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M.T. John[1*,4], P. Hujoel[2], D.L. Miglioretti[3], L. LeResche[4], T.D. Koepsell[5], and W. Micheelis[6]

[1]Department of Prosthodontics and Materials Science, School of Dentistry, University of Leipzig, Nürnberger Str. 57, 04103 Leipzig, Germany; [2]Department of Dental Public Health Sciences, School of Dentistry, University of Washington, Seattle, WA 98195-7475, USA; [3]Center for Health Studies, Group Health Cooperative, 1730 Minor Avenue, Suite 1600, Seattle, WA 98101-1448, USA, and Department of Biostatistics, University of Washington, Seattle, WA 98195-7232, USA; [4]Department of Oral Medicine, School of Dentistry, University of Washington, Seattle, WA 98195-6370, USA; [5]Department of Epidemiology and Department of Health Services, School of Public Health and Community Medicine, University of Washington, Seattle, WA 98195-7236, USA; and [6]Institute of German Dentists, Universitätsstr. 73, 50931 Köln, Germany; *corresponding author, mike.john@medizin.uni-leipzig.de

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Dimensions of Oral-health-related Quality of Life

ABSTRACT

Oral-health-related quality of life (OHRQoL) is expected to have multiple dimensions. It was the aim of this study to investigate the dimensional structure of OHRQoL measured by the Oral Health Impact Profile (German version) (OHIP-G) and to derive a summary score for the instrument. Subjects (N = 2050; age, 16-79 yrs) came from a national survey. We used rotated principal-components analysis to derive a summary score and to explore the dimensional structure of OHIP-G. The first principal component explained 50% of the variance in the data. The sum of OHIP-G item responses was highly associated with the first principal component (r = 0.99). This simple but informative OHIP-G summary score may indicate that simple sums are also potentially useful scores for other OHRQoL instruments. Four dimensions (psychosocial impact, orofacial pain, oral functions, appearance) were found. These OHIP-G dimensions may serve as a parsimonious set of OHRQoL dimensions in general.

KEY WORDS: oral-health-related quality of life, dimensions, factor analysis, questionnaire, population-based study.

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A supplemental appendix to this article is published electronically only at http://www.dentalresearch.org.

INTRODUCTION

Evidence suggests that health-related quality of life (HRQoL) has several dimensions (Patrick and Erickson, 1993). Oral-health-related quality of life (OHRQoL) is a subset of HRQoL. *A priori*, it seems plausible that dimensions exist here, too. Consequently, theoretical models characterize oral health as multidimensional (Locker, 1988; Gilbert *et al.*, 1998). Following this rationale, OHRQoL instruments group their items (Slade *et al.*, 1998). However, different instruments have grouped items into different topic categories, and the number of categories varies across instruments. The development of a set of core constructs is vital for international comparison of self-reported oral health. In the field of HRQoL, multinational efforts such as the IQOLA project for the SF-36 (Ware and Gandek, 1998) and a project of the World Health Organization to develop an international HRQoL instrument (WHOQOL) (WHOQOL group, 1993) are examples of this strategy.

The Oral Health Impact Profile (OHIP) (Slade and Spencer, 1994) might be a good option for identifying dimensions in OHRQoL, since it is one of the most sophisticated (Locker, 1995) and most popular instruments for measuring OHRQoL. The Scientific Advisory Committee of the Medical Outcomes Trust defined a set of attributes and criteria for the assessment of health status and quality-of-life measurement (Scientific Advisory Committee of the Medical Outcomes Trust, 2002). Except for limited information about psychometric properties of alternative modes of admininstration, all 8 key attributes of instrument assessment (*i.e.*, conceptual and measurement model, reliability, validity, responsiveness, interpretability, respondent and administrative burden, alternative forms, cultural and language adapatations) are met by the OHIP. The conceptual model is particularly well-suited. The OHIP is grounded on a theoretical framework based on the World Health Organization's International Classification of Impairments, Disabilities, and Handicaps (World Health Organization, 1980) and an accordingly derived multidimensional model of oral health (Locker, 1988). Based on this framework, the English-language version of this instrument has an elaborate structure with 49 items grouped into 7 subscales.

