ACTA ODONTOLOGICA SCANDINAVICA
VOLUME 78, 2020
NUMBER 03

Acta Odontologica Scandinavica

Taylor & Francis
Taylor & Francis Group

ISSN: 0001-6357 (Print) 1502-3850 (Online) Journal homepage: https://www.tandfonline.com/loi/iode20

Quality of life related to tooth loss and prosthetic replacements among persons with dependency and functional limitations

Angelika Lantto, Robert Lundqvist & Inger Wårdh

To cite this article: Angelika Lantto, Robert Lundqvist & Inger Wårdh (2020) Quality of life related to tooth loss and prosthetic replacements among persons with dependency and functional limitations, Acta Odontologica Scandinavica, 78:3, 173-180, DOI: 10.1080/00016357.2019.1668054

To link to this article: https://doi.org/10.1080/00016357.2019.1668054

© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group on behalf of Acta Odontologica Scandinavica Society.

Published online: 26 Sep 2019.

Submit your article to this journal

Article views: 1919

View related articles

View Crossmark data

Citing articles: 2 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=iode20

ACTA ODONTOLOGICA SCANDINAVICA
2020, VOL. 78, NO. 3, 173–180
https://doi.org/10.1080/00016357.2019.1668054

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

OPEN ACCESS Check for updates

Quality of life related to tooth loss and prosthetic replacements among persons with dependency and functional limitations

Angelika Lantto[a,b], Robert Lundqvist[c] and Inger Wårdh[a,d]

[a]Department of Dental Medicine, Unit for Oral Diagnostics and Surgery, Karolinska Institutet, Huddinge, Sweden; [b]Tandvårdens Kompetenscentrum, County of Norrbotten, Luleå, Sweden; [c]The Research and Innovation Unit, County of Norrbotten, Luleå, Sweden; [d]Academic Centre of Geriatric Dentistry, Stockholms Sjukhem, Stockholm, Sweden

ABSTRACT

Objectives: To examine if tooth loss or treatment with different prosthetic replacements are associated with oral health-related or health-related quality of life (OHRQoL or HRQoL) among persons with dependency and functional limitations.

Material and Methods: Comparisons between results of questionnaires and clinical data (number of teeth, Eichner index, presence, type, and condition of prosthetic replacements) from a population of 180 individuals with dependency and functional limitations sampled from the register of increased financial support in Norrbotten County, Sweden.

Results: The associations between clinical variables and the questionnaire responses were weak overall, e.g. Spearman's rho was 0.162 ($p = .033$) for correlation between number of teeth and GOHAI, 0.094 ($p = .249$) for number of teeth and OHIP, −0.070 ($p = .356$) for complete dentures and GOHAI, and −0.108 ($p = .185$) for complete dentures and OHIP.

Conclusions: The weak associations between clinical variables and questionnaire results in the present study suggest that good results on measured QoL do not necessarily indicate good oral health. As we cannot expect this specific population to report oral disorders by themselves, regular check-ups are necessary.

ARTICLE HISTORY
Received 21 August 2018
Revised 6 September 2019
Accepted 10 September 2019

KEYWORDS
Tooth loss; Dental prostheses; Disabled persons; Quality of Life

Introduction

Several instruments have been developed for measuring patients' subjective concerns regarding their health, i.e. how physical and mental health influence quality of life, QoL [1]. QoL measures are important for evaluating how diseases and treatments influence people and the benefit for patients of different treatment options [2]. Some instruments are generic; they measure the influence of health on QoL in general and are designated health-related quality of life instruments (HRQoL) [2]. Other instruments measure the influence of specific health factors, such as oral health-related quality of life (OHRQoL) [3,4].

Surveys using subjective measures have shown that oral disorders can have a significant impact on important aspects of everyday life. However, measurements of the associations between subjective and clinical indicators of oral health have not shown a consistent pattern. More specifically, studies of associations between oral health factors and HRQoL have reported contradictory results [5]. In a clinical review from 2017, the majority of the available evidence reported a negative impact of tooth loss on HRQoL [6]. The results of a German study among older individuals [7] suggested that reduced dentition without replacement of missing teeth by prosthetic replacements reduces the physical index of HRQoL. The authors' explanation was that tooth loss appears to be more of a physical handicap than a psychological one. The results from a Taiwanese study among elderly persons [8] indicated that individuals' subjective perceptions of their oral health status had a greater impact on HRQoL than the clinical factors. A Dutch study [9] found no significant associations between OHRQoL and HRQoL among care-dependent older people. The authors claim that specific factors that distinguish the populations have to be considered in comparisons between care-independent and care-dependent people and they refer to the well-known phenomenon of older people and chronically ill people often reporting better quality of life than younger and healthy people despite their generally worse oral health status. Personal and environmental variables may be one explanation for discrepancies between health status and outcome of quality of life assessments. Other explanations that have been suggested are "the disability paradox" [10] or the response shift theory [11].

