The Oral Health Impact Profile-14: a unidimensional scale?

Oral Health Impact Profile-14: uma escala unidimensional?

Oral Health Impact Profile-14: ¿una escala unidimensional?

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Abstract

The aim of this study was to investigate the dimensional structure of the Oral Health Impact Profile-14 *(OHIP-14). Data was obtained from studies carried out in Rio de Janeiro (N = 504) and Carlos Barbosa (N = 872), in the State of Rio Grande do Sul, Brazil. Exploratory factor analysis (EFA) was performed to identify the latent dimensions of the OHIP-14. Confirmatory factor analysis (CFA) was carried out of both samples to compare the one-dimensional structure found by the EFA and the proposed three-dimensional structure. This factorial structure was assessed using goodness-of-fit indices. In the Rio de Janeiro study, the eigenvalue was 9.2 and this one factor explained 65.6% of total variance, while in the Carlos Barbosa study the eigenvalue was 7.9 and this one factor explained 56.6% of variance. CFA indicated an adequate fit of the one-factor model for the Rio de Janeiro study (RMSEA = 0.04; CFI = 0.98; TLI = 0.98) and for the Carlos Barbosa study (RMSEA = 0.05; CFI = 0.97; TLI = 0.97). Our findings suggest that the OHIP-14 measures one single construct.*

Oral Health; Factor Analysis, Statistical; Quality of Life

Resumo

O objetivo foi investigar a estrutura dimensional do Oral Health Impact Profile-14 *(OHIP-14). Os indivíduos nas amostras foram provenientes de dois estudos realizados no Brasil, um no Rio de Janeiro, Brasil (N = 504) e o outro em Carlos Barbosa, Rio Grande do Sul, Brasil (N = 872). Análise fatorial confirmatória (AFC) foi conduzida para identificar as dimensões latentes do OHIP-14 e comparar um modelo de estrutura unidimensional com um modelo de três dimensões. A estrutura dimensional foi avaliada através de índices de qualidade de ajuste. A estrutura com um fator apresentou, no estudo do Rio de Janeiro, um autovalor de 9,2 e esta estrutura explicou 65,6% da variância total, enquanto que no estudo de Carlos Barbosa o autovalor foi de 7,9 e esta estrutura unidimensional explicou 56,6% da variância total. AFC realizada indicou um ajuste adequado para o modelo de 1 fator para o estudo do Rio de Janeiro (RMSEA = 0,04; CFI = 0,98; TLI = 0,98) e para o estudo de Carlos Barbosa (RMSEA = 0,05; CFI = 0,97; TLI = 0,97). O modelo de um fator foi mais parcimonioso. Nossos resultados sugerem que o OHIP-14 seja um instrumento unidimensional.*

Saúde Bucal; Análise Fatorial; Qualidade de Vida

Introduction

Oral Health-related Quality of Life (OHRQoL) has been defined as "*the absence of negative impacts of oral conditions on social life and a positive sense of dentofacial self-confidence*" [1] (p. 14). Theoretical models characterize OHRQoL as multidimensional, including physical, psychological and social dimensions [2,3]. In this context, the term dimension is defined as "*items that measure the same construct*" [4] (p. 67).

Among the various OHRQoL instruments, the *Oral Health Impact Profile* (OHIP) was developed with the aim of providing a comprehensive measure of self-reported dysfunction, discomfort and disability attributed to the oral condition [5]. The original OHIP contains 49 questions grouped in seven dimensions based on Locker's model of oral health, which was adapted from the World Health Organization's International Classification of Impairments, Disabilities, and Handicaps [5,6]. The OHIP-14 was developed as a shorter version of the OHIP-49 [7]. This instrument is one of the most widely used OHRQoL indicators internationally, is available in several languages (including Portuguese, Chinese, French, German, Japanese, Malaysian, Spanish and Somalian) and has been shown to have face and content validity for different populations [8,9].

A search of MEDLINE performed in early 2012 found 55 articles published in 2011 that contained the keyword OHIP-14. Approximately 80 percent of the studies surveyed used only the OHIP-14 score, meaning that the authors in question considered only one dimension. When the OHIP-14 was originally developed, exploratory analyses revealed that 70% of variance was explained by a single underlying factor. With respect to the responses to the OHIP questions, the results suggest one underlying single construct, which could be interpreted as representing oral ill-health. Thus, it is plausible that the general supra-dimension "oral illness" underlies a number of different dimensions [10]. Additionally, although the construct validity of the profile is well reported [9], the current conception of the OHIP does not provide an adequate description of its dimensional validity and its items do not represent the seven separate constructs of oral health as originally devised [11].

