VALIDATION OF THE CLINICIAN ATTITUDES TOWARD BIOSTATISTICS AMONG BRAZILIAN DENTISTRY GRADUATE STUDENTS

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- ABSTRACT*:* The aim of this study was to validity of the Portuguese version of the Clinician Attitudes Toward Biostatistics (CATB) among dentistry postgraduate students. The CATB is a psychometric instrument four-factor. We evaluated the validity (λ, χ^2/df, CFI, TLI e RMSEA) and reliability (Cronbach's alpha (α) and Composite Reliability (CR)) of the instrument to the sample. It took part of the study 115 postgraduate students (62 master's students, 80 women, average age 26 ± 4 years). The four-factor model did not fit the sample (λ=0.00-0.85, χ^2/df=1.83, CFI=0.85 e TLI=0.82 e RMSEA=0.09). After the fit of the refined orthogonal two-factor model ("Perceptions of Knowledge/Training" and "Perceptions of Biostatistics in Research and Scientific Evidence") was found to be adequate (λ>0.45, χ^2/df≤2.00; CFI e TLI>0.90, RMSEA≤0.10, α e CR>0.70). The "Perception of Knowledge/Training of Biostatistics" factor was not found to be correlated with the "Perception of Biostatistics in Research and Scientific Evidence".

- KEYWORDS: Validity; scales; dentistry; evidence-based practice.

1 Introduction

It is common to find studies that report on individuals involved in health care and their lack of experience with statistics and/or their difficulties in understanding statistical concepts (HANNIGAN *et al*., 2014; CAMPOS *et al*., 2013; WADHWA *et al*., 2015; ZHANG *et al*.,2012; KILIÇ and ÇELIK, 2013). This concern in the field of health care is guided by the fact that statistics is an important tool for decision-making (HANNIGAN *et al*., 2014; WADHWA *et al*., 2015; KUMAR *et al*., 2014; SHETTY *et al*., 2015). These decisions may be related to research (development/analysis of results of an experiment) or to clinical practice (interpretation/judgment of the evidence from the scientific community)

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(JAVALI and SUNKAD, 2016). Therefore, decisions must be made in a way that reduces the chance of error, and for that, an understanding of statistics is crucial (SHAKERI, 2016).

Thus, we emphasize the need to determine and measure these individuals' perceptions of statistics and how it is involved in their daily lives (ESCALERA-CHÁVEZ *et al*., 2014; MUTAMBAYI *et al*., 2016). Knowing the profiles of these individuals and their relationships with statistics can contribute to the teaching-learning process and may also indicate ways to implement statistics in their routines (WADHWA *et al*., 2015; ZHANG *et al*., 2012; BATRA *et al*., 2014). However, in order to measure individuals' perceptions of statistics, the use of psychometric instruments is necessary.

The Clinician Attitudes Toward Biostatistics survey (CATB) (WEST and FICALORA, 2007) is an instrument that was developed and used on individuals in the medical field to measure general perceptions of biostatistics, perceptions of knowledge and training of biostatistics, perceptions of biostatistics and research, and perceptions of biostatistics and evidence-based medicine/dentistry. This instrument has been used recently on graduate students in the field of dentistry (SHETTY *et al*., 2015; BATRA *et al*., 2014; NGUYEN *et al*., 2016)

However, the use of psychometric instruments requires a rigorous evaluation of the quality of the measured variables, including validity and reliability of the instrument relative to the sample data (CAMPOS *et al*., 2013; MAROCO, 2014). This analysis can reveal a need for validation studies to be performed on a psychometric instrument for each sample on which it is used. The validation process is recommended in the literature and may include construct validity (factorial and convergent validity) using confirmatory factor analysis (MAROCO, 2014; ANASTASI, 1988). Now, however, no validation studies on the Clinician Attitudes Toward Biostatistics survey (CATB) seem to exist in the literature.

Thus, the aim of this study was develop the Portuguese version of the Clinician Attitudes Toward Biostatistics survey (CATB) and to evaluate the validity and reliability of this instrument when it is applied to dentistry graduate students.

