Clin Oral Invest (2011) 15:691–697
DOI 10.1007/s00784-010-0437-3

ORIGINAL ARTICLE

Oral health-related quality of life is linked with subjective well-being and depression in early old age

Alexander Jochen Hassel · Daniel Danner · Marina Schmitt · Ina Nitschke · Peter Rammelsberg · Hans-Werner Wahl

Received: 26 February 2010 / Accepted: 14 June 2010 / Published online: 26 June 2010

Abstract Although a body of research has targeted predictors of well-being and depression in old age, the consideration of oral health-related quality of life (OHRQoL) as a predictor of these major psychosocial endpoints has been rare in the previous literature. The objective of this study was to test whether OHRQoL is associated with well-being and depression, after controlling for relevant confounders; also, the mediating role of subjective health, a major predictor of both well-being and depression, has been explored. OHRQoL was measured by two commonly used assessment instruments, the geriatric oral health assessment index (GOHAI) and oral health impact profile (OHIP); well-being was assessed by the Philadelphia Geriatric Center Morale Scale (PGCMS) and depression by the self-rating depression scale (SDS). We used a subsample of 197 participants from the older cohort (1930–1932) of the Interdisciplinary Longitudinal Study of Adult Development. Regression models and structural equations modeling (SEM) were used for the test for study variable relationships. Both GOHAI and OHIP revealed significant associations to both PGCMS and SDS at the bivariate level. In regression analyses considering gender, household situation, subjective health, and both OHRQoL indicators, only OHIP remained a significant predictor of well-being and depression. In addition, supportive evidence for a mediating role of subjective health regarding the linkage between OHRQoL and an overall latent construct of well-being was found in the SEM analysis. In conclusion, OHRQoL is significantly linked with well-being and depression in old age, while subjective health is able to mediate the relationship. The generally underrated role of OHRQoL with respect to well-being and depression in late adulthood deserves more attention.

Keywords Elderly · OHRQoL · Depression · Well-being · SEM

A. J. Hassel (✉) · P. Rammelsberg
Department of Prosthodontics, University of Heidelberg,
INF 400,
69120 Heidelberg, Germany
e-mail: alexander.hassel@med.uni-heidelberg.de

D. Danner · H.-W. Wahl
Institute of Psychology, University of Heidelberg,
Heidelberg, Germany

M. Schmitt
Institute of Gerontology, Technical University of Dortmund,
Dortmund, Germany

I. Nitschke
Clinic for Gerodontology and Special Care Dentistry,
University of Zurich,
Zurich, Switzerland

Introduction

There is growing interest in dentistry in understanding patients' perception of oral health and diseases [1] and its linkage to clinical oral health status, sociodemographics, but also psychological situation. An important development on this topic has been the successful establishment of measures of quality of life especially related to oral health (OHRQoL), in particular, the oral health impact profile (OHIP) [2] or the geriatric oral health assessment index (GOHAI) [3]. These measures have been found to be more sensitive in detecting clinical oral health conditions as compared to generic health-related quality-of-life measures, such as SF-36 [4]. A recent study found that 10% of variance in SF-12 scores could be explained by OHIP-14 [5].

A variety of negative clinical conditions have been found to be negatively related to OHRQoL in different study collectives, such as dental status (edentulism), tooth loss, and especially for older patients, denture functioning [6–10]. Furthermore, studies have been provided, which support meaningful statistical associations between OHRQoL and psychological variables like higher tendency for somatization in older adults, depression in xerostomia patients, and more pronounced pain sensitivity [11–14].