The few studies that have evaluated the dimensional structure of the OHIP present contradictory results. Two studies used exploratory factor analysis (EFA) [10,12] and only one used EFA and confirmatory factor analysis (CFA) [13]. Of those that performed EFA, one used the OHIP-49 and found the following four dimensions: (1) oral functions; (2) orofacial pain; (3) psychosocial impact; and (4) appearance [10]. The other study used the OHIP-14 and described a range of OHIP items loaded highly on two factors [12]. In a more recent study that used the *Oral Impacts on Daily Performance* (OIDP) and the OHIP-14 simultaneously, CFA showed a three-factor structure for the OHIP-14 [13]. These results confirmed the existence of a set of three underlying factors considered as functional limitation, pain-discomfort and psychosocial impacts, that showed high consistency when integrated with the Locker model [6].

Many OHRQoL questionnaires are a combination of formative and reflective measurement models that, despite its vast impact on the questionnaires construction and evaluation, is generally ignored [14]. Construct validity is an assessment of how well ideas or theories translate into actual programs or measures [15]. Dimensional validity is important because it indicates how an instrument should be used in practice. Further analysis on the dimensionality and the adequacy of the OHIP can serve to help improve the interpretation of the results obtained with this instrument. This study is important to the discussion surrounding the construct validity of the OHIP. Therefore, the objective of this study was to investigate the dimensional structure of the OHIP-14.

Material and methods

This paper reports findings from a secondary analysis of data collected from two studies that used the Brazilian version of the OHIP-14. The first was carried out in Rio de Janeiro and evaluated the measurement properties of the Brazilian version of the OHIP-14 in postpartum women [9]. The second, carried out in Carlos Barbosa (Rio Grande do Sul State), analyzed a sample of older adults which is the age group originally targeted by the OHIP [16].

Sample

- **The Rio Janeiro study**

Data was obtained from a cross-sectional study undertaken in Rio de Janeiro, designed to evaluate the measurement properties of the Brazilian version of the short form of the OHIP-14. The study involved a consecutive sample of 504 postpartum women admitted to a Public Maternity Hospital interviewed using the OHIP-14 between January and February 2002. Further details regarding sampling are available elsewhere [9].

- **The Carlos Barbosa study**

Data was obtained from a cross-sectional study designed to assess the effects of oral diseases on the general health and quality of life of older people living in the city of Carlos Barbosa. Participants were randomly selected from the municipal register of persons aged 60 years and over. A total of 983 older individuals were contacted of which 872 were evaluated during the second semester of 2004. The OHIP-14 was administered in interview form with 848 individuals. More information on sampling is presented elsewhere [16].

Instrument

The OHIP-14 comprises 14 items that explore seven dimensions of impact: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. The responses were classified using the Likert scale with five options ranging from "never" (0) to "very often" (4).

Data analysis

An initial EFA of the data taken from the two studies was undertaken. Subsequently, CFA was used to verify the dimensional structure captured by the EFA and the three-dimensional structure proposed by Montero et al. [13]. The three-dimensional structure was used to test the existence of separate dimensions. Figure 1 shows the theoretical model tested through this process.

EFA was performed in the Rio Janeiro study (N = 504) and in the Carlos Barbosa study (N = 848) to identify the latent dimensions of the OHIP-14. No set rules exist for defining the optimum number of factors [17]. The Kaiser-Guttman rule of thumb, which specifies that only factors with an eigenvalue larger than 1.0 should be retained, was adopted, together with screeplot elbow and theoretically postulated dimensions. The current analysis used the geomin oblique rotation [17] and polychoric correlation. An item was considered to load on a factor if its correlation with that factor was greater than 0.3 [18]. Communality measures the common factor variance in a given item. A communality of 0.3 or less indicates that a variable may be unreliable [18], while a value greater than 0.3 indicates that a large percentage of sample variance for each item is accounted for by the given factor.

EFA showed one appropriate factor for both datasets. Subsequently, CFA of the data taken from the two studies was performed employing the Mplus and weighted least squares means and variances adjusted estimation (WLSMV) [17] to compare the one-dimensional structure found by EFA and the three-dimensional structure proposed by Montero et al. [13]. Measurement errors (uniqueness) and loadings were also calculated.