OHRQoL is a construct applicable for the entire age range, but differences have been found between children and adults (Tapsoba *et al.*, 2000). Further differences may exist between younger and older adults, because oral health is strongly age-dependent. Most instruments were developed in older adults and may therefore not be generalizable to the entire adult population. Although expert opinion may serve to assign items to factors, statistical methods such as exploratory factor analysis are helpful to explore multivariable relationships.

The aims of this study were: (i) to determine which dimensions of OHRQoL are measured by the Oral Health Impact Profile (German version) (OHIP-G) and (ii) to derive an informative summary measure for the OHIP-G.

MATERIALS & METHODS

Setting, Sampling, and Subjects

Subjects were 2050 participants (proportion of subjects responding: 60%) in a national survey conducted February-April, 2001, at 255 locations in Germany. Potential study participants were identified by means of a multistage sampling technique. The sample was designed to be representative of the German-speaking population aged 16-79 yrs living in private households of the Federal Republic of Germany. Details about sampling are described elsewhere (John *et al.*, 2003).

The study protocol was reviewed and approved by an Institutional Review Board consisting of members of Federal Chamber of Dentists-Association of German Chambers of Dentists (Bundeszahnärztekammer-Arbeitsgemeinschaft der Deutschen Zahnärztekammern e.V.) and Federal Association of Statutory Health Insurance Dentists (Kassenzahnärztliche Bundesvereinigung). All study subjects gave their signed informed consent.

Data Collection

Data for the OHIP-G (John *et al.*, 2002) were collected in a computer-assisted personal interview. Each of the 53 items describes a specific impact. Subjects were asked how frequently they had experienced the impact in the preceding month. Responses were made on a Likert-type scale (0-never, 1-hardly ever, 2-occasionally, 3-fairly often, 4-very often). The OHIP-G summary score was computed as the sum of all item responses and characterizes the construct as a whole. Higher scores imply poorer OHRQoL, because the OHIP index measures the frequency of problems.

Data Analysis

To derive an informative summary score, we subjected the data to a principal-components analysis. The first principal component was retained and scored for all subjects. A Pearson product-moment correlation was calculated for the relationship between the first principal component and the sum of all item responses.

The OHIP-G dimensional structure was explored in 2 ways. First, the structure of the English-language instrument (OHIP-E) was applied to the German data. Items were grouped according to the 7 subscales of the OHIP-E, and sums of the item responses within the particular scale were computed as dimension scores. Pearson product-moment correlations compared all possible pairs of correlations among the 7 scales. Second, a new OHIP-G dimensional structure was developed by principal-components analysis. Retained principal components were varimax-rotated. Items (see Appendix) were assigned to retained rotated principal components when they had a loading on these components (*i.e.*, dimensions) of 0.5 or greater in absolute value (Dawis, 1998).

We performed a sensitivity analysis to check the robustness of the exploratory factor analysis against methodological influences (see Appendix). Finally, we interpreted dimensions (retained rotated principal components found to be stable in the sensitivity analysis) using knowledge about the subject matter.

Table 1. Matrix of Correlations among the 7 Dimension Scores According to OHIP-E Structure

	Functional Limitation	Physical Pain	Psychological Discomfort	Physical Disability	Psychological Disability	Social Disability
Functional limitation (9 items)	-					
Physical pain (9 items)	0.75	-				
Psychological discomfort (5 items)	0.79	0.80	-			
Physical disability (9 items)	0.81	0.74	0.84	-		
Psychological disability (6 items)	0.74	0.70	0.80	0.84	-	
Social disability (5 items)	0.70	0.61	0.71	0.82	0.86	-
Handicap (6 items)	0.75	0.64	0.75	0.83	0.86	0.85

RESULTS

Derivation of an Informative OHIP-G Summary Score

The first principal component explained 50% of the total variance and was very highly correlated with a simple sum of the 46 OHIP item responses (r = 0.99). This suggests that the simple sum is an informative OHIP-G summary score.