However, data regarding the relationship between OHRQoL and major psychological endpoints such as subjective well-being and depression have remained rare in the previous literature. A study investigating a conceptual model in 85 patients with structural equation modeling (SEM) found evidence that severe clinical signs predicted worse patient-reported symptoms followed by lower functional status; however, there was no relationship between global oral health perception and subjective well-being [15]. Given that OHRQoL is a major issue of day-to-day life in old age in conjunction with other constraining conditions such as loss in general health and functioning, the major research question of the present study has been whether a meaningful relationship between OHRQoL and well-being and depression exists. Given that we already have robust evidence on the most important predictors of these endpoints, it must be shown that such a possible relationship exists even after controlling for a selection of major predictors of well-being and depression. In particular, subjective health has been consistently revealed to be among the strongest predictors of well-being and depression even after controlling for objective morbidity [16–18]. In addition, we will also consider gender and household situation, both of which were also found to be linked with well-being and depression [17, 18]. Going further, we explored whether subjective health is able to play a mediating role when it comes to the relationship between OHRQoL and well-being and depression. Given that subjective health plays such an important role for both endpoints, it could well be that a possible linkage between OHRQoL and these endpoints is mediated by subjective health. On the other hand, if OHRQoL has a more unique and specific contribution to offer, a direct linkage between OHRQoL and well-being and depression may even remain existing, while subjective health is also part of the model.

Methods

Participants

Participants were from the Interdisciplinary Longitudinal Study of Adult Development (ILSE). ILSE is an interdisciplinary research project comprising two cohorts, one born in the years 1930–1932 and the other born in the years 1950–1952, conducted in the cities of Heidelberg and Leipzig, Germany [19]. As part of the third measurement point of ILSE, completed in 2007, dental examinations and questionnaires were added to the medical and psychological assessment program for the first time; consequently, the data reported here were cross-sectional. For this analysis, only data from the 1930–1932 cohort were used, which means that the subjects' ages varied from 73 to 75 years. Of the 319 subjects (62%) recruited for the third ILSE measurement wave, 197 agreed to undergo, in addition to the other examinations, a dental examination also. The main explanation of the number 197 is that ILSE already comes with quite an intensive measurement program, and further additions must be expected to find only partial acceptance. As a consequence, such a subgroup is prone to positive selectivity. The subsample used for this analysis revealed a somewhat better self-rated health (3.7 to 3.4, $t(293)=-2.75$, $p=0.006$, $d=0.34$) than the other participants in ILSE at T1, but no significant sex difference was observed ($\chi^2(1)=1.64$, $p=0.201$). The study was approved by the local review board of Heidelberg University, and all participants gave written informed consent (no. 181/2005).

OHRQoL measures

OHRQoL was measured with the 12-item German version of the GOHAI [20] and the OHIP in the German short-form OHIP-14 [21]. Both instruments are based on a five-category Likert-type answering format from “never” (0 for OHIP and 5 for GOHAI) to “very often” (4 for OHIP and 1 for GOHAI). For both instruments, a summary score (SC) was calculated by unweighted simple addition. Low scores mean reduced OHRQoL in GOHAI (SC 12 means highest possible impairment, 60 means lowest). In the OHIP, the SC could reach values between 0 (no impairment and therefore best OHRQoL) and 56, meaning maximum impairment of OHRQoL. We used Cronbach's alpha to estimate the reliability of these measurements. The higher is the correlation between several items of a scale, the higher the Cronbach's alpha gets, whereas a coefficient above 0.70 indicates good reliability [22]. In our sample, Cronbach's alpha was found to be 0.88 for OHIP and 0.81 for GOHAI.

Well-being and depression

Well-being was assessed with the 17-item German version of the revised standardized Philadelphia Geriatric Center Morale Scale (PGCMS) [23], a widely used measure of subjective well-being and life satisfaction. The participants could answer “yes” or “no” to each item (e.g., “I am satisfied with my life”). Data were recorded so that each high-satisfaction response received a score of “1,” and each

low-satisfaction response was scored "0." The mean score of the 17 items was calculated, which corresponds to the percentage of high-satisfaction responses. For this sample, Cronbach's alpha was 0.82. Depression was assessed by use of the 20-item German version of the internationally long-established self-rating depression scale (SDS) [24]. Each item was measured on a four-point scale. The total score has a possible range from 20 to 80, with a higher total score indicating greater depression (SDS-SUM). Cronbach's alpha was found to be only 0.42. Caution is therefore necessary in interpreting our findings regarding depression. Our outcome measures therefore cover both the cognitive component of well-being and its more emotional and clinical aspect.

