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A New Factorial Approach in the Assessment of Health-Related Quality of Life (HRQoL) in Dentistry Patients

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Abstract

Objective: Due to the complexity and multidimensional nature of the variable health-related quality of life (HRQoL), it has been measured by psychometric scales as the Short Form Health Survey (SF-36). The aim of this study was evaluate both the psychometric properties and the factorial structure of the Portuguese version of the Short Form Health Survey (SF-36) and propose a new factorial approach to assess HRQoL in Brazilian patients who seek dental care.

Materials & Methods: It was a cross-sectional study. A total 1,198 adult subjects participated in the study, 70.5% were female and the mean age was 45.6 (SD=15.2) years. SF-36 is originally divided into eight first-order factors (physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health). Confirmatory factor analysis was performed. We tested two third-order hierarchical models: the original structure and the current structure with three second-order factors. Convergent validity, discriminant validity and internal consistency were also estimated.

Results: Despite the satisfactory fit of the two structures tested, the analysis revealed some very low factor weights, impaired discriminant validity, and high modification indices in the sample. A factorial structure with seven first-order factors was tested and presented adequate fit. Convergent validity was below adequate for the General Health factor. Internal consistency and discriminant validity were adequate.

Conclusion: The new structure with seven first-order factors proposed can be considered a new factorial approach in the assessment of HRQoL in dentistry patients.

Keywords: Community dentistry; Factorial structure; Health status indicators; Quality of life; Validity of tests

Abbreviations: HRQoL: Health-related Quality of Life; SF-36: Short Form Health Survey; CVR: Content Validity Ratio; CFA: Confirmatory Factor Analysis; Ku: Kurtosis; Sk: Skewness; χ^2/df: Ratio of chi-square per Degrees of Freedom; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index; RMSEA: Root mean Square Error of Approximation; $\Delta\chi^2$: Chi-square Difference Test; AVE: Average Variance Extracted; CR: Composite Reliability; SEM: Structural Equation Modeling

Introduction

Quality of life assessment has changed over the years, and many researchers now recognize the importance of individual perceptions of health conditions in the understanding of this construct.

When quality of life is used as a research variable, results are complex and multidimensional in nature. As a result, psychometric scales are used to measure quality of life. These scales are able to estimate the impacts caused by symptoms of disease, physical impairments, or limitations to normal function, as well as the consequences of these aspects on health and individual well-being [1]. Thus, many instruments have been developed to measure health-related quality of life, including the Short Form Health Survey (SF-36) [2].

The SF-36 is part of the Medical Outcomes Study [2,3] and is a generic health indicator used worldwide to measure Health-related quality of life [4,5]. There are many translations and adaptations of this instrument. These adaptations are used in different countries, including France, Denmark, Italy, Germany, the Netherlands, Spain, Norway, Sweden, the United Kingdom, the United States [4] and Brazil [6], among others [1,5]. The survey has been used in health research, in clinical practices, and to assess and/or monitor levels of health and quality of life in different populations [3,7,8].

The original SF-36 is composed of 36 items distributed into eight first-order factors (physical functioning, physical role functioning, bodily pain, general health, vitality, social functioning, emotional role functioning, and mental health) and two second-order factors (physical health and general mental health) [7]. Several factorial structures of the SF-36 have been developed and tested based on the original proposal. One includes the structure proposed by Keller et al. [4], who added a third second-order factor referred to as "general well-being" to the original structure. The original structure and Keller et al.'s structure [4] are the most commonly used versions of the SF-36 in the literature [5,9].

The validity and reliability of these proposed factorial structures have been widely tested on different samples and in different cultures both by the original creators of the survey [2,7,9,10] and by other researchers around the world [5,11,12]. However, despite the frequent use of this instrument in Brazilian studies, there seem to be no studies in the literature that have used structural equation modeling techniques to evaluate the psychometric properties of the SF-36. Laguardia et al. [13] conducted a study to evaluate the psychometric properties of the SF-36 applied to a wide and representative sample of the Brazilian population. However, the authors used an exploratory strategy to evaluate the validity of the instrument for sample, and this approach is not recommended when the factorial structure of the instrument is based on a theoretical model established *a priori* [14-16], as is the case of the SF-36 [4,10].