Studies of associations between clinical oral factors and OHRQoL have also shown varying results and in some cases psychosocial factors have explained as much variance in scores of OHRQoL as clinical oral factors [5]. However, associations have been found between tooth loss, prosthetic replacements and OHRQoL among the general population [12–17]. A systematic review from 2010 provided fairly strong evidence that tooth loss is associated with impairment of OHRQoL [12]. Location and distribution of tooth loss had

CONTACT Angelika Lantto angelika.lantto@norrbotten.se Tandvårdens Kompetenscentrum, Box 922, 971 28 Luleå, Sweden

© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group on behalf of Acta Odontologica Scandinavica Society.
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (http://creativecommons.org/licenses/by-nc-nd/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

significance. A significant increase in OHRQoL after treatment with implant-retained overdentures has been observed in several studies [13–15] and was also concluded in a systematic review in 2007 [16]. In another systematic review from 2012, the conclusion was that treatment of tooth loss has positive effects on quality of life even if the scientific basis is insufficient to support general conclusions about the influence of various interventions on the OHRQoL [17]. However, QoL measures are context-dependent [9] and there are few studies concerning people with dependency and functional limitations. Considering that care dependency may affect many domains of people's daily lives, it is uncertain to what degree tooth loss and prosthetic replacements are of significance for quality of life in these groups. The kind of functional impairment may also influence how individuals assess the role of oral conditions in relation to quality of life. For example, it may be difficult for persons with cognitive impairments to understand what oral health-related quality of life means.

For persons with dependency and functional limitations, we do not know if higher degrees of tooth loss or different prosthetic replacements are related to HRQoL or OHRQoL [18–21].

Persons with dependency and functional limitations suffer from tooth loss to a greater extent than the general population, and health problems and extensive medication are more common in this group [9,22–24]. Additionally, these individuals are common patients in dental practices, they may have difficulties tolerating complicated treatments and they usually have a lack of economic resources. They are often treated with different prosthetic replacements than the general population: more dentures and fewer tooth-supported and implant-supported prostheses [23]. These factors could be reasons for a greater impact on OHRQoL and HLQoL. However, due to the broader impact of general health conditions on QoL in this population, they are often excluded from studies, resulting in a knowledge gap in this area. For these reasons, more studies are needed. The aim of the present study was therefore to, with the aid of common QoL instruments, examine if tooth loss or treatment with different prosthetic replacements are associated with measured OHRQoL or HRQoL among persons with dependency and functional limitations.

Material and methods

Study design

This study was part of a cross-sectional survey based on oral examinations and questionnaires among a group of 355 persons with dependency and functional limitations, randomly sampled from the register of increased financial support [25] in the north of Sweden in 2015, as previously described by the authors in an earlier study based on the same study material as the present study [26]. Clinical variables were compared with another epidemiological study, EPI-Norr, from the same geographical region and the results were reported in this separate study [26]. After the clinical examinations, the subjects' ability to complete the RAND-36, GOHAI and

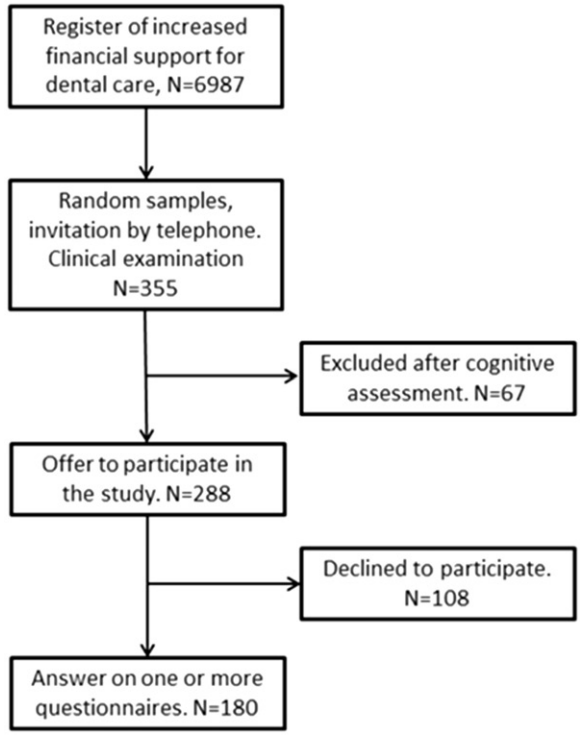

Figure 1. Flow chart.

OHIP-14 questionnaires was assessed. As a complement to the researcher's assessment, the Short Portable Mental Status Questionnaire (SPMSQ) [27] was used. The instrument consists of ten questions and the results are categorized into four levels from normal to severe cognitive impairment. It is not a test for diagnosis, but rather a brief screening. A total of 67 (19%) participants were regarded as unable to understand the questionnaires and were excluded, leaving 288 who were asked to participate. Of these, 180 subjects responded to one or more questionnaires; see Figure 1.

For participants with motor or sight impairments, the questionnaires were completed in writing or verbally with help from the project's research nurse or care personnel/family members, who acted as advocates. If more time was needed, the questionnaires could be completed at another time and mailed back.

All examinations and assessments were conducted by the same examiner (author AL), who was also one of the calibrated examiners in the EPI-Norr study [26].

