

Burden of oral symptoms and health-related quality of life in long-term care settings in Helsinki, Finland

Saarela Riitta KT, PhD¹; Niina N Savikko, PhD^{2,3} Soini Helena, DSc⁴, Muurinen Seija, DSc³; Suominen Merja H, DSc³; Kautiainen Hannu PhD³, Pitkälä Kaisu H, MD, PhD^{3,5}

¹ City of Helsinki, Department of Social Services and Health Care, Oral Health Care, Finland

² City of Espoo, Elderly Care, Finland

³ Department of General Practice and Primary Health Care, University of Helsinki, Finland

⁴ City of Helsinki, Department of Social Services and Health Care, Developmental and Operational Support, Finland

⁵ Helsinki University Hospital, Unit of Primary Health Care

Correspondence:

Riitta Saarela, PhD

City of Helsinki, Department of Social Services and Health Care, Oral Health Care

PO Box 6452

FI-00099 City of Helsinki

Finland

riitta.saarela@hel.fi

ABSTRACT

Objectives: Poor oral health may complicate eating and deteriorate nutritional status. However, little is known about how the burden of oral symptoms (OS) is associated with the health-related quality of life (HRQoL) of vulnerable older people in institutional settings. This study explores how the burden of certain OS (chewing problems, swallowing difficulties, dry mouth) is associated with functioning, morbidity, nutritional status and eating habits. It also examines the association between the OS burden and HRQoL.

Design: A cross-sectional study in 2017.

Setting: All long-term care wards in Helsinki, Finland.

Participants: 2401 older residents (74% females, mean age 83.9).

Measurements: Nurses assessed the residents and completed questionnaires on the participants' demographics, functional status, diagnoses, OS and eating habits. Nutritional status was assessed using the Mini Nutritional Assessment (MNA) and HRQoL with a 15-dimensional instrument (15D).

Results: Of the residents, 25.4% had one OS and 16.6% two or three OS. OS burden was associated linearly with poorer cognitive and physical functioning and a higher number of comorbidities, edentulousness without dentures, and less frequent teeth brushing/denture cleaning. OS burden was also associated with malnutrition, lower BMI and eating less during main meals. In the multivariate analyses adjusted for various confounding factors, a higher number of OS was associated with lower HRQoL. OS burden correlated with nearly all dimensions of HRQoL.

Conclusion: Oral symptoms are associated with generic HRQoL. Therefore, OS should be regularly assessed and managed in daily care.

Keywords: dry mouth, chewing problems, swallowing difficulty, health-related quality of life, nursing home

Introduction

Oral health remains poor among older people, especially among those living in institutional settings (1-3). For example, in previous studies, the prevalence of xerostomia (dry mouth) among vulnerable older people has varied from 20% to 72% (4-5). Certain diseases, such as Sjögren's syndrome, diabetes and Alzheimer's disease predispose sufferers to xerostomia (6). Polypharmacy is also a major risk factor for dry mouth (4). Dry mouth increases the risk of tooth decay and infections and complicates chewing and swallowing and the use of dentures (7). The impact of dry mouth on the oral health-related quality of life (OHRQoL) of older people has been previously reported (2, 8-10).

In addition to the amount of saliva, the ability to chew also depends on factors such as the number and distribution of remaining teeth, the quality of prosthetic restorations and masticatory muscle function (11). Previous studies have suggested that mastication-related problems are important factors influencing nutritional status (12) and the quality of life (13-15).

Chewing problems and dry mouth are often related to dysphagia, i.e. difficulties or discomfort in swallowing (16). Dysphagia is common among institutionalized older people (17-19). It is also common among stroke, Parkinson's disease and dementia patients (16). It may cause severe complications such as malnutrition, aspiration pneumonia, morbidity and mortality (19-20).

Thus, oral problems are highly intertwined, and may lead to changes in food and fluid selection. This makes them risk factors for malnutrition (21-24).

The impact of oral-specific HRQoL (OHRQoL) is being increasingly investigated (25). Individual oral problems, such as tooth loss, dry mouth, pain, ill-fitting dentures, chewing problems and swallowing difficulties have been associated with poorer OHRQoL (2, 9). However, very few studies have assessed how the burden of oral symptoms (OS) affects older residents' generic HRQoL in long-term care.

The aim of this study were to explore how OS burden (chewing problems, swallowing difficulties, dry mouth) is associated with cognitive and physical functioning, morbidity, nutritional status and eating habits. Another aim was to study the association between OS burden and Health-Related Quality of Life (HRQoL).

Methods

This study is part of a larger project exploring the nutritional status and developing the nutritional care of long-term care residents (of nursing homes and assisted living facilities) in Helsinki, Finland. Data collection was in four waves (2003, 2007, 2011, 2017) and used the same assessment methods as those among long-term care residents (26). All the facilities provided round-the-clock care and a registered nurse was in charge of each ward. However, the environment in assisted living facilities is more home-like than that of traditional nursing homes. In these facilities, the residents may live in their own apartments or group homes if they have dementia. We approached all the residents living in these settings who were 65 years or older (approximately N=3673) and asked them to participate. The participation rate was 67.6% (n=2482). Of these, 2401 had complete OS and HRQoL data.