2 Material and methods

2.1 Study design and participants

This is a cross-sectional study. Graduate students who were enrolled in Master's and PhD degree programs in 2015 in the School of Dentistry of São Paulo State University, Araraquara, in Brazil, were invited to participate. It should be noted that all are dental surgeons and that the Master's and PhD programs are academic graduate-level programs focused on clinical and scientific education. In addition, all of the respondents had had training in statistics at some point in their academic careers.

The sample size was estimated following proposal by Hair *et al*. (2005) which recommends the inclusion of 5 to 10 individuals per instrument item. The Clinician Attitudes Toward Biostatistics survey includes 18 items; thus, the sample size necessary

was between 90 and 180 participants. For this reason, 123 students were invited to participate in the study. Of these 123, 115 signed the informed consent form.

2.2 Measurement instrument

The Clinician Attitudes Toward Biostatistics survey (CATB) was used. This instrument was originally proposed by West and Ficalora (2007) in English and consists of 18 items divided into four factors ("General Perceptions", "Perceptions of Knowledge and Training", "Perceptions of Biostatistics and Research", and "Perceptions of Biostatistics and Evidence-Based Medicine/Dentistry"). Responses were given on a 5-point Likert scale (1: Strongly Disagree; 5: Strongly Agree).

The Portuguese version of the CATB was developed by the authors of the current study. Therefore, two translators translated the document independently from English to Portuguese, and a consensus was then obtained. This version was compared to the original English version. The back translation was carried out by a native speaker of the English language with knowledge of Portuguese. The Portuguese version obtained followed the spelling and grammar agreement established between Portuguese-speaking countries in 2009. The version used also included the adaptation for use in dentistry (BATRA et al., 2014), in which the word "dentistry" was added when the word "medicine" was used. The version of CATB used in this study is shown in Table 1.

To characterize the sample, personal information such as gender, age, economic status, education level, and the period when the respondent was first trained in statistics (before or during the graduate program) was acquired. To characterize individuals' economic status, the Brazilian Economic Classification Criteria was used (BRAZILIAN MARKET RESEARCH ASSOCIATION, 2016).

2.3 Procedures and ethical aspects

The graduate students who agreed to participate and who signed the informed consent form completed the Portuguese version of the CATB in the classroom. The days on which the survey was administered had been agreed upon with the professors. The instrument was distributed by a researcher (graduate student) who had no relationship with the students in order to avoid embarrassment and/or coercion. It should be noted that participants were anonymous. This project was approved by the Ethics Committee on Human Research at the São Paulo State University, Araraquara School of Dentistry in Brazil (CAAE Registry No. 34783414.2.00005416).

2.4 Statistical analysis

The psychometric properties of the Clinician Attitudes Toward Biostatistics survey were evaluated relative to the sample. The psychometric sensitivity of the items, the construct validity (factorial and convergent), and the reliability of the measurements of the instrument were all estimated.

Psychometric sensitivity was estimated using the measurements of the summary and shape of the distribution (skewness $|Sk|<3$; kurtosis $|Ku|<7$).

Factorial validity was assessed using confirmatory analysis. The chi-square to degrees of freedom ratio (χ^2/df), the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA) were used.[10] The method of Lagrange multipliers (LM>11) was used to insert the correlation between the errors of the items in order to determine the fit of the model. The appropriate fit values were set as $\chi^2/df \leq 2.00$; CFI and TLI > 0.90, RMSEA ≤ 0.10, and α and CR >0.70 (MAROCO, 2014). Items that exhibited factorial weights (λ) < 0.45 were removed from the model, as were those which were found to be redundant based on the method of Lagrange multipliers (LM > 11).

The confirmatory factor analysis was performed using a polychoric correlation matrix, the weighted least squares mean and variance adjusted (WLSMV) estimation method. The Mplus software, version 6.12 (MUTHÉN; MUTHÉN, 2010) was used.