The study-group participants

The subjects were persons aged 20 to 97 with functional limitations, the majority also with dependency. They lived in nursing homes, group housing or in regular homes, the majority with assistance from care personnel or from family members. The subjects were divided according to the categories in the financial support system [25]:

a. *Elderly in nursing homes*
b. *Persons with certain functional impairments, which applies to people who have intellectual disabilities, autism or a*

condition resembling autism, considerable and permanent mental impairment, some other lasting physical or mental impairment that is clearly not due to normal aging, and who have an extensive need for help in daily life as a result of these disabilities [28]

c. *Home-care patients*
d. *Independent individuals with extensive need for dental care due to an illness that causes functional impairments*

The participants were also divided into age groups. These were defined according to the order in the EPI-Norr study [26].

Ethical approval was obtained from the Regional Ethical Review Board in Umeå (2013-46-31 M). Information about the study was sent to the subjects by letter. They were assured confidentiality and that they could withdraw at any time. When needed, they were assisted by an advocate. Informed consent was given in writing.

Clinical variables

The clinical variables were number of teeth, presence, type, condition of prosthetic replacements, and the Eichner index, which is an indicator of the extent of the support zones in the dentition [29,30]. A partially or fully erupted tooth was defined as a tooth. A root with function in the dentition was also defined as a tooth. Eichner index is divided into four posterior support zones, defined as number of occlusal contacts between premolars and molars. In level A there are occlusal contacts in all four posterior support zones. Level B has posterior occlusal contacts in three, two or one zone, or occlusal contact in the anterior region only. In level C there are no occlusal contacts.

The prosthetic replacements were classified as:

- removable prostheses: complete and partial dentures
- tooth-supported prostheses: crowns and bridges
- implant-supported prostheses: fixed and overdentures

The condition of the prostheses was assessed based on the examiner's knowledge and long experience of prosthetic dentistry and was classified as:

- *good:* Good retention, fit, stability, occlusion, articulation, hygienic design and esthetic appearance. No wear.
- *acceptable:* Good retention, fit, stability, occlusion, articulation, hygienic design and esthetic appearance. Moderate wear.
- *poor:* Impaired retention/fit/stability/occlusion/articulation/hygienic design/esthetic appearance. Extensive wear.

Questionnaires

Three questionnaires were used: RAND-36 to measure HRQoL, and GOHAI and OHIP-14 to measure OHRQoL.

RAND-36 is comprised of 36 items, was developed from the RAND Medical Outcomes Study (MOS) [31] and is validated in Sweden [32]. It measures the following eight health concepts:

- Physical functioning (PF)
- Role limitations caused by physical health problems (RP)
- Role limitations caused by emotional problems (RE)
- Social functioning (SF)
- Emotional well-being/mental health (MH)
- Energy/fatigue (VT)
- General health perceptions (GH)
- Change in perceived health during the last 12 months (HF)

Each concept was analyzed separately. Higher values represent better QoL.

GOHAI, the General Oral Health Assessment Index [33], has been validated for use in many countries, including Sweden [3]. In a Swedish context, the test-retest reliability has shown a correlation of 0.64 [3]. GOHAI consists of 12 items in three dimensions: 'physical function,' 'psycho-social function,' and 'pain and discomfort.' The responses are scored on a Likert scale with five categories (always, often, sometimes, seldom and never). We used one of the suggested methods, the additive method, to calculate the scores, in which the response codes for the items are summarized and range from 12 to 60, with higher scores indicating better OHRQoL.

OHIP-14, the short version of the Oral Health Impact Profile [34], is another instrument with good reliability, validity and precision in several languages, including Swedish [4]. The test-retest reliability has been assessed in a Swedish context and the correlation was 0.85 [4]. The responses to the OHIP-14 items are scored on a Likert scale with five response categories for each question, as in GOHAI. We used the additive method to calculate the scores, which range from 14 to 70, where it should be noted that a high score on OHIP-14 indicates worse OHRQoL.

The correlation between OHIP-14 and GOHAI has in a Swedish context shown to be −0.83 [3,4].

Statistical analysis

In order to achieve a graphical display of the associations between variables, ordinary scatter plots have been used. Since most variables are basically sums of subscales, the results are not continuous values but rather discrete integers. As a consequence, individual study participants could end up with the same combination of values, and in a scatter plot, this would result in repeated points being masked. In order to ameliorate this slight problem, the scatter plots used here have been complemented with a so-called jitter function, making points representing identical combinations come close without masking other values; see Figures 2(a–c) and 3(a,b).

Associations between variables have been investigated with tables and correlations depending on the variable types. Since the numbers of study objects are relatively high, t-tests and ANOVA for comparison of means are regarded as