Confounding and mediating variables

Household situation was considered as "living alone" or "living with others" [17]. Subjective health was assessed based on a one-item approach [17, 18], with a five-graded Likert-type answering format ranging from "poor" (1) to "excellent" (5). Finally, self-perceived oral health was assessed on a five-point Likert-type scale ranging from "excellent" (1) to "bad" (5). Furthermore, the presence or absence of a removable denture was recorded [10].

Statistical design

After inspection of zero-order Pearson intercorrelations, separate hierarchical linear regression models were used to test the hypothesis that OHRQoL is associated with well-being and depression. In the first step, both well-being and depression were regressed on a first set of possibly confounding variables. In the second step, oral health-related confounders were added. In the third and final step, the OHRQoL indicators were added.

To explore whether perceived health mediates the relationship between OHRQoL and well-being and depression, SEM was used. The principle of SEM is specification of a model, which explains the relationships between the observed manifest variables and then testing the fit between the conceptually specified model and the observed data [25]. In our model, OHIP and GOHAI, assessed on the manifest level, both served as indicators for the latent variable OHRQoL. Similarly, PGCMS and SDS were seen as the manifest variables able to define a latent variable representing an overall well-being (O-Well) variable at the latent level. It should also be mentioned here that SEM analysis also compensates to a large extent for missing reliability of single indicators, which is particularly important with respect to our depression assessment. However, not all parameters are specified a priori. The magnitude of the relationship between OHRQoL and overall well-being, for example, is not fixed but estimated. That is, the relationship between OHRQoL and overall well-being and its possible mediation by subjective perception of health is modeled, whereas the magnitude of the relationship itself is estimated.

The comparative fit index (CFI) and the root mean square error of approximation (RMSEA) are widely accepted means of testing the fit of the global model. CFI should be above 0.97 and RMSEA below 0.10, at least, for the fit to be regarded as acceptable. An RMSEA below 0.06 would be regarded as very good [26]. In addition, the path coefficients are given as indicators of the magnitude of the relationships between the variables.

Statistics were performed with SAS 9.2, the SEM with Mplus 5 [27].

Results

Of the study population, 33.3% (n=64) lived alone. Self-rated oral health was an approximately normally distributed variable (skewness=0.23, kurtosis=0.27) with a mean of 3.02 (SD=0.63, range from 2 to 5). The subjective health variable was also approximately normally distributed (skewness=−1.08, kurtosis=1.35) with a mean of 3.67 (SD=0.83, range from 1 to 5). A removable denture was used by 66.2% (n=127) of the subjects. Mean OHIP-SC was 4.4 (SD=5.7, range from 0 to 25), and mean GOHAI-SC was 52.8 (SD=5.9, range from 32 to 60). PGC-MEAN was 0.7 (SD=0.2, range from 0.1 to 1), and mean SDS-SUM was 34.9 (SD=7.5, range from 21 to 58).

The intercorrelations are given in Table 1, which shows that significant correlations were obtained between PGC-MEAN and SDS-SUM, between OHIP and GOHAI, and between GOHAI-SC/OHIP-SC and SDS-SUM/PGC-MEAN.

The findings of regression analysis, presented in Tables 2 and 3, consistently confirmed that OHIP-SC was significantly associated with PGC-MEAN and SDS-SUM, even after a set of confounders were controlled for. For PGC-MEAN, explanation of the variance increased by approximately 8% points (R^2 from 32% to 40%). With regard to SDS-SUM as dependent variable, again OHIP-SC was significantly associated. R^2 increased from 22% to 28%.