Convergent validity was evaluated using the average variance extracted (AVE), and it was considered appropriate when AVE ≥ 0.50.

The reliability of the model was estimated using Cronbach's alpha coefficient (α) and composite reliability (CR). The model was considered reliable when α and CR ≥ 0.70.

3 Results

The study included 115 graduate students from a school of dentistry. Women made up 70% of the sample (n=80). The average age was 27 ± 4 years. Most individuals were enrolled in the Master's program (n=62; 55%), had first been trained in statistics before the graduate program (n=92; 82%) and belonged to higher socioeconomic classes (n=90; 78%).

The Portuguese version the Clinician Attitudes Clinical Toward Biostatistics survey (CATB) as well as the summary and shape measurements of the responses to the items are shown in Table 1. It is important to note that 10 surveys were missing data and that these respondents were therefore removed from the analysis.

Table 1 - Clinician Attitudes Toward Biostatistics (CATB) - Portuguese version and summary and shape measurements of the responses to the scale items given by graduate students from a school of dentistry. Brazil, 2015

English Version	Portuguese Version	Summary Measure				Shape Measure	
Clinician Attitudes Clinical Toward Biostatistics	**Atitudes de Clínicos frente à Bioestatística**	**Mean**	**Median**	**Mode**	**Standard-Deviation**	**Skewness**	**Kurtosis**
1. Biostatistics is a difficult subject.	1. Bioestatística é um assunto difícil.	3.78	4	4	0.88	-0.95	0.71
2. Biostatistics is more difficult than other subjects in medical training.	2. Bioestatística é mais difícil do que outras disciplinas da formação.	3.27	3	4	0.88	-0.21	-0.70
3. Biostatisticians would be more helpful as teachers and consultants if they understood more medicine.	3. Bioestatísticos seriam mais úteis, como professores e consultores, se entendessem mais sobre medicina/odontologia.	3.54	4	4	0.98	-0.46	-0.12
4. Within the medical field, biostatisticians have high status.	4. Dentro do campo da medicina/odontologia, os bioestatísticos estão em alta.	3.31	3	4	0.93	-0.17	-0.47
5. It would benefit my career to better understand biostatistics.	5. Entender melhor a bioestatística poderia beneficiar a minha carreira.	4.55	5	5	0.57	-0.84	-0.28
6.My training in biostatistics is adequate for my needs.	6. Minha formação em bioestatística é adequada para atender as minhas necessidades.	2.80	3	2	1.04	0.41	-0.74
7. The current level of training in biostatistics in medicine is adequate.	7. O atual nível de formação em bioestatística na medicina/odontologia é adequado.	2.59	2	2	0.90	0.42	-0.55
8. My previous biostatistics coursework was taught effectively.	8. Meu último curso de bioestatística foi ministrado de forma eficaz.	3.25	3	4	1.10	-0.38	-0.71
9. I am able to tell when the correct statistical methods have been applied in a study.	9. Eu sou capaz de dizer se os métodos estatísticos utilizados em um estudo foram aplicados corretamente.	2.74	3	2	0.98	0.35	-0.78

Source: Research Data

Table 1 (Continuation) -Clinician Attitudes Toward Biostatistics (CATB) - Portuguese version and summary and shape measurements of the responses to the scale items given by graduate students from a school of dentistry. Brazil, 2015