The goodness-of-fit of the model to the data was evaluated using the ordinary comparative parameters provided by the software. The root mean square error of approximation (RMSEA) incorporates a penalty function for poor model parsimony [17]. Values under 0.06 suggest close approximate (adequate) fit, whereas values above 0.10 indicate poor fit and that the model should be rejected [17]. The comparative fit index (CFI) and the Tucker-Lewis index (TLI) represent incremental fit indices [17] contrasting the hypothesized model to a more restricted nested baseline model, the "null model". Both range from zero to one and values > 0.9 are indicative of adequate fit [17]. An overall conclusion about the fit of each model can be obtained by considering these indices simultaneously [19].

Factor correlations in the three-dimensional structure were evaluated to show the strength of association between factors. Discriminant validity exists when the degree of relationship between measures from different dimensions is low [15]. Average variance extracted (AVE) assesses the amount of variance captured by a common factor in relation to the amount of variance due to random measurement error [20] with values ranging from 0 to 1. It is a function of the relationship between the standardized item factor loadings and the related measurement error (uniqueness) that refers to the portion of an indicator not explained by the latent factor [21]. Convergent validity exists with values ≥ 0.50, indicating that at least 50% of variance is due to the hypothesized underlying trait. Factor-based convergent validity is questionable if AVE is < 0.50 since the variance due to measurement error is greater than the variance due to the construct [20]. The DIFFTEST was used to compare the fit of two nested models. The DIFFTEST shows the difference between two chi-square values and the degrees of freedom between the two models. A significant chi-square difference test result suggests that the constraints on the more restricted model are too strict and therefore the model should be rejected [17].

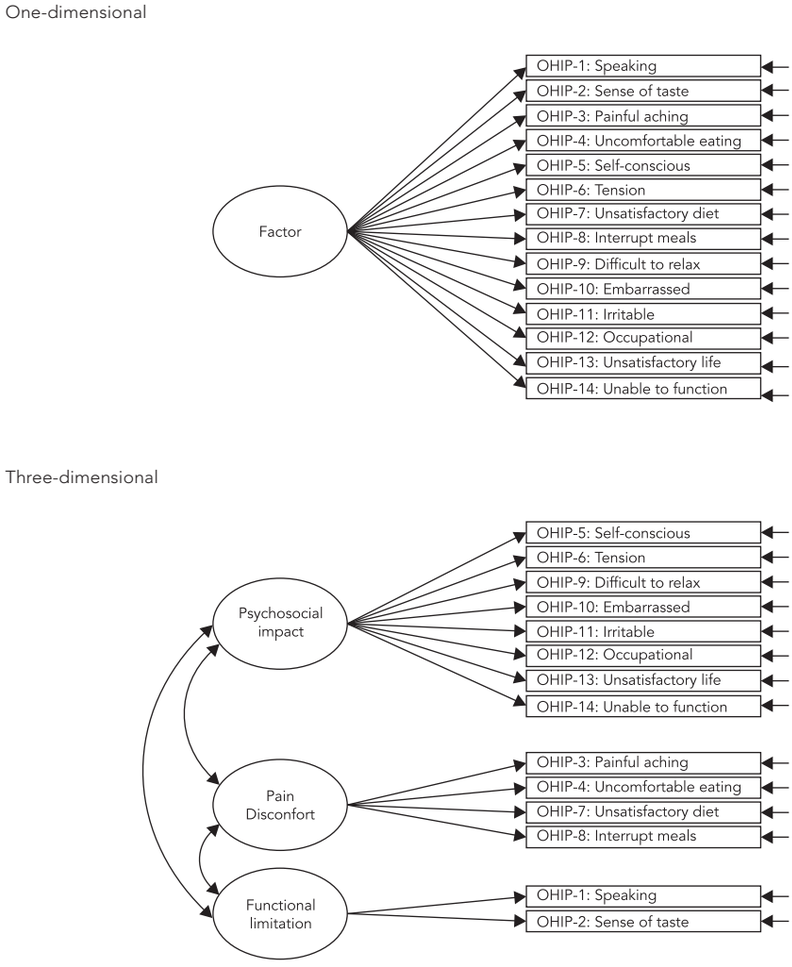
All analyses were performed using Mplus version 6.0 (Muthén & Muthén, Los Angeles, USA) software for statistical analysis.

Results

The EFA of the OHIP-14 highlighted one factor that had an eigenvalue greater than 1 supported by an "elbow" in the corresponding scree plot of

Figure 1

Theoretical model tested.