Dimensional Structure of the OHIP-G

Application of the OHIP-E structure to the German data

When the questionnaire was scored according to the OHIP-E dimensions, pair-wise correlations between dimensions ranged between 0.61 and 0.86 (Table 1). According to guidelines (Cohen, 1977), these are considered large correlations.

Exploratory factor analysis for the derivation of OHIP-G dimensions

The exploratory factor analysis resulted in 8 principal components (PC) which together explained 70% of the variance. Five PCs had Eigenvalues ≥ 1. The first component explained half of the variance, and the second PC added 7% to the variance explained. The third, fourth, and fifth components had Eigenvalues of 1.5, 1.3, and 1.0, and explained variances were 3%, 3%, and 2%, respectively.

After the sensitivity analyses, only 4 rotated principal components (RPC)—the first, second, third, and fifth—were considered robust against methodological influences (Table 2). The fourth RCP—a single-item factor (stale breath)—did not appear to be as stable as the other factors in sensitivity analyses. A simple structure was achieved, because each of the 21 items loaded highly on only one particular dimension and not substantially on the other dimensions (Table 3). In our opinion, the 9 items in the first RPC describe psychological and social impairments, disabilities, and handicaps, so were interpreted as "psychosocial impact". Robust items referring to orofacial pain were found only in the second factor, which was named "orofacial pain". *Chewing, communication*, and *appearance* are main functions of the stomatognathic system, which led to the name "oral functions" for the third dimension. Two of the 3 items among the 46 items reflecting dental and facial appearance (*appearance affected, uncomfortable about appearance,* and *noticed tooth that doesn't look right*) were found in the last dimension, so this dimension was interpreted as "appearance".

DISCUSSION

This national study covering almost the entire adult range

Table 2. Sensitivity Analysis for Item Loadings > 0.50 from a Principal-components Analysis Followed by a Varimax Rotation

No.	OHIP-G Item	Rotated Principal Component 1	2	3	4	5	6	7	8
1.	Difficulty chewing			0.59[1,2,3,4a]					
2.	Trouble pronouncing words			0.74[1,2,3,4]					
3.	Noticed tooth which doesn't look right					-0.69[1,2,3,4]			
4.	Appearance affected			0.66[1,2,3,4]					
5.	Breath stale				0.56[3]				
6.	Taste worse			0.56[2,3,4]					
7.	Food catching					-0.58[2,3]			
8.	Digestion worse								
10.	Painful aching		0.69[1,2,3,4]						
11.	Sore jaw		0.70[1,2,3,4]						
12.	Headaches								
13.	Sensitive teeth		0.65[1,2,3,4]						
14.	Toothache		0.70[1,2,3,4]						
15.	Painful gums		0.78[1,2,3,4]						
16.	Uncomfortable to eat						-0.51[2,3]		
17.	Sore spots		0.68[1,2,3,4]						
19.	Worried					-0.73[1,2,3,4]			
20.	Self-conscious								
21.	Miserable								
22.	Uncomfortable about appearance					-0.74[1,2,3,4]			
23.	Tense	0.52[2,4]							
24.	Speech unclear		0.55[4]						
25.	Others misunderstood		0.57[3,4]						
26.	Less flavor in food								
27.	Unable to brush teeth								
28.	Avoid eating						-0.56[2,3]		
29.	Diet unsatisfactory					-0.52			
31.	Avoid smiling								
32.	Interrupt meals								
33.	Sleep interrupted	0.62[1,2,4]							
34.	Upset					-0.51[2]			
35.	Difficult to relax							-0.64[2,3,4]	
36.	Depressed	0.67[1,2,3,4]							
37.	Concentration affected	0.68[1,2,3,4]							
38.	Been embarrassed	0.65[1,2,3,4]							
39.	Avoid going out	0.73[1,2,3,4]							
40.	Less tolerant of others	0.79[1,2,3,4]							
41.	Trouble getting on with others			0.52[2]					
42.	Irritable with others	0.70[1,2,3,4]							
43.	Difficulty doing jobs	0.80[1,2,3,4]							
44.	Health worsened								
45.	Financial loss							-0.69[2,3]	
46.	Unable to enjoy people's company	0.56[1,2,4]							
47.	Life unsatisfying							-0.69[2,3,4]	
48.	Unable to function	0.72[1,2,3,4]							
49.	Unable to work	0.72[1,2,3,4]							