Thus, the lack of studies to determine the validity and reliability of the factorial structure of SF-36 when applied to Brazilian samples can be considered an important gap that must be filled in order to determine the best factorial structure for assessing health-related quality of life in the country. This study sought to evaluate the psychometric properties of the Portuguese version of the Short Form Health Survey (SF-36) when applied to a Brazilian sample of dentistry patients and propose a new factorial structure to assess health-related quality of life in dentistry context.

Materials and Methods

Study design and sampling

This is a cross-sectional study with non-probabilistic sampling design. The sample was comprised of 1,198 adult patients treated at the School of Dentistry of São Paulo State University - Araraquara Campus. Data was collected for eight months.

Ethical Considerations

The study was authorized by the Research Ethics Committee of the School of Dentistry of São Paulo State University- Araraquara Campus (Certificate (CAAE) Number: 01040312.5.0000.5416; case number 50802). The study included only individuals over 18 years of age who agreed with and signed the Free and Informed Consent Form. The authorization and license to use the Short Form Health Survey (SF-36) was purchased from Quality Metric, Inc. (License: QM13691).

Study Variable

To characterize the sample, a socio-demographic questionnaire was also used. Information on gender, age, educational level, and economic level was collected. The questionnaire also included questions on the presence and types of any chronic diseases. Economic level was classified according to the Brazilian Economic Classification Criterion [17].

Instrument

To assess HRQoL, we used the Portuguese version of the SF-36 in its original format (patients' recall of the previous four weeks) provided by Quality-Metric Incorporation®. The SF-36 was used in the original format; no changes were made prior to its application.

This instrument consists of 36 items, 35 of which were originally divided into eight first-order factors (physical functioning, physical role functioning, bodily pain, general health, vitality, social functioning, emotional role functioning, and mental health). The final item (Item 2) assesses changes in health status in longitudinal studies. However, Item 2 is not part of the SF-36 factorial structure and was not used in this study [3,18].

The answers are given on a three-point Likert scale for the "physical functioning" factor (Item 3a to 3j) and on a five-point Likert scale for the other factors. The items making up the "general health" and "bodily pain" factors were inverted and recorded as suggested by the SF-36 manual [3,18].

Two factor structures of the SF-36 were tested in our sample. The original structure (Model 1) uses physical health (physical functioning, physical role functioning, bodily pain, and general health) and mental health (vitality, social functioning, emotional role functioning, and mental health) as second-order factors [2,10] in addition to a third-order factor referred to as "health". The second factor structure used was the version proposed by Keller et al. [4] (Model 2), with a third second-order factor referred to as "general well-being".

Analysis of Psychometric Properties

The psychometric sensitivity of the SF-36 items was assessed through the measurement of central tendency, variability, and the shape of the distribution. An absolute kurtosis (Ku) value of <7 and an absolute skewness (Sk) value of <3 were considered indicators of psychometric sensitivity [19].

The content validity ratio (CVR) was estimated following the proposal by Lawshe [20]. A total of 15 experts in the quality of life research field participated in this stage of the study. They rated each SF-36 item in terms of its essentiality. The categories used in this rating were "essential", "useful but not essential", and "unnecessary". Decisions were made based on the proposal by Wilson et al. [21], which adopted a significance level of 5%. It is important to note that these judges were professionals and researchers from the fields of dentistry and psychology who have or have had quality of life as a topic in their line of research.