English Version	Portuguese Version	Summary Measure				Shape Measure	
Clinician Attitudes Clinical Toward Biostatistics	**Atitudes de Clínicos frente à Bioestatística**	**Mean**	**Median**	**Mode**	**Standard-Deviation**	**Skewness**	**Kurtosis**
10. I am able to design my own research projects with confidence.	10. Eu sou capaz de delinear/desenhar/planejar meus próprios projetos de pesquisa com confiança.	2.81	3	2	1.01	0.34	-0.69
11. I am able to conduct my own statistics analyses with confidence.	11. Eu sou capaz de realizar/conduzir minhas próprias análises estatísticas com confiança.	2.75	3	3	0.94	0.02	-0.49
12. Biostatistics should be an integral part of most research.	12. Bioestatísticos devem ser parte integrante na maioria das pesquisas.	4.38	5	5	0.75	-1.31	1.87
13. Biostatistics is a necessary skill for a clinician involved in research.	13. Bioestatística é uma habilidade necessária para um clínico envolvido em pesquisa.	4.36	4	4	0.65	-0.74	0.50
14. Biostatistics is a necessary skill for a clinician not involved in research.	14. Bioestatística é uma habilidade necessária para um clínico não envolvido em pesquisa.	2.71	2	2	1.12	0.50	-0.49
15. Biostatistics are not necessary for most research.	15. Bioestatísticos não são necessários para a maioria das pesquisas.	1.59	1	1	0.80	2.01	5.58
16. Biostatistics is an important part of evidence-based medicine.	16. Bioestatística é uma parte importante da medicina/odontologia baseada em evidências.	4.51	5	5	0.59	-1.06	1.68
17. Knowledge of biostatistics is necessary when evaluating medical literature.	17. O conhecimento em bioestatística é necessário quando se avalia a literatura médica/odontológica.	4.38	4	4	0.58	-0.28	-0.72
18. Evidence-based medicine is important for clinical practice.	18. A medicina / odontologia baseada em evidências é importante para a prática clínica.	4.45	5	5	0.60	-.60	-0.56

Source: Research Data

The mode measurement reflects the fact that, although many of the respondents agreed that statistics is a subject that is difficult and more than other subjects (items 1 and 2), that their training in biostatistics was inadequate (items 6 and 7), and that they feel unable to determine when the correct statistical methods have been applied to a study (item 9). The students still believe that a better understanding of biostatistics would improve their careers (item 5) and their development and interpretations of scientific research (items 13, 16, 17 and, 18). The CATB items exhibited no severe violations of normality.

Table 2 presents the polychoric correlation matrix for the 18 items from the CATB.

Table 2 - Correlation matrix for the 18 items of the Clinician Attitudes Clinical Toward Biostatistics survey, Brazil, 2015

Item	1	2	3	4	5	6	7	8	9
1	1	-	-	-	-	-	-	-	-
2	0.000	1	-	-	-	-	-	-	-
3	0.053	-0.001	1	-	-	-	-	-	-
4	0.044	-0.001	0.160	1	-	-	-	-	-
5	0.085	-0.001	0.309	0.256	1	-	-	-	-
6	0.020	0.000	0.074	0.061	0.119	1	-	-	-
7	0.012	0.000	0.044	0.037	0.071	0.344	1	-	-
8	0.016	0.000	0.059	0.049	0.094	0.456	0.272	1	-
9	0.019	0.000	0.070	0.058	0.113	0.547	0.326	0.433	1
10	0.017	0.000	0.063	0.053	0.102	0.492	0.294	0.390	0.468
11	0.009	0.000	0.034	0.028	0.055	0.266	0.159	0.211	0.253
12	0.079	-0.001	0.288	0.239	0.461	0.092	0.055	0.073	0.087
13	0.092	-0.001	0.335	0.277	0.536	0.107	0.064	0.085	0.102
14	0.025	0.000	0.092	0.076	0.147	0.029	0.017	0.023	0.028
15	0.059	-0.001	0.214	0.177	0.343	0.068	0.041	0.054	0.065
16	0.090	-0.001	0.325	0.269	0.521	0.044	0.026	0.035	0.042
17	0.074	-0.001	0.267	0.222	0.428	0.036	0.022	0.029	0.034
18	0.075	-0.001	0.272	0.225	0.435	0.037	0.022	0.029	0.035

Source: Research Data

Table 2 (continuation) - Correlation matrix for the 18 items of the Clinician Attitudes Clinical Toward Biostatistics survey, Brazil, 2015