OHIP: *Oral Health Impact Profile*.

the eigenvalues. The eigenvalue of this factor in the Rio de Janeiro study was 9.2 and it explained 65.6% of total variance, while in the Carlos Barbosa study the eigenvalue was 7.9 and 56.6% of variance was explained by this factor. In both studies all items had loadings that exceeded 0.5 and communality values of over 0.3, indicating that the items were reliable (Table 1).

The CFA (Table 2) indicated an adequate fit of the one-factor model for the Rio de Janeiro study (RMSEA = 0.04; CFI = 0.98; TLI = 0.98) and for the Carlos Barbosa study (RMSEA = 0.05; CFI = 0.97; TLI = 0.97). Loadings were high in both studies. The three-factor model showed adequate fit for the Rio de Janeiro study (RMSEA = 0.04; CFI = 0.99; TLI = 0.98) and for the Carlos Barbosa study (RMSEA = 0.05; CFI = 0.98; TLI = 0.97). Measurement error (uniqueness) values were acceptable for the one-factor model and three-factor model in both studies. Although the three-factor model showed adequate fit, factor correlations were relatively high suggesting that they may not represent three distinct factors [Rio de Janeiro study (f1↔f2 = 0.95, f1↔f3 = 0.84, f2↔f3 = 0.82) and Carlos Barbosa study (f1↔f2 = 0.92, f1↔f3 = 0.77, f2↔f3 = 0.81)]. In the Rio de Janeiro Study,

Table 1

Exploratory factor analysis (EFA) of the *Oral Health Impact Profile-14* (OHIP-14) (all loadings shown > 0.5).

	Rio de Janeiro study		Carlos Barbosa study	
	Factor 1		Factor 1	
	$\lambda i_{(1)}$ (SE)	h^2	$\lambda i_{(1)}$ (SE)	h^2
OHIP-1: Speaking	0.69 (0.05)	0.48	0.58 (0.03)	0.34
OHIP-2: Sense of taste	0.65 (0.04)	0.43	0.55 (0.03)	0.31
OHIP-3: Painful aching	0.80 (0.02)	0.66	0.57 (0.03)	0.33
OHIP-4: Uncomfortable eating	0.80 (0.02)	0.65	0.75 (0.02)	0.57
OHIP-5: Self-conscious	0.74 (0.03)	0.56	0.90 (0.01)	0.82
OHIP-6: Tension	0.90 (0.01)	0.82	0.93 (0.01)	0.88
OHIP-7: Unsatisfactory diet	0.89 (0.02)	0.81	0.68 (0.02)	0.47
OHIP-8: Interrupt meals	0.80 (0.02)	0.65	0.77 (0.02)	0.61
OHIP-9: Difficult to relax	0.89 (0.02)	0.80	0.83 (0.02)	0.70
OHIP-10: Embarrassed	0.61 (0.04)	0.38	0.60 (0.04)	0.37
OHIP-11: Irritable	0.79 (0.03)	0.64	0.60 (0.04)	0.37
OHIP-12: Occupational	0.87 (0.02)	0.77	0.80 (0.03)	0.65
OHIP-13: Unsatisfactory life	0.80 (0.03)	0.66	0.76 (0.03)	0.59
OHIP-14: Unable to function	0.85 (0.03)	0.74	0.88 (0.04)	0.79
Eigenvalues	9.20		7.90	
Variance explained (%)	65.6		56.6	

h^2: communality; SE: standard error; $\lambda i_{(1)}$: loadings.

AVE was f1 = 0.67, f2 = 0.67 and f3 = 0.44, indicating that f1 and f2 have convergent validity. In the Carlos Barbosa study, AVE was f1 = 0.64, f2 = 0.42 and f3 = 0.28, showing that only f1 has convergent validity.

The chi-square difference test showed a significant difference between the one-factor and three-factor models in the Carlos Barbosa study (d.f.: 3; chi-square: 38.17; $p < 0.000$) indicating that the three-dimensional structure was more effective in accounting for the data. In the Rio de Janeiro study, the chi-square difference test showed a significant difference between the one-factor and three-factor models (d.f.: 3; chi-square: 20.27; $p < 0.000$), indicating that the three-factor model had a better fit.