The factorial validity was estimated using confirmatory factor analysis (CFA), which incorporates the polychoric correlation matrix, as well as the weighted least squares mean and the variance-adjusted estimation methods. The estimations were performed in the MPLUS software, version 6.0 (Muthén & Muthén, Los Angeles, CA). The goodness of fit indices used included the ratio of chi-square per degrees of freedom (χ^2/df), the comparative fit index (CFI), the Tucker-Lewis index (TLI) and the root mean square error of approximation (RMSEA) [19,22]. The fit of the models was considered adequate when χ^2/df 3.0, CFI and TLI $\geq$ 0.90 and RMSEA<0.10 [19]. To verify the correlation between the errors, we used the modification indices created using the Lagrange Multipliers method [19].

The comparison between the models was performed using the chi-square difference test ($\Delta\chi^2$) [19]. The best model was the one that had the smallest value of χ^2 with a significant difference.

The stability of each model was tested in independent samples. The total sample was randomly divided into two equal parts. One part was considered the Test Sample, and the other was considered the Validation Sample. The factorial invariance between the models was estimated using multigroup analysis, which utilizes the chi-square difference ($\Delta\chi^2$) for the factor weights (λ), for covariances between factors (Cov), and for specific factors (Res) [19].

Convergent validity was estimated based on the calculations of average variance extracted (AVE) and composite reliability (CR) [19,23] which themselves were based on Fornell and Larcker's proposal [24]. AVE $\geq$ 0.50 and CR $\geq$ 0.70 were established as convergent validity indicators [19]. Discriminant validity was assessed using correlation analysis. Discriminant validity was considered adequate when AVE_i and $AVE_j \geq \rho_{ij}^2$ (where ρ_{ij}^2 is square of the correlation between the factors *i* and *j*). In other words, the items that reflect a factor are correlated more strongly with this factor than with any other [19,24].

Internal consistency was estimated using Cronbach's alpha coefficient (α) for polychoric correlations. For this analysis, the R-cran® software was used (R Development Core Team, Vienna, Austria), in which $\alpha \geq 0.70$ was considered adequate [25].

It is important to emphasize, however, that the psychometric characteristics of the instrument are reflective of its application to the study sample [16]. It may vary according to the characteristics of the respondents.

Results

Among the participants, 70.5% were female, with a mean age of 45.6 (SD=15.2) years and with low economic level with 53.4% belonging to economy class C (estimated monthly revenue: U.S. $402.43) and 13.3% to classes D and E (estimated monthly revenue: U.S. $89.86 to U.S. $184.07). Of the participants, 24.8% reported having some type of chronic disease, hypertension and Diabetes Mellitus were the most frequently reported.

The summary measures for each item of SF-36 and Content Validity Ratio (CVR) are presented in Table 1.

We may observe that the items of the SF-36 presented adequate skewness and kurtosis values, which indicates an approximation to a normal distribution, with the exception of item 3j.

Table 2 presents the goodness of fit indices of the factor models (CFA), convergent validity (AVE), composite reliability (CR) and the internal consistency (α) for different models.

We can observe a satisfactory fit of the models according to the results of the CFA. Two items (3j and 5c) showed factor weights below adequate in our sample (λ=0.40). Convergent validity was compromised in the factor "general health" and the internal consistency was inadequate for the factor "role-emotional" for both models. High modification indices were detected for the two models. Table 3 presents the results of the average variance extracted (AVE) and the square of the correlation between factors (r^2) for the eight first-order factors of the SF-36.

Table 1: Summary measures and Content Validity Ratio of each item of the Short Form Health Survey. Araraquara, Brazil, 2014.