Item	10	11	12	13	14	15	16	17	18
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-
10	1	-	-	-	-	-	-	-	-
11	0.228	1	-	-	-	-	-	-	-
12	0.079	0.043	1	-	-	-	-	-	-
13	0.092	0.049	0.514	1	-	-	-	-	-
14	0.025	0.014	0.141	0.164	1	-	-	-	-
15	0.059	0.032	0.329	0.382	0.105	1	-	-	-
16	0.038	0.020	0.568	0.661	0.181	0.422	1	-	-
17	0.031	0.017	0.467	0.543	0.149	0.347	0.593	1	-
18	0.031	0.017	0.474	0.551	0.151	0.353	0.602	0.495	1

Source: Research Data

Figure 1 presents the original four-factor model of the CATB (Figure 1A) and the refined orthogonal two-factor model of the CATB (Figure 1B).

The four-factor model (Figure 1A) presented low factorial weights and did not fit to the sample (λ = 0.00-0.85, χ^2/df = 1.83, CFI = 0.845, TLI = 0.816, RMSEA = 0.089). Thus, as per theoretical guidelines and based on the indices observed, the “Perceptions of Biostatistics and Research” factor and the “Perceptions of Biostatistics and Evidence-Based Medicine/Dentistry” factor were found to be highly correlated (r = 1.00, p<0.001) and were therefore combined into one factor denominated "Perceptions of Biostatistics in Research and Scientific Evidence" (Figure 1B). As shown in Figure 1A and 1B, in the “General Perceptions” factor, only item 5 exhibited a satisfactory weight factor. For this reason, we chose to exclude this factor and to reallocate item 5 into the “Perceptions of Biostatistics in Research and Scientific Evidence” factor (Figure 1C) for theoretical affinity. A low and no significant correlation was found between the “Perceptions of Knowledge and Training” factor and the “Perceptions of Biostatistics in Research and Scientific Evidence” factor (r = 0.12; p= 0.191). Thus, an orthogonal model was proposed with no correlations between the factors (Figure 1C).

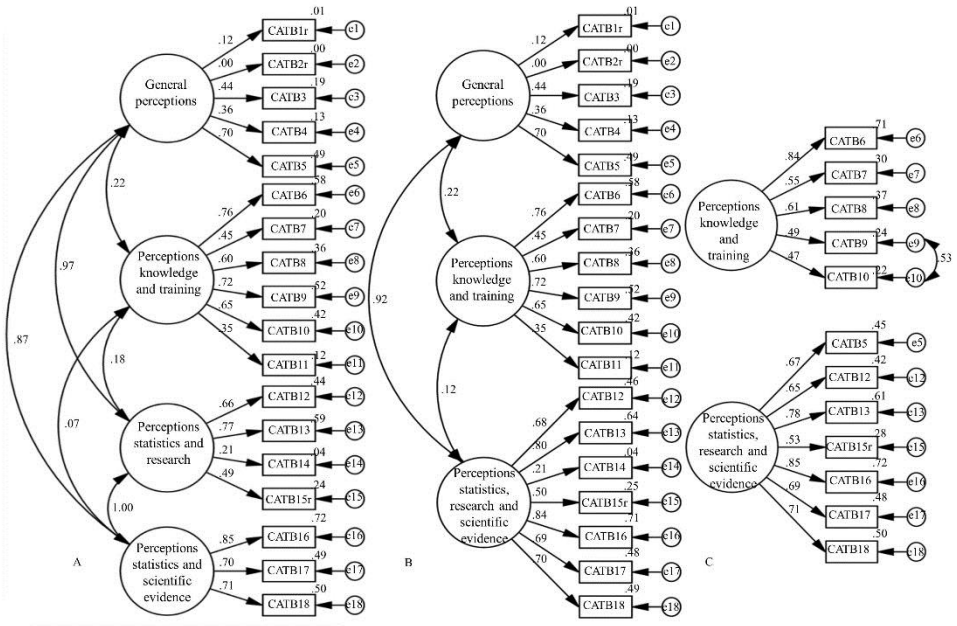

Figure 1 - Original four-factor model (Figure 1A) and the refined orthogonal two-factor model (Figure 1B) of the Clinician Attitudes Clinical Toward Biostatistics survey applied to graduate students from a school of dentistry, Brazil, 2015.