Discussion

The present study investigated the dimensional structure of the OHIP-14. To the best of our knowledge, this is the first study to focus on confirmatory factor analysis of the structure of the OHIP-14 using two different samples. EFA and the CFA identified and respectively confirmed that the one-factor models used in the Rio de Janeiro and Carlos Barbosa studies are adequate parsimonious models. A similar situation was observed with the derivation of a short-form of the OHIP-49, where a single underlying factor with an eigenvalue of 15.1 accounted for 69.2% of variance [7]. Another study observed three components that had eigenvalues ranging from 1.6 to 3.8 that explained 58.1% of variance [13]. Although OHRQoL is a multidimensional construct, our findings suggest that the OHIP-14 may be considered a single construct scale. Thus, when using this instrument, it would be appropriate to describe research findings by reporting total scores.

While EFA has been used to evaluate the dimensionality of a set of multiple indicators by uncovering the smallest number of interpretable factors needed to explain correlations, CFA requires *a priori* specification of a model supported by theory, including the number of factors that exist in that data and knowledge of which items are related to each factor [17]. In our study, the information necessary to specify the model was captured using EFA and the three-dimensional structure proposed by Montero et al. [13]. In the present study, CFA confirmed that a one-factor model fitted in both samples in contrast to another study that identified a three-factor structure for the OHIP-14. However, this study found

Table 2

Dimensional models of the *Oral Health Impact Profile-14* (OHIP-14): one-dimensional confirmatory factor analysis (CFA) and three-factor CFA.

	Rio de Janeiro study						Carlos Barbosa study					
	1-Factor CFA		3-Factor CFA				1-Factor EFA		3-Factor CFA			
	Factor 1		Factor 1	Factor 2	Factor 3		Factor 1		Factor 1	Factor 2	Factor 3	
	λ i $_{(1)}$ (SE)	δ	$\lambda_{(1)}$	$\lambda_{(2)}$	$\lambda_{(3)}$	δ	λ i $_{(1)}$ (SE)	δ	$\lambda_{(1)}$	$\lambda_{(2)}$	$\lambda_{(3)}$	δ
OHIP-1	0.69 (0.55)	0.52			0.80 (0.06)	0.35	0.58 (0.03)	0.66			0.71 (0.04)	0.49
OHIP-2	0.65 (0.04)	0.57			0.75 (0.05)	0.42	0.55 (0.03)	0.69			0.67 (0.04)	0.55
OHIP-3	0.80 (0.02)	0.34		0.82 (0.02)		0.31	0.57 (0.03)	0.67		0.59 (0.03)		0.65
OHIP-4	0.80 (0.02)	0.35		0.81 (0.02)		0.33	0.75 (0.02)	0.43		0.78 (0.02)		0.38
OHIP-5	0.74 (0.03)	0.44	0.75 (0.03)			0.43	0.90 (0.01)	0.18	0.90 (0.01)			0.17
OHIP-6	0.90 (0.01)	0.18	0.91 (0.01)			0.16	0.93 (0.01)	0.12	0.94 (0.01)			0.11
OHIP-7	0.89 (0.02)	0.19		0.91 (0.02)		0.16	0.68 (0.02)	0.53		0.70 (0.02)		0.49
OHIP-8	0.80 (0.02)	0.35		0.81 (0.02)		0.33	0.77 (0.02)	0.39		0.81 (0.02)		0.34
OHIP-9	0.89 (0.02)	0.20	0.89 (0.02)			0.19	0.83 (0.02)	0.30	0.84 (0.02)			0.28
OHIP-10	0.61 (0.04)	0.62	0.61 (0.04)			0.61	0.60 (0.04)	0.63	0.61 (0.04)			0.62
OHIP-11	0.79 (0.03)	0.36	0.79 (0.03)			0.36	0.60 (0.04)	0.63	0.61 (0.04)			0.62
OHIP-12	0.87 (0.02)	0.23	0.88 (0.02)			0.22	0.80 (0.03)	0.35	0.81 (0.03)			0.34
OHIP-13	0.80 (0.03)	0.34	0.81 (0.03)			0.33	0.76 (0.03)	0.41	0.77 (0.03)			0.40
OHIP-14	0.85 (0.03)	0.26	0.86 (0.03)			0.25	0.88 (0.04)	0.21	0.89 (0.04)			0.20
AVE			0.67	0.67	0.44				0.64	0.42	0.28	
f1↔f2 *				0.95						0.92		
f1↔f3 *				0.84						0.77		
f2↔f3 *				0.82						0.81		
RMSEA	0.04			0.04			0.05			0.05		
CFI	0.98			0.99			0.97			0.98		
TLI	0.98			0.98			0.97			0.97		

AVE: average variance extracted; CFI: comparative fit index; RMSEA: root mean square error of approximation; SE: standard error; TLI: Tucker-Lewis index; λ: loadings; δ: measurement errors (uniqueness).