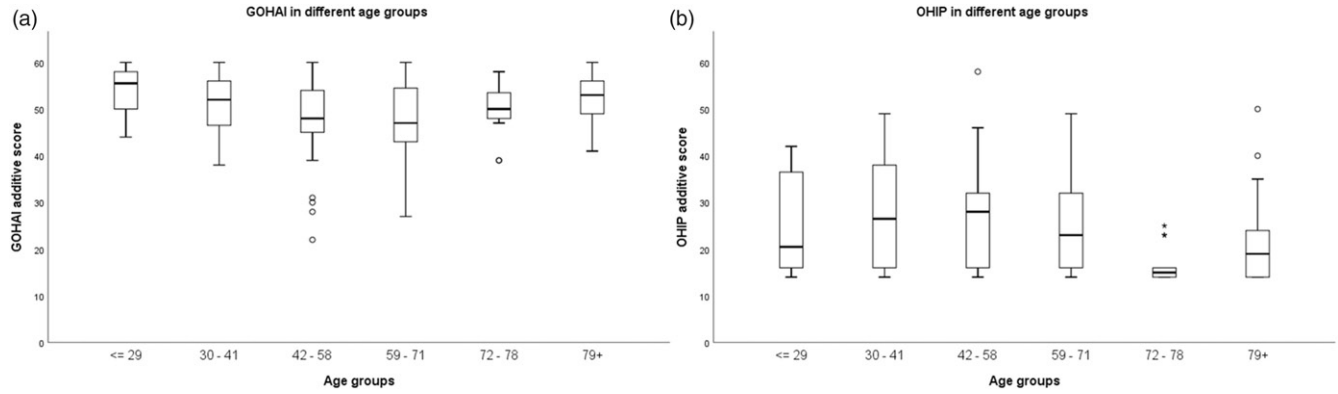

Figure 2. (a) GOHAI scores in different age groups. ANOVA $p = .001$. (b) OHIP-14 scores in different age groups. ANOVA $p = .014$.

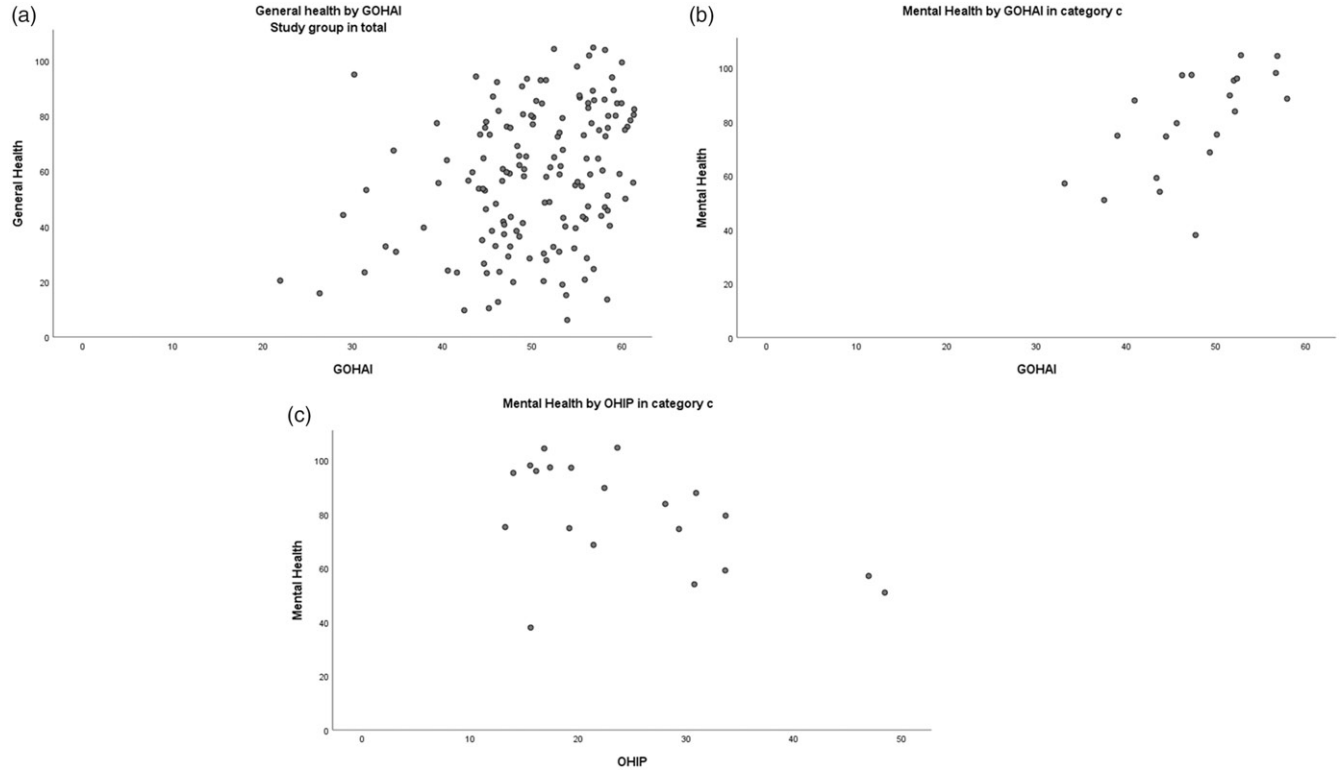

Figure 3. (a) RAND-36 concept General Health related to GOHAI in the study group in total. Spearman's rho 0.29, $p < .001$. (b) RAND-36 concept Mental Health related to GOHAI in category c. Spearman's rho 0.69, $p = .001$. (c) RAND-36 concept Mental Health related to OHIP-14 in category c. Spearman's rho −0.51, $p = .022$.

sufficiently robust against possible deviations from the normal distribution [35,36]. The significance level was set to $p = .05$. Data were analyzed in SPSS version 24.