Also, because of the low factorial weight presented by item 14 (λ = 0.21) and by item 11 (λ = 0.35), these items were removed from "Perceptions of Biostatistics in Research and Scientific Evidence" and the "Perceptions of Knowledge and Training", respectively. Moreover, a correlation between the errors of items 9 and 10 was proposed (LM=27.471). (Figure C)

Figure C presents the refined orthogonal two-factor model. The CATB model proposed herein exhibited adequate factorial validity and was reliable for the sample. The fit indices of the model and the reliability to the "Perceptions of Knowledge and Training" factor were as follows: λ = 0.47-0.84, χ^2/df = 0.574, CFI = 1.00, TLI = 1.00, RMSEA = 0.001, CR = 0.736, and α = 0.700. When it came to the "Perceptions of Biostatistics in Research and Scientific Evidence" factor, the fit indices of the model and reliability were as follows: λ = 0.53-0.85, χ^2/df = 2.00, CFI = 0.972, TLI = 0.959, RMSEA = 0.098, AVE = 0.496, CR = 0.871, and α = 0.724. However, the "Perceptions of Knowledge and Training" factor presented low convergent validity (AVE = 0.370), and the "Perceptions of Biostatistics in Research and Scientific Evidence" factor presented convergent validity within acceptable limits (AVE = 0.496).

4 Discussion

This paper is apparently the first study to use the Clinician Attitudes Toward Biostatistics survey (CATB) on dentistry graduate students. It is the first presentation of the Portuguese version, and it is the first assessment the psychometric properties of the CATB using confirmatory factor analysis.

Based on the confirmatory factor analysis, the four-factor model of the CATB did not fit to this sample of graduate students. It should be noted that fitting the data to the model required an extensive configurational change with a new theoretical proposal regarding the constructs measured by the instrument. For example, the orthogonal two-factor model not measure the concepts involved in general perceptions of biostatistics. The exclusion of most of the items of this factor was based on the low total variability of the items explained by the factor and led to its exclusion. This low variability may be due to the fact that the items are so general that they do not express a unique construct. The other configurational changes were based on fact that two factors were appointed to a new construct referred to as "Perceptions of Biostatistics in Research and Scientific Evidence" due to the strong correlation between the "Perceptions of Biostatistics and Research" factor and the "Perceptions of Biostatistics and Evidence-Based Medicine/Dentistry" factor. The other configurational changes also resulted from the lack of correlation between the "Perceptions of Knowledge/Training of Biostatistics" factor and the "Perceptions of Biostatistics in Research and Scientific Evidence" factor. The latter finding suggests that individuals may attach importance to biostatistics in research and scientific evidence regardless of how much knowledge/training of biostatistics they have.

For this sample, the refined two-factor model proposed for the CATB exhibited adequate factorial validity; however, it is known that the validity of an instrument is inherent to the sample to which it is applied. The measurement of the constructs may be altered by characteristics of the sample (CAMPOS, et al., 2013; MAROCO, 2014) such as cultural factors (and language in particular). Thus, due to the potential use of CATB in different contexts, it is recommended that validation studies be conducted to determine the validity, reliability, and stability of the CATB when applied to different samples or when used in different countries. These types of reports are currently lacking in the literature. The Clinician Attitudes Toward Biostatistics survey (CATB) has been previously used in the field of health care (SHETTY *et al*., 2015; BATRA *et al*., 2014; WEST and FICALORA; 2007) but only a descriptive statistic of each item of the instrument was presented.

