. Available from: http://www.socialresearchmethods.net/kb/reltypes.php
6. Saunders B, Trapp R. Basic & Clinical Biostatics. 2nd ed. UNITED STATES OF AMERICA: Prentice-Hall International Inc.; P. 57-58
7. Musurlieva N, Stoykova M, Boyadjiev D. Validation of a scale assessing the impact of periodontal diseases on patients' quality of life in Bulgaria (pilot research) Braz Dent J. 2012;23(5):570-574.
8. Majstorovic M, Veerkamp J, Skrinjaric I. Reliability and validity of measures used in assessing dental anxiety in 5-15-year-old Croatian Children. Eur J. Paediatric Dent. 2003;197-202