Results

In the study population of 180 subjects, there was an internal drop-out. The response rate varied between the different questionnaires, 96% ($n = 174$) in GOHAI and 85% ($n = 153$) in OHIP-14. In RAND-36, it varied between the different concepts from 84% to 96%. The largest category was *b, Persons with certain functional impairments*, followed by category *a, Elderly in nursing homes*. Half of the participants were assessed to have normal cognitive ability. The age and sex distributions among the participants were similar for all instruments. The overall mean age was 60.3 (SD 21.5), with 63.4 (SD 21.2) among women and 56.5 (SD 21.4) among men. The proportion of women was 56%. The majority of the participants were dentate, 16% were edentulous and 13% had complete dentures in both jaws. For information about the prosthetic replacements, see Table 1.

OHRQoL in the study group

The overall mean GOHAI score was 50.1 (95% CI 49.0–51.3) and the mean OHIP-14 score was 23.9 (95% CI 22.3–25.6). Women had a lower mean GOHAI score than men (2.9 in mean difference 95% CI 0.7–5.1). There was no significant

Table 1. Dental prostheses in the different categories.

	a. Elderly in nursing homes	b. Persons with certain functional impairments	c. Dependent, home-care patients	d. Independent individuals	Total
Complete dentures					
No denture n (%)	19 (43)	85 (96)	18 (78)	23 (96)	145 (81)
One jaw n (%)	7 (16)	1 (1)	2 (9)	1 (4)	11 (6)
Both jaws n (%)	18 (41)	3 (3)	3 (13)	–	24 (13)
Total n (%)	44 (100)	89 (100)	23 (100)	24 (100)	180 (100)
Type of prosthetic replacement					
No prosthesis n (%)	4 (9)	67 (75)	10 (44)	9 (38)	90 (50)
Removable n (%)	22 (50)	6 (7)	7 (30)	–	35 (19)
Tooth- or implant-supp. n (%)	16 (36)	15 (17)	5 (22)	15 (63)	51 (28)
Combination n (%)	2 (5)	1 (1)	1 (4)	–	4 (2)
Total n (%):	44 (100)	89 (100)	23 (100)	24 (100)	180 (100)

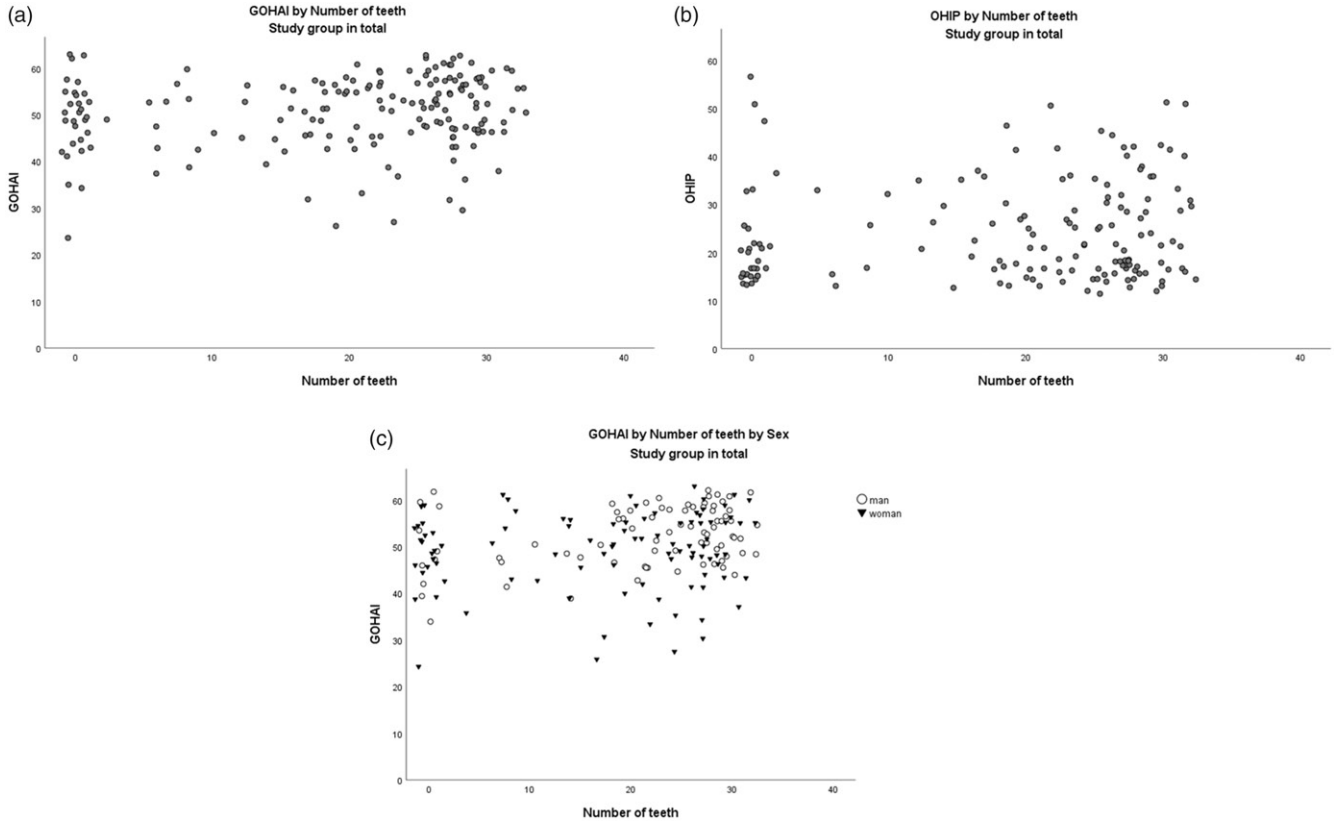

Figure 4. (a) GOHAI scores for number of teeth. Spearman's rho 0.16, $p = .033$. (b) OHIP-14 scores for number of teeth. Spearman's rho 0.094, $p = .249$. (c) GOHAI scores for number of teeth among men(Spearman's rho 0.240, $p = .055$) and women (Spearman's rho 0.074, $p = .501$) for the study group in total.