[a] Item confirmation in bootstrap sampling[1], with the use of sampling weights[2], promax (oblique) rotation[3], and principal-factor analysis with varimax rotation[4] (superscript is shown when item loading > 0.5 in these analyses).

suggests that a simple summary score may be highly informative about OHRQoL. Second, it suggests that *psychosocial impact, orofacial pain, oral functions*, and *appearance* are dimensions derived from the OHIP-G that might serve as a parsimonious set of dimensions for OHRQoL in general.

[For a comparison of dimensions presented in this study, and of our results with dimensions found in the area of health-related quality of life, see the Appendix.]

Comparison of OHIP-G Dimensions with Other OHRQoL Instruments

Most OHRQoL instruments group their items. For instance, one of the earliest OHRQoL instruments (Cushing *et al.*, 1986), the Social Impacts of Dental Disease measure, has 14 items (response: no impact *vs.* any impact). Questions are grouped into 5 categories (a score of '1' is given to the impact category if a positive response has been given to any of the items in the category) according to the authors' expert knowledge based on a theoretical framework: *(1) eating*, *(2) communication* (which might be similar to our dimension *oral functions*), *(3) pain,* and *(4) discomfort* (could be part of our dimension *psychosocial impact*), and *(5) aesthetics* (equivalent to our category *appearance*). Later work resulted in an instrument with 36 questions with response codes '+1' for positive impacts, '0' for not totally negative impacts, and '-1' for negative impacts (Leao and Sheiham, 1996). Items are summed into a score for each dimension. The authors suggested *comfort, appearance, pain, performance,* and *eating restriction* as categories

identified by factor analysis. Their categories *comfort* and *performance* could be integrated into our *psychosocial* dimension, and *eating restriction* would be an indicator for *oral functions.* Strauss and Hunt, using factor analysis, identified 4 subscales in their Dental Impact Profile (25 items; format, Do you think your teeth or dentures have a good [positive] effect, a bad [negative] effect, or no effect on your [example] eating?). This is the same number of dimensions as in our study (Strauss and Hunt, 1993). These authors named their subscales *eating, health/well-being, social relations,* and *romance,* where their first scale could be contained in our dimension *oral functions,* and their second and third scales could be similar to our dimension *psychosocial impact* (facial appearance is contained in Strauss and Hunt's scale *social relations*).

The English-language OHIP (Slade and Spencer, 1994) has 7 dimensions. It contains the dimensions *functional limitation* and *physical pain.* There is a high degree of equivalence between the item assignments in the OHIP-E and our findings for these 2 dimensions. The OHIP-E dimensions *physical, psychological, social disability,* and *handicap* characterize more severe psychosocial impact, which might be captured in our dimension *psychosocial impact.* The OHIP-E also has a domain *psychological discomfort,* which might be related to our dimension *appearance*.

Although dimensions were identified, close relationships among these concepts make differentiation among dimensions somewhat difficult. Our first principal component explained 50% of the variance in the data. Thus, a general factor "oral illness" might underlie many dimensions. Therefore, it does not seem surprising that some OHRQoL instruments consider OHRQoL a single construct. In the development of the Geriatric Oral Health Assessment Index (GOHAI), which is an instrument with 12 questions of the form "How often (example) were you able to eat anything without feeling discomfort?" (response: never [0] to always [5]), the dimensions *physical function, psychosocial function,* and *pain or discomfort* were expected (Atchison and Dolan, 1990). However, only one factor was found in the principal-components factor analysis. We also found a dominating first principal component. However, rotation allowed for a better interpretation of factors and led to the identification of 4 factors.