As can be seen in Fig. 1 and Table 4, support was also found for an indirect effect of OHRQoL on O-Well, for which subjective perception of health has a mediating effect and for an independent direct effect of OHRQoL on overall well-being. The standardized path coefficient of overall well-being on OHRQoL (0.37) is a substantial direct effect, whereas the magnitude of the mediation can be calculated as the product of the path coefficient of subjective perception of health on OHRQoL and that of

Table 1 Intercorrelations of variables

	Sex	Living circumstances	Self-rated health	Self-rated oral health	Presence of removable denture	GOHAI-SC	OHIP-SC	PGC-MEAN
Living circumstances	0.427***							
Self-rated health	−0.109	0.042						
Self-rated oral health	0.238**	0.213**	−0.285***					
Presence of removable denture	0.098	0.177* 0.0240*	−0.146	0.174*				
GOHAI-SC	−0.064	−0.107	0.334***	−0.495***	−0.291***			
OHIP-SC	0.051	0.124	−0.328***	0.355***	0.172*	−0.770***		
PGC-MEAN	−0.103	−0.152	0.486***	−0.336***	−0.069	0.372***	−0.488***	
SDS-SUM	0.095	0.175*	−0.385***	0.293***	0.033	−0.379***	0.415***	−0.743***

See text for explanation of abbreviations

*$p<0.05$; **$p<0.01$; ***$p<0.001$

overall well-being on subjective perception of health ($0.31 \times 0.37 = 0.12$). As can be seen in Table 4, all theoretically relevant path coefficients were found to be statistically significant. The model fit indices also revealed that the postulated model explains the observed data rather well (CFI=0.99, RMSEA=0.09).

Discussion

Our analysis consistently indicated that OHRQoL is significantly associated with two key indicators of well-being, that is, PGCMS and SDS. This could be seen in accordance with previous published studies, focusing on higher tendency for somatization in elderly or more pronounced pain sensitivity [11–13]. In comparison, the OHIP is supposed to be a more comprehensive measure of OHRQoL, largely reflecting psychological and social effects of oral health, whereas the GOHAI is predominantly a measure of subjective perception of oral health [1]. Some aspects of OHRQoL, like esthetics, were only present in one of both instruments (GOHAI). As a result, having both measures available in one study enables wider understanding of OHRQoL than use of each measure alone. Given the differences between the content and nature of these measures, it makes sense that OHIP performed better as a predictor of general well-being after controlling for a set of confounders [1]. The OHIP reflects in a broader way psychological and

Table 2 Dependent variable PGC-MEAN

Step	Predictor	Std. estimate	*t* value	*p* value	R^2
1	Constant	0	3.27	0.0013	0.28
	Sex	−0.01035	−0.15	0.8821	
	Living alone	−0.13893	−2.00	0.0469	
	Self-rated health	0.51426	8.15	<0.0001	
2	Constant	0	3.81	0.0002	0.32
	Sex	0.02715	0.39	0.6950	
	Living alone	−0.14789	−2.14	0.0340	
	Self-rated health	0.48551	7.49	<0.0001	
	Self-rated oral health	−0.17682	−2.67	0.0083	
	RD present	0.06441	1.02	0.3090	
3	Constant	0	3.01	0.0030	0.40
	Sex	0.00464	0.07	0.9441	
	Living alone	−0.11559	−1.75	0.0817	
	Self-rated health	0.41822	6.58	<0.0001	
	Self-rated oral health	−0.13713	−1.96	0.0521	
	RD present	0.07701	1.25	0.2137	
	GOHAI-SC	−0.14042	−1.40	0.1640	
	OHIP-SC	−0.38173	−4.47	<0.0001	