difference in OHIP score with respect to sex. Both GOHAI and OHIP scores differed between age groups; see Figure 2(a,b). The differences in mean GOHAI score were not significant between the categories of the study group. Differences in mean OHIP-14 score were only significant between categories *a* and *b*. Category *a, Elderly in nursing homes* had a lower mean value (19.9) than *b, Persons with certain functional impairments* (25.4), ($p = .029$).

Associations between OHRQoL and HRQoL

The associations between GOHAI or OHIP-14 and RAND-36 were weak overall. A typical pattern was found in Figure 3(a). However, there were some differences with respect to the different categories, and an example is group *c*, *Home-care patients*, where the association between the OHRQoL instruments and the RAND-36 concept *Mental Health* was more evident than in other categories; see Figure 3(b,c).

Number of teeth

There was no clear association between number of teeth and GOHAI (Figure 4(a)), number of teeth and OHIP-14 (Figure 4(b)) or between number of teeth and RAND-36. Figure 4(c) shows GOHAI by number of teeth in men and women. A similar pattern was seen for OHIP. Control for the same variables in different age groups did not show any clear association according to sex.

Dental prostheses

There were no significant correlations between complete dentures in one or both jaws and the GOHAI or OHIP-14

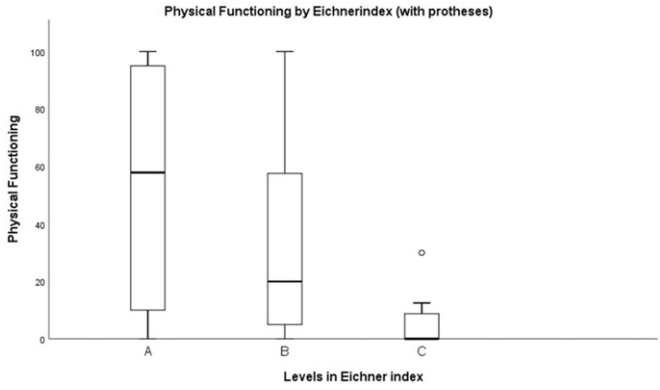

Figure 5. Physical function (RAND-36) for levels of the Eichner index. ANOVA $p < .001$.

scores. For RAND-36, the highest correlation was found for the concept *Physical functioning*, Spearman's rho 0.241, $p = .002$, which is a weak association.

There were no significant differences in mean GOHAI, OHIP-14 or RAND-36 scores between different levels of the variable 'condition of the prostheses' in the study group in total.

Support zones in the dentition

Only for the mean values of the *Physical functioning* concept of RAND-36 was there a significant difference in the mean values of GOHAI or OHIP-14, with higher values for the A-levels of Eichner index (ANOVA $p < .001$) (Figure 5). There were no significant differences in the mean values of GOHAI or OHIP-14 between the A, B or C levels of Eichner index.

Discussion

Results from the general population have shown fairly strong associations between tooth loss and OHRQoL [12]. This was shown in a systematic review from 2010 and has also been found after that, for example in a Chinese study from 2013 [37]. However, this was not seen in the present study for either OHRQoL or HRQoL.

The instruments used in this study measure different aspects of QoL. RAND-36 assesses eight concepts of general health, GOHAI can be used as a measure of subjective oral health status, and OHIP-14 is intended to assess the social impact of oral disorders. This explains why the correlation differs between the instruments for the same clinical variable. However, it does not change the overall pattern of weak associations.

Results from other studies of subjects with care dependency have been straggling. An article from 2005 was based on one study including care-dependent subjects and one study including care-independent subjects. The article reported significant association between self-ratings of oral health and satisfaction with oral health in both studies [38]. However, a discrepancy was found between the measures, with some of the participants with favorable oral health reporting dissatisfaction and some with poor oral health reporting satisfaction. Those with discordant responses had significantly higher scores on OHRQoL measures such as the GOHAI and the OHIP-14 than those with concordant responses [38]. The conclusion was that this was related to the expectations concerning health in later life. In a study from 2017, the effect of prosthetic status on OHRQoL was evaluated among 169 subjects, of which 70% were living with dementia [19]. The results showed that OHRQoL and objective oral health were statistically similar in subjects with or without dementia. Edentulism without tooth replacement and having fewer than five teeth resulted in increased risk of poorer OHRQoL [19]. A study from 2016 [9] examined relationships between oral health factors, general health factors and OHRQoL in a care-independent and a care-dependent older population. The conclusion was that GOHAI outcomes are associated with different variables in care-independent and care-dependent older subjects and the authors claim that OHRQoL outcomes should not be compared across care-dependent and care-independent populations without careful interpretation. In the present study, there may be many explanations for the low associations, such as care dependency, cognitive impairments, compromised general health, and intellectual disabilities. However, the purpose of the study was not to explain the weak associations, but instead only to examine possible associations between measured HRQoL/OHRQoL, tooth loss and prosthetic replacements in this special population.