Item	Mean	Median	Standard Deviation	Kurtosis	Skewness	CVR*
1	2.65	3.00	0.84	0.14	-0.42	0.87
3a	2.67	2.00	0.92	-1.16	-0.50	0.33[a]
3b	2.27	3.00	0.77	0.51	-1.35	0.87
3c	2.59	3.00	0.67	1.10	-1.55	0.73
3d	2.64	3.00	0.64	-0.41	-0.97	0.47[a]
3e	2.47	3.00	0.71	0.99	-1.49	0.60
3f	2.63	3.00	0.63	-0.18	-1.07	0.87
3g	2.51	3.00	0.69	-0.03	-1.14	-0.20[a]
3h	2.53	3.00	0.69	0.40	-1.30	0.47[a]
3i	2.58	3.00	0.66	5.47	-2.46	0.87
3j	2.82	3.00	0.45	16.88	-4.03	0.87
4a	2.92	5.00	0.31	0.46	-1.19	1.00
4b	4.11	4.00	1.16	0.01	-1.03	0.73
4c	4.01	5.00	1.20	0.48	-1.26	0.73
4d	4.15	5.00	1.18	0.70	-1.32	0.60
5a	4.18	5.00	1.17	0.41	-1.20	1.00
5b	4.10	5.00	1.19	0.28	-1.14	0.73
5c	4.07	5.00	1.19	0.87	-1.36	0.87
6	4.18	4.00	1.16	0.04	0.99	1.00
7	1.94	3.00	1.08	-0.85	0.19	0.87
8	2.46	4.00	1.11	-0.04	0.99	1.00
9a	1.99	4.00	1.12	-0.89	0.44	1.00
9b	2.41	4.00	1.23	-0.78	-0.44	0.60
9c	3.37	4.00	1.25	-0.16	-0.87	0.87
9d	3.85	3.00	1.19	-1.07	0.18	0.60
9e	2.72	3.00	1.25	-1.10	0.17	0.73
9f	2.69	4.00	1.28	0.11	-0.94	0.73
9g	3.90	4.00	1.15	-0.36	-0.74	0.73
9h	3.65	4.00	1.22	-0.90	0.47	0.87
9i	2.36	4.00	1.23	-0.32	-0.68	0.73
10	3.57	4.00	1.17	-0.41	-0.86	0.73
11a	3.79	5.00	1.30	-0.67	-0.80	0.87
11b	3.84	4.00	1.36	-0.47	0.80	0.87
11c	2.26	4.00	1.30	-0.72	-0.53	0.20[a]
11d	3.84	4.00	1.18	-0.83	0.94	0.87

$CVR_{15;0.05}$=0.506; [a]values below minimum significant value

Table 2: Psychometric properties of the different models evaluated. Araraquara, Brazil, 2014.

Estimates*	Model 1[#]	Model 2[##]
λ	0.13-0.96	0.14-0.96
χ^2	3.322.96	3.402.15
χ^2/df	6.02	6.20
CFI	0.95	0.95
TLI	0.95	0.95
RMSEA	0.07	0.07
AVE	0.40-0.83	0.40-0.83
CR	0.75-0.96	0.75-0.96
α	0.57-0.93	0.57-0.93
MI	11.54-278.96	11.37-336.83

#Original proposal (8 first-order factors, 2 second-order factors and 1 third-order factor);
##Proposal by Keller et al. (8 first-order factors, 3 second-order factors e 1 third-order factor).

Table 3: Square of the correlation between factors (r^2) and average variance extracted for the first-order factors. Araraquara, Brazil, 2014.

	Factor*							
Factor	PF	RF	BP	GH	VT	SF	RE	MH
PF	0.73[#]							
RF	0.33	0.83[#]						
BP	0.18	0.19	0.60[#]					
GH	0.16	0.15	0.20	0.41[#]				
VT	0.14	0.17	0.26	0.24	0.53[#]			
SF	0.11	0.13	0.33	0.18	0.37	0.70[#]		
RE	0.15	0.27	0.16	0.10	0.21	0.21	0.55[#]	
MH	0.08	0.13	0.23	0.20	0.58	0.41	0.21	0.53[#]

*PF=Physical Functioning; RP=Role-Physical; BP=Bodily Pain; GH=General Health;
VT=Vitality; SF=Social Functioning; RE=Role-Emotional; MH=Mental Health;
#Average Variance Extracted (AVE).