See text for explanation of abbreviations

Table 3 Dependent variable SDS-SUM

Step	Predictor	Std. estimate	*t* value	*p* value	R^2
1	Constant	0	18.16	<0.0001	0.18
	Sex	−0.01798	−0.23	0.8218	
	Living alone	0.19253	2.43	0.0163	
	Self-rated health	−0.38877	−5.38	<0.0001	
2	Constant	0	9.59	<0.0001	0.22
	Sex	−0.06095	−0.76	0.4466	
	Living alone	0.19170	2.38	0.0187	
	Self-rated health	−0.36055	−4.79	<0.0001	
	Self-rated oral health	0.17730	2.30	0.0229	
	RD present	−0.07825	−1.07	0.2874	
3	Constant	0	4.60	<0.0001	0.28
	Sex	−0.03222	−0.42	0.6773	
	Living alone	0.16583	2.12	0.0356	
	Self-rated health	−0.28585	−3.80	0.0002	
	Self-rated oral health	0.07963	0.97	0.3350	
	RD present	−0.11311	−1.55	0.1222	
	GOHAI-SC	−0.08802	−0.74	0.4599	
	OHIP-SC	−0.22578	2.07	0.0400	

See text for explanation of abbreviations

social impacts of oral health. It must, however, also be acknowledged that the added amount of variance in general well-being explained by OHIP and GOHAI was limited, although statistically significant, and ranged 6% points to 8% points, depending on the outcome. Another study in an elderly collective found an increase of 15% points when somatization was introduced in a model using OHIP-G49 as dependent variable [11]. However, variables like subjective health and oral health were not used as confounders in this study, which might explain the higher variance explanation. A much higher unique contribution to the explanation of variance would have been surprising, given that well-being and depression reflect a very wide range of issues, and oral health seems to be important but, obviously, not the only factor. However, we regard this as an important finding because oral health tends to be neglected in assessment of general well-being literature in old age [28].

The structural equation findings further qualify our results and the dynamics between predictors, particularly perceived health, and outcomes. A clear advantage of the SEM approach can be seen in the latent definitions of our target variables, i.e., OHRQoL and gQoL (name of latent variable: O-Well), thus modeling only variance adjusted by measurement error. We found that OHRQoL had a direct relationship with overall well-being and perceived health, but perceived health also affects the relationship between OHRQoL and overall well-being. That is, OHRQoL seems to affect both directly and indirectly the bridge between perceived health and overall well-being. This sheds even light on the relationship between OHRQoL and overall

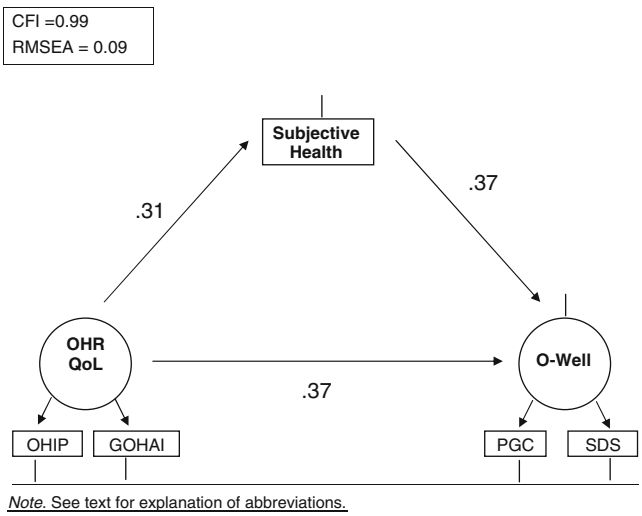

Fig. 1 Structural model with estimated standardized path coefficients and fit indices

Table 4 Findings of structural equation modeling (estimated path coefficients)

Parameter	Estimate	Std. estimate	*p* value
OHIP on OHRQoL	−1.00	−0.96	Fixed
GOHAI on OHRQoL	0.82	0.76	<0.0001
PGC on O-Well	0.03	0.94	<0.0001
SDS on O-Well	−1.00	−0.79	Fixed
Subjective health on OHRQoL	0.05	0.31	<0.0001
O-Well on subjective health	2.66	0.37	<0.0001
O-Well on OHRQoL	0.41	0.37	<0.0001

See text for explanation of abbreviations

well-being because OHRQoL also seems to be critical for one of the major predictors of overall well-being, i.e., perceived health [17, 18]. This should, however, be treated with caution because causality could not be drawn from this cross-sectional analysis.