The literature (HANNIGAN *et al*., 2014; WADHWA *et al*., 2015; ZHANG *et al*., 2012; SHETTY *et al*., 2015; BATRA *et al*., 2014) reports the need for improvements in the teaching of biostatistics. These improvements could increase knowledge and/or training among professionals and would create awareness of the importance of biostatistics in research and clinical work (GARCÍA-SANTILLÁN *et al*., 2014). However, students' perceptions of statistics must be measured (MILIC *et al*., 2016). To do so, it is believed that the essential use of psychometric instruments could help researchers to work with more

precise measurements. This precision could be obtained through the more rigorous evaluation of the instruments, which itself would depend on the use of validity and reliability of the instruments. Thus, the more precise measurements of individuals' perceptions of statistics could contribute to a better assessment of the impact that social and educational initiatives have in teaching and in clinical research centers.

A limitation of this study is reflected in the need to replicate the methodology in a similar sample in order to gather more evidence on the construction of the factors associated with the Clinician Attitudes Toward Biostatistics survey. This type of study is encouraged, given the extensive modifications made to the original instrument so that it would fit to the sample. Further research involving other graduate-level dentistry students and students from other health science programs should also be performed in order to obtain more information on biostatistics in health science education and on healthcare education as a whole. Finally, it is also recommended that groups' "perceptions of knowledge and training of biostatistics" and "perceptions of biostatistics in research and scientific evidence" be compared according to different characteristics such as gender, level of education, and experience in research. These comparisons should be made in a future study.

Conclusions

The orthogonal two-factor model of the Clinician Attitudes Toward Biostatistics survey (CATB) was found to be valid and reliable for measuring both perceptions of knowledge and training of biostatistics and perceptions of biostatistics in research and scientific evidence among dentistry graduate students with clinical experience.

Acknowledgements

We would like to thank Dr. Livia Nordi Dovigo for her collaboration in developing the Portuguese version of the instrument. We are also grateful for Grant No. 2014/21778-2 from the São Paulo Research Foundation (FAPESP), which provided financial support. We thank reviewers and editors for their comments and suggestions. The authors report no conflicts of interest with respect to this study.

BONAFÉ, F. S. S; COSTA, M. A.; CAMPOS, J. A. D. B. Validação do "Clinician Attitudes Toward Bioestatistics" entre estudantes brasileiros de pós-graduação em odontologia. *Rev. Bras. Biom.* Lavras, v.36, n.3, p.588-600, 2018.

- *RESUMO: O objetivo deste estudo foi validar a versão em português do "Clinician Attitudes Toward Bioestatistics (CATB)" entre os estudantes de pós-graduação em odontologia. O CATB é um instrumento psicométrico de quatro fatores. Avaliamos a validade (λ, χ^2/gl, CFI, TLI e RMSEA) e confiabilidade (alfa (α) de Cronbach e confiabilidade composta (CC)) do instrumento para a amostra. Participaram do estudo 115 estudantes de pós-graduação (62 estudantes de mestrado, 80 mulheres, idade média 26 ± 4 anos). O modelo de quatro fatores não se ajustou aos dados da amostra (λ = 0,00-0,85, χ2/df = 1,42, CFI = 0,85 e TLI = 0,82 e RMSEA = 0,09). Após*

o ajuste do modelo de dois fatores ortogonal refinado ("Percepção de Conhecimento/Treinamento" e "Percepção da Bioestatística na Pesquisa e Evidência Científica") foi considerado adequado (λ> 0,45, $\chi^2/gl \leq 2$, 0; CFI e TLI> 0,90, RMSEA ≤ 0,10, α e CC> 0,70). O fator "Percepção de Conhecimento/Treinamento em Bioestatística" não foi encontrado correlacionado com a "Percepção da Bioestatística na Pesquisa e Evidência Científica".

- *PALAVRAS-CHAVE: Validade; escalas; odontologia; prática baseada em evidências.*

References

ANASTASI, A. *Psychological Testing*. New York City: Macmillan; 1988.

BATRA, M. *et al*. Perception of dental professionals towards Biostatistics. *International Scholarly Research Notices*, Article ID 291807, 2014

BRAZILIAN MARKET RESEARCH ASSOCIATION. BRAZILIAN ECONOMIC CLASSIFICATION CRITERIA. 2015. At: http://www.abep.org/criterio-brasil. Accessed on: March 08, 2016.