The major treatment goals of dental care for individuals with care dependency and functional limitations are to improve the ability to eat and speak, avoid pain and infections in the mouth and increase quality of life [25]. Our interpretation of the findings from the present study is that the results highlight the difficulties in measuring QoL with common instruments, the difficulties in showing improvements in QoL after dental treatment and, as a consequence of this, the difficulties in planning for dental treatment that improves quality of life in this population.

The clinical variables in the present study had been presented in another study and compared with the results from a study in the general population [26]. Edentulism was more common in the study population compared with a general population. Additionally, a high percentage of the dentures were in poor condition [26]. It is a common misconception that edentulous people who use dentures do not need dental care [39]. Dentures are exposed to abrasion and the surrounding tissues are exposed to traumatic stress and microorganisms. The results from this study indicate that persons with dependency and functional limitations may not be able to report disorders. For this reason, dental prostheses, including dentures, need to be followed up by dentists in this group. The American College of Prosthodontics recommends annual follow-ups of dentures [40].

As for validity, since the participants were drawn from the Swedish register of those eligible for increased financial support, they represent a highly relevant proportion of persons with dependency and functional limitations in Sweden. However, we cannot say to what extent the criteria for being included in this register transfers to other settings. Further,

all those invited did not take part in the study. The reasons ranged from a general unwillingness to participate to severe cognitive difficulties. Our overall impression is that the participants were healthier than those who did not take part. This suggests that results concerning oral status in this group may be generally poorer within the group at large.

There was only one examiner in this study. The examiner had substantial experience in the field and had also participated in two waves of an epidemiological study among the general population in the same geographical region. In that study, all examiners took part in an extensive calibration program [26]. The results could thus be expected to be fairly consistent and reliable. There are, however, a number of variables in which subjective assessments have been made, such as the status of dentures. There is no way of telling whether or not other examiners would have made the same assessments.

One limitation of the study is that we did not consider the participants'opinions when evaluating the condition of the prostheses. It is possible that having done so would have led to different results. Another limitation of the study is that categories *c* and *d* had few participants. Additionally, it is possible that some of the participants had difficulties understanding the questions in the present study.

The instruments used in this study are well known and widely used in different contexts. The study participants were randomly sampled from a population of persons with functional limitations. They represent common patients in general dental practices. The results of the study indicate that if the described instruments are used in contexts similar to that of this study, the results should be interpreted carefully.

Conclusions

The weak associations between clinical variables and questionnaire results in the present study suggest that good results of measured QoL do not necessarily indicate good oral health. As we cannot expect this specific population to report oral disorders by themselves, regular check-ups are necessary.

Acknowledgments

The authors thank all participants and personnel in dental clinics, nursing homes and group housing facilities in Norrbotten County for their cooperation. A special acknowledgement to Gerd Pettersson, who contributed as research nurse. The Public Dental Health Service in Norrbotten County has supported the study by means of personnel and utilization of dental clinics.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research was supported by Norrbotten County Council, Karolinska Institutet and the National Society for Research on Ageing.

References

[1] Locker D, Allen F. What do measures of 'oral health-related quality of life' measure? Commun Dent Oral Epidemiol. 2007;35(6):401–411.

[2] Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes. JAMA. 1995;273(1):59–65.

[3] Hägglin C, Berggren U, Lundgren J. A Swedish version of the GOHAI index. Psychometric properties and validation. Swed Dent J. 2005;29(3):113–124.

[4] Hägglin C, Berggren U, Hakeberg M, et al. Evaluation of a Swedish version of the OHIP-14 among patients in general and specialist dental care. Swed Dent J. 2007;31(2):91–101.

[5] Locker D, Slade G. Association between clinical and subjective indicators of oral health status in an older adult population. Gerodontology. 1994;11(2):108–114.

[6] Haag DG, Peres KG, Balasubramanian M, et al. Oral conditions and health-related quality of life: a systematic review. J Dent Res. 2017;96(8):864–874.

[7] Mack F, Schwahn C, Feine JS, et al. The impact of tooth loss on general health related to quality of life among elderly Pomeranians: results from the study of health in Pomerania (SHIP-O). Int J Prosthodont. 2005;18(5):414–419.

[8] Lee I, Shieh T, Yang Y, et al. Individuals' perception of oral health and its impact on the health-related quality of life. J Oral Rehabil. 2007;34(2):79–87.

[9] Niesten D, Witter D, Bronkhorst E, et al. Oral health-related quality of life and associated factors in a care-dependent and a care-independent older population. J Dent. 2016;55(Supplement C):33–39.

[10] Albrecht GL, Devlieger PJ. The disability paradox: high quality of life against all odds. Soc Sci Med. 1999;48(8):977–988.

[11] Schwartz CE, Andresen EM, Nosek MA, et al. Response shift theory: important implications for measuring quality of life in people with disability. Arch Phys Med Rehabil. 2007;88(4):529–536.

[12] Gerritsen AE, Allen PF, Witter DJ, et al. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. Health Qual Life Out. 2010;8(1):126.