From a more specific dental point of view, clinical factors associated with OHRQoL in later life have already been isolated in previous research showing that dental treatment could make a major contribution to improving OHRQoL. For older adults with removable dentures, for example, this factor is related to denture retention or overall denture satisfaction [29, 30]. Associations were, furthermore, described between OHRQoL and tooth loss, dental and periodontal status, and xerostomia [31–33]. Our findings underline the significant association between OHRQoL and well-being and, at the more practical level, the need for more intensive and thorough consideration of oral health-related issues in medical treatment plans for older adults. If further studies could prove that the described relationship is a causal relationship, improving oral health and OHRQoL has the potential to enhance the maintenance of mental health in later life.

Study limitations and conclusion

Several aspects in our study design limit our conclusions. A first point of concern is the narrow age range of our study population, a consequence of the original study design and its sole focus on the 1930–1932 birth cohort. As a consequence, our results cannot be extended to cover all older, particularly very old, adults. Furthermore, our depression measure revealed rather low reliability and, although this might have been compensated for to some extent in the SEM analysis, respective findings should be treated with caution. Also, the generalizability of our findings is limited because of the positive sampling bias inherent in our data. In addition, as already mentioned, we had only cross-sectional data at our disposal, preventing from any causal derivation in a strict empirical sense.

Bearing these limitations in mind, OHRQoL was found to be significantly and meaningfully linked with well-being and depression in early old age, while subjective health was able to mediate this relationship. The generally underrated role of OHRQoL with respect to well-being and depression in late adulthood deserves more attention. Further studies on this topic based on longitudinal data are needed to prove the causality of described relationship and, in consequence, to address treatment plans.

Acknowledgements The ILSE study has been funded by Germany's Federal Ministry of Family Affairs, Senior Citizens, Women, and Youth (AZ: 301-1720-295/2) and VITA Zahnfabrik H. Rauter GmbH & Co. KG, Bad Säckingen, Germany.

Conflict of interests The authors declare that they have no conflict of interests.