CAMPOS, J. A. D. B. *et al*. Avaliação psicométrica da escala de atitudes em relação à estatística. *Revista Brasileira de Biometria*, v.31, p.327-37, 2013.

ESCALERA-CHÁVEZ, M. E.; GARCÍA-SANTILLÁN, A.; VENEGAS-MARTÍNEZ, F. Confirmatory factorial analysis to validity a theoretical model to measure attitude toward statistic. *Mediterranean Journal of Social Sciences*, v.5, n.1, p.569-571, 2014.

GARCÍA-SANTILLÁN, A. *et al*. Empirical study on students and their attitudes toward statistics course and statistical field. *American Journal of Educational Research*, v.2, n.12, p.1151-1159, 2014.

HAIR, J. F. et al. *Multivariate data analysis*. 6.ed. New York: Prentice Hall, 2005. 928p.

HANNIGAN, A.; HEGARTY, A.C.; MCGRATH, D. Attitudes towards statistics of graduate entry medical students: the role of prior learning experiences. *BMC medical education*, v.14, 2014.

JAVALI, S. B.; SUNKAD, M. Comparison of knowledge and attitude towards biostatistics among oral health Professionals. *International Journal of Health Sciences and Research*, v.6, n.9, p.32-39, 2016.

KILIÇ, I.; ÇELIK, B. The views of academic staff on biostatistics education in health sciences. *International Journal of Health Sciences and Research*, v.7, p.142-149, 2013.

KUMAR, L. et al. Attitudes toward Biostatistics among post-graduate medical students in Kishanganj, Bihar. *Journal of Evolution Medical Dental Science*, v.3, n.3, p.758-761, 2014.

MAROCO, J. *Análise de equações estruturais: fundamentos teóricos, software & aplicações*. Pero Pinheiro: Report Number, p.374, 2014.

MILIC, N. M. et al. The Importance of medical students' attitudes regarding cognitive competence for teaching applied statistics: Multi-site study and meta-analysis. *PLoS ONE*, v.11, n.10, p.1-13, 2016.

MUTAMBAYI, R. M.; ODEYEMI, A. S.; NDEGE, J. O.; MJOLI, Q. T.; QIN, Y. A statistical analysis of students' attitudes towards statistics: A case study of undergraduate Bachelor of Science students at the University of Fort Hare. *International Journal of Education Science*, v.14, n.3, p.294-303, 2016.

MUTHÉN, L. K.; MUTHÉN, B. O. *Mplus statistical analysis with latent variables user's guide*. Los Angeles, 2010.

NGUYEN, T. H.; CHARITY, I.; ROBSON, A. Students' perceptions of computer-based learning environments, their attitude towards business statistics, and their academic achievement: implications from a UK university. *Studies in Higher Education*, v.41, n.4, p.734-755, 2016.

SHAKERI, N. Effectiveness of some educational methods and tools on improving the level of understanding of biostatistics among medical students and paramedical postgraduate students. *Global Journal of Health Science*, v.8, n.11, p.302-310, 2016.

SHETTY, A. C.; AL RASHEED, N. M.; ALBWARDI, S. A. Dental professionals' attitude towards biostatistics. *Journal of Dentistry and Oral Hygiene*, v.7, n.7, p.113-118, 2015.

WADHWA, M.; KALYAN, P.; KALANTHARAKATH, T. Knowledge and attitude of medical and dental postgraduate students towards practice of biostatistics. *Journal of Post Graduation in Medical Education Research*, v.49, n.1, p.1-4, 2015.

WEST, C. P.; FICALORA, R. D. Clinician attitudes toward biostatistics. *Mayo Clinic Procedures*, v.82, n.8, p.939-943, 2007.

ZHANG, Y. *et al.* Attitudes toward statistics in medical postgraduates: measuring, evaluating and monitoring. *BMC Medical Education*, v.2, p.117, 2012.

Received on 19.12.2016

Approved after revised on 09.10.2017