[13] Harris D, Höfer S, O'Boyle CA, et al. A comparison of implant-retained mandibular overdentures and conventional dentures on quality of life in edentulous patients: a randomized, prospective, within-subject controlled clinical trial. Clin Oral Implants Res. 2013;24(1):103.

[14] Heydecke G, Locker D, Awad MA, et al. Oral and general health related quality of life with conventional and implant dentures. Commun Dent Oral Epidemiol. 2003;31(3):161–168.

[15] Mendes FA, Borges TF, Gonçalves LC, et al. Effects of new implant-retained overdentures on masticatory function, satisfaction and quality of life. Acta Odontol Latinoam: AOL. 2016;29(2):123–129.

[16] Thomason JM, Heydecke G, Feine JS, et al. How do patients perceive the benefit of reconstructive dentistry with regard to oral health-related quality of life and patient satisfaction? A systematic review. Clin Oral Implants Res. 2007;18:168–188.

[17] Hultin M, Davidson T, Gynther G, et al. Oral rehabilitation of tooth loss: a systematic review of quantitative studies of OHRQoL. Int J Prosthodont. 2012;25(6):543–552.

[18] Santucci D, Attard N. The Oral Health-related quality of life in state institutionalized older adults in malta. Int J Prosthodont. 2015;28(4):402–411.

[19] Klotz AL, Hassel AJ, Schröder J, et al. Oral health-related quality of life and prosthetic status of nursing home residents with or without dementia. Clin Interv Aging. 2017;12:659–665.

[20] Zenthöfer A, Rammelsberg P, Cabrera T, et al. Determinants of oral health-related quality of life of the institutionalized elderly. Psychogeriatrics. 2014;14(4):247–254.

[21] Hassel AJ, Koke U, Schmitter M, et al. Factors associated with oral health-related quality of life in institutionalized elderly. Acta Odontol Scand. 2006;64(1):9–15.

[22] Kisely S, Quek LH, Pais J, et al. Advanced dental disease in people with severe mental illness: systematic review and meta-analysis. Br J Psychiatry. 2011;199(3):187–193.
[23] Lantto A, Lundqvist R, Wårdh I. Tooth loss and prosthetic treatment in dependent and functionally impaired individuals with respect to age and gender. Int J Prosthodont. 2016;29(1):68–70.
[24] Ribeiro GR, Costa JL, Ambrosano GM, et al. Oral health of the elderly with Alzheimer's disease. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114(3):338–343.
[25] The National Board of Health and Welfare 1998;SFS:1338. Swedish.
[26] Lantto A, Lundqvist R, Wårdh I. Oral status and prosthetic treatment needs in functionally impaired and elderly individuals. Int J Prosthodont. 2018;31(5):494–501.
[27] Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc. 1975;23(10):433–441.
[28] Act concerning Support and Service for Persons with Certain Functional Impairments [Internet]. Independent Living Institute (ILI) Swedish Code of Statutes, SFS 1993:387. [Cited 2018 Aug 20]. Available from www.independentliving.org/docs3/englss.html.
[29] Eichner K. Renewed examination of the group classification of partially edentulous arches by Eichner and application advices for studies on morbidity statistics. Stomatol DDR. 1990;40(8):321–325.
[30] Ikebe K, Matsuda K, Murai S, et al. Validation of the Eichner index in relation to occlusal force and masticatory performance. Int J Prosthodont. 2010;23(6):521–524.
[31] Hays RD, Sherbourne CD, Mazel RM. The RAND 36-Item Health Survey 1.0. Health Econ. 1993;2(3):217–227.
[32] Orwelius L, Nilsson M, Nilsson E, et al. The Swedish RAND-36 Health Survey - reliability and responsiveness assessed in patient populations using Svensson's method for paired ordinal data. J Patient Rep Outcomes. 2018;2(1):4.
[33] Atchison KA, Dolan TA. Development of the geriatric oral health assessment index. J Dent Educ. 1990;54(11):680–687.
[34] Slade GD. Derivation and validation of a short-form oral health impact profile . Commun Dent Oral Epidemiol. 1997;25(4):284–290.
[35] Posten H, Yeh HC, Owen DB. Robustness of the two-sample t-test under violations of the homogeneity assumption. Commun Stat. 1982;11(2):109–126.
[36] Posten H. The robustness of the two-sample t-test over the Pearson system. J Stat Comput Simul. 1978;6(3–4):295–311.
[37] Zhang Q, Witter DJ, Gerritsen AE, et al. Functional dental status and oral health-related quality of life in an over 40 years old Chinese population. Clin Oral Invest. 2013;17(6):1471–1480.
[38] Locker D, Gibson B. Discrepancies between self-ratings of and satisfaction with oral health in two older adult populations. Community Dent Oral Epidemiol. 2005;33(4):280–288.
[39] Steinmassl PA, Steinmassl O, Kraus G, et al. Shortcomings of prosthodontic rehabilitation of patients living in long-term care facilities. J Oral Rehabil. 2016;43(4):286–290.
[40] Felton D, Cooper L, Duqum I, et al. Evidence-based guidelines for the care and maintenance of complete dentures: a publication of the american college of prosthodontists. J Prosthodont. 2011;20(1):1.