References

1. Locker D, Allen F (2007) What do measures of 'oral health-related quality of life' measure? Community Dent Oral Epidemiol 35:401–411
2. Slade GD, Spencer AJ (1994) Development and evaluation of the oral health impact profile. Community Dent Health 11:3–11
3. Atchison KA, Dolan TA (1990) Development of the geriatric oral health assessment index. J Dent Educ 54:680–687
4. Allen PF, McMillan AS, Walshaw D, Locker D (1999) A comparison of the validity of generic- and disease-specific measures in the assessment of oral health-related quality of life. Community Dent Oral Epidemiol 27:344–352
5. Zimmer S, Bergmann N, Gabrun E, Barthel C, Raab W, Rüffer JU (2010) Association between oral health-related and general health-related quality of life in subjects attending dental offices in Germany. J Public Health Dent 70:167–170
6. Slade GD, Spencer AJ, Locker D, Hunt RJ, Strauss RP, Beck JD (1996) Variations in the social impact of oral conditions among older adults in South Australia, Ontario, and North Carolina. J Dent Res 75:1439–1450
7. Slade GD, Nuttall N, Sanders AE, Steele JG, Allen PF, Lahti S (2005) Impacts of oral disorders in the United Kingdom and Australia. Br Dent J 198:489–493
8. Carter K, Stewart J (2002) National dental telephone survey 1999. AIHW Cat. No. DEN 109. AIHW Dental Statistics and Research Unit, Adelaide
9. Savolainen J, Suominen-Taipale AL, Hausen H, Harju P, Uutela A, Martelin T, Knuuttila M (2005) Sense of coherence as a determinant of the oral health-related quality of life: a national study in Finnish adults. Eur J Oral Sci 113:121–127
10. John MT, Koepsell TD, Hujoel P, Miglioretti DL, LeResche L, Micheelis W (2004) Demographic factors, denture status and oral health-related quality of life. Community Dent Oral Epidemiol 32:125–132
11. Hassel AJ, Rolko C, Leisen J, Schmitter M, Rexroth W, Leckel M (2007) Oral health-related quality of life and somatization in the elderly. Qual Life Res 16:253–261
12. Klages U, Esch M, Wehrbein H (2005) Oral health impact in patients wearing removable prostheses: relations to somatization, pain sensitivity, and body consciousness. Int J Prosthodont 18:106–111
13. Kressin NR, Reisine S, Spiro A 3rd, Jones JA (2001) Is negative affectivity associated with oral quality of life? Community Dent Oral Epidemiol 29:412–423
14. Baker SR, Pankhurst CL, Robinson PG (2006) Utility of two oral health-related quality-of-life measures in patients with xerostomia. Community Dent Oral Epidemiol 34:351–362
15. Baker SR, Pankhurst CL, Robinson PG (2007) Testing relationships between clinical and non-clinical variables in xerostomia: a structural equation model of oral health-related quality of life. Qual Life Res 16:297–308
16. Diener E, Suh EM, Lucas RE, Smith HL (1999) Subjective well-being: three decades of progress. Psychol Bull 125:276–302
17. George LK (2006) Perceived quality of life. In: Binstock RH, George LK (eds) Handbook of aging and the social sciences, 6th edn. Academic, Burlington, pp 321–336
18. Smith J, Baltes PB (1999) Trends and profiles of psychological functioning in very old age. In: Baltes PB, Mayer KU (eds) The Berlin aging study aging from 70 to 100. Cambridge University Press, Cambridge, pp 197–226

19. Martin M, Grunendahl M, Martin P (2001) Age differences in stress, social resources, and well-being in middle and older age. J Gerontol B Psychol Sci Soc Sci 56:214–222
20. Hassel AJ, Rolko C, Koke U, Leisen J, Rammelsberg P (2008) A German version of the GOHAI. Community Dent Oral Epidemiol 36:34–42
21. John MT, Miglioretti DL, LeResche L, Koepsell TD, Hujoel P, Micheelis W (2006) German short forms of the oral health impact profile. Community Dent Oral Epidemiol 34:277–288
22. Cortina JM (1993) What is coefficient alpha? Examination of theory and applications. J Appl Psychol 78:98–104
23. Lawton MP (1975) The Philadelphia geriatric center morale scale: a revision. J Gerontol 30:85–89
24. Zung WWK (1965) A self-rating depression scale. Arch Gen Psychiatry 12:63–70
25. Bollen KA (1989) Structural equations with latent variables. Wiley, New York
26. Hu L, Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Modeling 6:1–55
27. Muthén LK, Muthén BO (2007) Mplus user's guide, 5th edn. Muthén & Muthén, Los Angeles
28. Walker A, Lowenstein A (2009) European perspectives on quality of life in old age. Eur J Ageing 6:61–66
29. Hassel AJ, Rolko C, Grossmann AC, Ohlmann B, Rammelsberg P (2007) Correlations between self-ratings of denture function and oral health-related quality of life in different age groups. Int J Prosthodont 20:242–244
30. Inukai M, Baba K, John MT, Igarashi Y (2008) Does removable partial denture quality affect individuals' oral health? J Dent Res 87:736–739
31. Wong MC, McMillan AS (2005) Tooth loss, denture wearing and oral health-related quality of life in elderly Chinese people. Community Dent Health 22:156–161
32. Ekanayake L, Perera I (2004) The association between clinical oral health status and oral impacts experienced by older individuals in Sri Lanka. J Oral Rehabil 31:831–836
33. Locker D (2003) Dental status, xerostomia and the oral health-related quality of life of an elderly institutionalized population. Spec Care Dent 23:86–93