A similar situation was observed for the OHQoL-UK(W) (McGrath and Bedi, 2001). It is an instrument with 16 questions in the format, "In what way does the condition of your teeth, gums, mouth, or false teeth reduce your quality of life (negative effects)/add to your quality of life (positive effects)?" Respondents are then asked to rate the impact of each effect on a scale from 'none' to 'extreme' impact (scale ranges from 1 = bad effect of extreme impact to 9 = good effect of extreme impact; 5 = no impact). Two principal components (factors) with Eigenvalues above 1 (which could have been submitted to factor rotation according to some recommendations [Norman and Streiner, 2000]) were observed. The authors reported that all items correlated above 0.4 with the first factor—a result that we observed for our data. However, the previous authors stopped there and considered their quality-of-life measure as a single construct, while we proceeded with rotation of the principal components.

Table 3. Assignment of 21 Stable Items to Rotated Principal Components (all loadings shown > 0.3).

	Dimensions			
	1	2	3	4
3. Factor: Oral functions				
Difficulty chewing		0.35	0.59	
Trouble pronouncing words	0.36		0.74	
Appearance affected			0.66	
2. Factor: Orofacial pain				
Painful aching		0.69		
Sore jaw		0.70		
Sensitive teeth		0.65		
Toothache		0.70		-0.34
Painful gums		0.78		
Sore spots		0.68		
1. Factor: Psychosocial impact				
Depressed	0.67			
Concentration affected	0.68			
Been embarrassed	0.65			-0.30
Avoid going out	0.73			
Less tolerant of others	0.79			
Irritable with others	0.70			
Difficulty doing jobs	0.80			
Unable to function	0.72		0.31	
Unable to work	0.72			
4. Factor: Appearance				
Noticed tooth that doesn't look right		0.34		-0.69
Worried		0.36		-0.73
Uncomfortable about appearance				-0.74

When questions related to the comprehensive assessment of oral health outcomes not belonging to a specific OHRQoL instrument were used in factor analytic work, Gift *et al.* (1997) identified 4 factors, as did we. Others found 3 factors in children and 5 in adults, with content similar to that in our dimensions (Tapsoba *et al.*, 2000).

Our results are similar to those of the OHIP-E. Although OHIP-E items were assigned by expert opinion, factor-analytic methods were considered an option to develop an abbreviated OHIP version (Slade, 1997). A very strong first principal component was identified that explained 69.2% of the variance. Many of the items had loadings of > 0.4 on the rotated first factor. However, 3 other components had Eigenvalues above 1. All these findings are similar to our results, supporting the cross-cultural comparability of the OHIP. These results also suggest that our dimensional structure may be applicable to the English-language version.

Findings from OHIP-G may be Generalizable to Other OHRQoL Instruments

Rotated principal-components analysis/exploratory-factor analysis leaves room for subjective decisions. We hypothesized *a priori* that OHRQoL is multifactorial, and our exploratory

analyses supported this. We considered smaller variance portions after the first principal component as worth exploring.

Given the variety of OHRQoL instruments and how they operationalized the measurement of this concept, the similarities discussed here in the conceptualization of OHRQoL are reassuring. Although different populations, sampling strategies, and sample sizes were used for different OHRQoL instruments, we see a considerable agreement in findings. Based on our results, the study limitations (see Appendix), and the interpretation of the literature, we first hypothesized that OHRQoL instruments' summary scores in general contain a major part of the information in the raw data. Summary scores, preferably as simple as ours (a simple sum of item responses), are likely to be an informative and efficient way to characterize the construct OHRQoL. Studies with the OHIP-E and investigation of the performance of different summary scores did not show notable differences across different computational methods (Allen and Locker, 1997; Allen *et al.*, 2001). Second, if one is willing to accept that OHRQoL dimensions overlap to a certain degree, and therefore share a considerable amount of information, a parsimonious set of OHRQoL dimensions could be described by *oral functions, orofacial pain, psychosocial impact,* and possibly *appearance*. Such dimensions, if confirmed in subsequent studies, could function as an efficient and informative profile describing important domains of OHRQoL and supplementing the questionnaire's summary score that describes the construct as a whole.

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