Once the AVE of the factors "Vitality" and "Mental Health" is not greater than the square of the correlation between these factors, we cannot accept discriminant validity between them in our sample.

Due to the lack of discriminant validity between the first-order factors, the was difficulty in adjusting the data to the structures proposed in the literature (Model 1 and 2), where we observe items with low factor weights and high modification indices in our sample, and the notorious theoretical similarity between items of factors "Vitality" and "Mental Health" (after inversion of items of "Vitality" as suggested in the SF-36 manual), we chose to test a new structural model (Model 3).

The new model (Model 3) was comprised by six of the first-order factors of the original proposal (Physical Functioning, Role-Physical, Bodily Pain, General Health, Social Functioning and Role-Emotional) and a new first-order factor called "Mental Health and Well-Being". This factor is the result of the union of the factors "Mental Health" and "Vitality". Both second-order factors, "Physical Health" (Physical-Functioning, Role-Physical, Bodily Pain and General Health) and "Mental Health" (Social Functioning, Role Emotional and Mental Health and Well-being), and the third-order factor "Health", followed the names used in the original proposal.

The items 3j and 5c were excluded from the analyzes because the factor weights were below adequate in the analyzes of Models 1 and 2.

Figure 1 presents the third-order hierarchical model (Model 3) proposed for the SF-36, with seven first order factors and the results of the Confirmatory Factor Analysis (CFA).

The Model 3 presented an adequate fit. Convergent validity (AVE) was bellow adequate for the factor "General Health". The internal consistency (α) was inadequate only for the factor "Role-Emotional". Discriminant validity (r^2) was adequate.

The best model tested was the Model 3 according to the results of the chi-square difference ($\Delta\chi^2_{M1XM3}$(d.f.) = 441.64; p<0.01; $\Delta\chi^2_{M2XM3}$(d.f.) = 520.83; p<0.01).

Strong stability was detected for the Model 3 in the multigroup analyzes ($\Delta\chi^2$: λ=27.88; p=0.41; COV=43.67; p=0.12; RES=100.16; p<0.01).

Discussion

The results of this study confirm the need for the reconsideration of both the original factor structure of the SF-36 and other psychometric scales when they are applied to Brazilian samples. This need has been previously highlighted in other studies in the literature [4,5]. Although the factor structures of both the original survey and of the survey proposed by Keller et al. [4], are widely used and present a good fit in