* Factors correlation.

that the first factor strongly dominated the factorial structure [13]. Additionally, some authors have considered OHQoL in adults or older adults as a single construct [22,23].

Both one-factor and three-factor models were adequate and the three-factor model showed a statistically superior fit. However, the correlations between factors in the three-factor model were relatively high suggesting that they may not represent three distinct factors and do not need to be separated. With respect to CFA, factor correlations of over 0.85 typically reflect poor discriminant validity [17]. The present study showed the following correlations between the domains proposed by Montero et al. [13]: pain and psychosocial = 0.95 Rio de Janeiro study/0.92 Carlos Barbosa study; pain and functional limitation = 0.82/Rio de Janeiro study/0.81 Carlos Barbosa study; and psychosocial and functional limitation = 0.84 Rio de Janeiro study/0.77 Carlos Barbosa study. AVE was low for f3 in the Rio de Janeiro study and for f2 and f3 in the Carlos Barbosa study, indicating that convergent validity was questionable in the three-factor model. It is thus laudable that the OHIP-14 may be described as a single factor. Our results show that the general factor "oral illness" underlies a number of different dimensions [10], thus supporting this claim.

The present findings have important implications for clinical practice and research. The OHRQoL assessment tool is used to identify and evaluate how oral problems influence people's daily lives and quality of life. In addition, researchers studying oral health problems have used OHRQoL as an outcome measure to analyze treatment effects, trends in oral health and population-based needs assessment [2]. OHRQoL assessments are being incorporated into observational clinical studies and trials to measure effectiveness of treatment with the goal of im-

proving care [2]. Numerous investigations utilizing the OHIP-14 report scores for each originally proposed dimension. However, if the scale does not have adequate construct validity such conclusions are not reliable and results should be treated with caution[11]. It is also important to highlight that short-forms of other OHRQoL questionnaires (e.g., the Child-OIDP [24] and the *Child Perceptions Questionnaire* [25]) may also present a unidimensional structure and this should be subject to evaluation.

Conclusion

The findings of the present study suggest that the OHIP-14 is one-dimensional and may not provide a multidimensional perspective in the evaluation of oral health impacts on quality of life, therefore casting doubt on the appropriateness of reporting results as being multidimensional. The generalization of the results of this study may have been affected by the characteristics of the sample, which was composed mainly of white individuals, and further studies in broader settings are needed to corroborate our results. Moreover, additional research addressing the impact of specific oral conditions on quality of life would help to assess whether specific dimensions are most affected by such conditions. Additional studies to evaluate the impact of exogenous variables on OHRQoL are also needed. Finally, studies involving item response theory analysis would certainly contribute towards a better understanding of the dimensionality of the OHIP-14.

Resumen

El objetivo fue investigar la estructura dimensional del Oral Health Impact Profile-14 (OHIP-14). Los individuos en las muestras provinieron de dos estudios realizados en Brasil, uno en Río de Janeiro (N = 504) y el otro en Carlos Barbosa, Río Grande do Sul (N = 872). Un análisis factorial confirmatorio (AFC) se llevó a cabo para identificar las dimensiones latentes del OHIP-14 y comparar un modelo de estructura unidimensional con un modelo de tres dimensiones. La estructura dimensional fue evaluada a través de índices de calidad de ajuste. La estructura con un factor presentó, en el estudio de Río de Janeiro, un autovalor de 9,2 y esta estructura explicó un 65,6% de la variancia total, mientras que en el estudio de Carlos Barbosa el autovalor fue de 7,9 y esta estructura unidimensional explicó un 56,6% de la variancia total. El AFC realizado indicó un ajuste adecuado para el modelo de 1 factor en el estudio de Río de Janeiro (RMSEA = 0,04; CFI = 0,98; TLI = 0,98) y en el estudio de Carlos Barbosa (RMSEA = 0,05; CFI = 0,97; TLI = 0,97). El modelo de un factor fue más parsimonioso. Nuestros resultados sugieren que el OHIP-14 sea un instrumento unidimensional.

Salud Bucal; Análisis Factorial; Calidad de Vida

Contributors

C. M. Santos, B. H. Oliveira, P. Nadanovsky, J. B. Hilgert, R. K. Celeste and F. N. Hugo contributed to study design, data collection and analysis, writing this article and approval of the final version for publication.

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