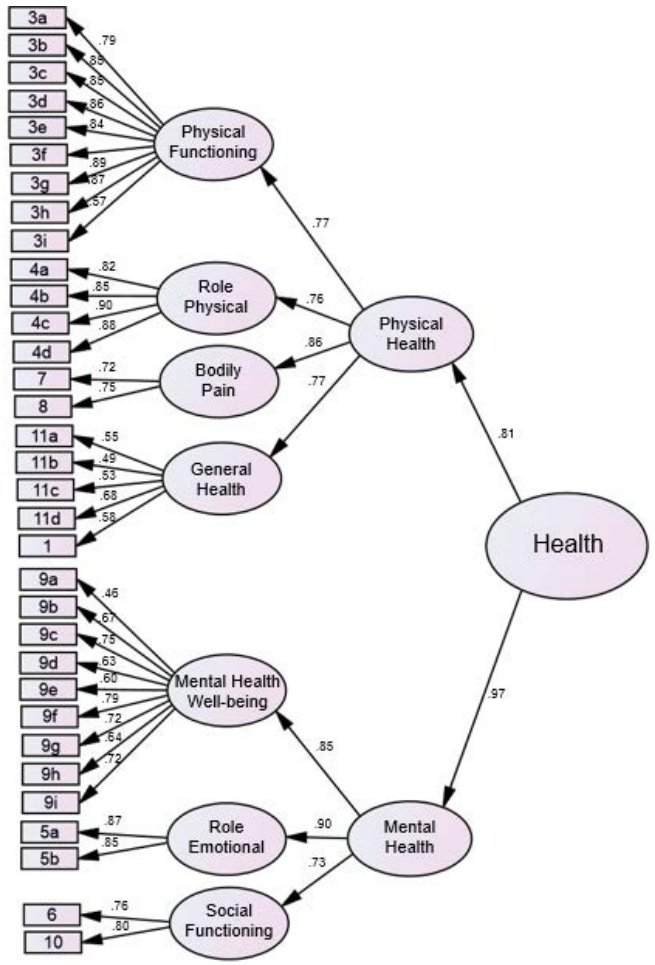

Figure 1: The new structural model which contains seven first-order factors.

different samples from different countries [5,9,10,26], these structures did not present a good fit in this study. As mentioned previously, items with low factor weights and high and discrepant modification indices were found (Table 2). In addition, discriminant validity was inadequate for the "vitality" and "mental health" factors (Table 3). Thus, we cannot consider either these factor structures to be the most appropriate instrument for assessing health-related quality of life in this study sample. It is important to emphasize that our newly proposed factorial structure for the SF-36 is an alternative that is a better fit to our data. Thus, we stress the imperative need for studies of these characteristics in different samples.

Items 3j and 5c had low factor weights in this study. Item 3j corresponds to the "physical functioning" factor and is linked to possible difficulties in bathing and/or dressing without help from others, while item 5c corresponds to the "emotional role functioning" factor and is linked to the amount of time that the person did not work or perform daily activities due to emotional problems. These items were considered essential by the judges for the measurement of the health-related quality of life as a construct in the calculation of the content validity ratio. However, these items did not present adequate values in the confirmatory factor analysis, a result which may have occurred due to particular characteristics of the study sample. The study sample was obtained based on convenience and was composed of individuals who sought dental care. In general, these individuals did not have limited mobility or any physical or emotional problems that prevented them from seeking out dental care in recent weeks. This aspect can be considered a limitation of this study.

In regards to the CVR, items classified under the "physical function" factor were considered to be non-essential by the judges. These items address the difficultly in performing vigorous physical activities. It can be speculated that the judges understood that not all people have the physical aptitude to perform these activities but may not have a lower quality of life as a result. Thus, the judges classified these items as "useful, but not essential" for the evaluation of the construct.

Furthermore, it should be noted that all factors were found to have adequate internal consistency in Model 3 (Figure 1), unlike those from Models 1 and 2 (Table 2). This finding is the result of the removal of item 5c from Model 3.

The lack of discriminant validity between certain first-order factors ("vitality" and "mental health") inspired our creation of a model with seven first-order factors. According to Nix et al. [27] and Pascoal and Tamayo [28], vitality can be understood as part of a construct that can be referred to as "affective well-being," which is associated with the experience of "feeling alive". Vitality is strongly correlated both with mental health and with each individual's perception of problems [29]. Due to the theoretical approximation of the constructs and to the similarity of the items that make up the two factors, we decided to combine these items (9a to 9i) and create a single factor that we referred to as "mental health and well-being".

The new structural model proposed in this study, which contains seven first-order factors, was found to be of adequate fit for this sample (Figure 1). This new model represents a new approach to the evaluation of health-related quality of life. The lack of Brazilian studies evaluating the psychometric properties of the SF-36 using structural equation modeling (SEM) does not allow for a direct comparison between these results and others from the literature, which can be considered a limitation. We emphasize the need to conduct more studies to test the stability of the new factor structure proposed in this study in different samples of the Brazilian population.

Conclusion

We conclude that the new structural model with seven first-order factors proposed in this study presented adequate validity and reliability for a Brazilian sample of dentistry patients. It represents a new approach for assessing health-related quality of life as a statistical construct.

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Conflicts of Interest

The authors declare that they have no conflicts of interest relevant to the manuscript submitted to Transfusion.

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