The data were collected in March 2017 by registered nurses, who knew the residents well and had received thorough training in the Mini Nutritional Assessment (MNA) (27) and all assessment protocols before the data collection cycle. They also retrieved information from medical records (demographics, diagnoses, medication use). The questionnaire included questions on demographic factors, health and functional status, medical history, oral health care and nutritional care as well as HRQoL. OS (chewing and swallowing difficulties and dry mouth) were recorded using yes/no options. Dependence in activities of daily living (ADL) was assessed using the Clinical Dementia Rating (CDR) 'Personal care' (28). CDR personal care class ≥ 2 ('needs at least assistance in dressing, personal hygiene and caring for personal belongings') was defined as dependence in ADL. We used the Mini-Mental State Examination (MMSE) to assess the participants' cognition (29).

Medical records were used to retrieve medical diagnoses and information on medication use. We evaluated the burden of comorbidities using the Charlson Comorbidity Index (CCI) (30). The dentition status of the residents was categorized, according to type, into the following five groups: 1) edentulous without dentures, 2) edentulous with complete dentures in the upper and lower jaws, 3) edentulous, upper or lower complete denture, 4) natural teeth with one or more dentures (mixed dentition) or 5) natural teeth only. Daily teeth brushing/denture cleaning was elicited using yes/no questions. The use of oral care services was assessed by asking: 'When was your most recent oral examination performed by a dentist or dental hygienist?'. The responses were categorized as follows: 1=less than one year ago, 2=one to three years ago, and 3=more than three years ago.

Nutritional status was assessed using the MNA (27). We also calculated body mass index (BMI). The consistency of the food the resident typically ate was categorized as liquid, pureed, soft and normal food. The average proportion of the offered food that the resident ate was assessed by the question 'How much, on average, does the resident eat during their main meals?' The nurses used images of model portions to assess this and the responses were dichotomized into: eats inadequately (eats only a little, eats less than half) and eats more than inadequately (eats half their meal, eats most of their meal or eats all or nearly all of their meal). The use of protein supplements was recorded using yes/no questions.

The 15D instrument was used to measure residents HRQoL (31). The 15D is a generic, comprehensive, 15-dimensional, standardized measure of HRQoL, which may be used as either a profile or single index score measure. It consists of 15 dimensions (mobility, vision, hearing, breathing, sleeping, eating, speech, excretion, usual activities, mental function, discomfort and symptoms, depression, distress, vitality, and sexual activity) with five ordinal levels. The single index score of the 15D instrument ranges from 0 (poorest HRQoL) to 1 (excellent HRQoL) and represents overall HRQoL. In this study, all the participants responded to a question on sexuality: 'My state of health makes sexual activity almost impossible'. This question was excluded from partial correlation

analysis. Usually the 15D questionnaire is filled in by the individual whom it concerns, but it may also be administered during an interview with the participant or their proxy (31). The 15D shows very good discriminant validity among various aged populations (32).

The local ethics committee of Helsinki University Hospital approved the study protocol. We also obtained approval from the City of Helsinki. The participants or, in cases of moderate-severe dementia, their closest proxies gave written informed consent.

The statistical significances of the unadjusted hypothesis of linearity across the categories of the number of oral problems were evaluated using the Cochran-Armitage test for trend and analysis of variance with an appropriate contrast. We evaluated the adjusted hypothesis of linearity (orthogonal polynomial) using analysis of covariance, logistic models and linear regression analysis. In the case of violation of the assumptions (e.g., non-normality), we used bootstrap-type tests (10 000 replications). We calculated the correlation coefficients using the Spearman method. The normality of the variables was tested by the Shapiro-Wilk W test, and we used the Stata 15.1, StataCorp LP (College Station, TX, USA) statistical package for the analysis.

Results

The mean age of the participants (N=2401) living in long-term care settings (nursing homes and assisted living facilities) was 83.9 years, and 74% were female. Forty-two per cent of the participants had at least one OS: 29% had chewing problems, 19% swallowing difficulties and 15% dry mouth. These OS also overlapped. Of the residents, 25% had one OS (Group 1) and 17% had two or more OS (Group 2), whereas 58% had no OS (Group 0). The associations between OS burden and demographic, physical and cognitive function, diagnoses, medications, oral condition, nutritional status and nutritional care are shown in Table 1. The functional status of the residents was impaired; almost all (89%) needed help with ADL according to CDR 'personal care'. Dependence in ADL was associated with a higher OS burden. The mean MMSE score of the

participants was 13. Participants with a higher OS burden had significantly poorer cognitive status than those with a lower OS burden according to MMSE. There was also an association between OS burden and a higher number of comorbidities according to CCI. Dementia diagnosis was not associated with OS burden, whereas stroke was. A higher mean number of medications was associated with a lower OS burden.

Of the residents, 13% were edentulous but did not use dentures. Most residents (80%) had their teeth brushed or dentures cleaned daily. Edentulousness without dentures and less frequent teeth brushing/denture cleaning was linearly associated with a higher OS burden. A quarter of the residents had visited a dentist or dental hygienist more than three years ago. There was no significant association between OS groups and the time since the most recent dental check-up.

About 16% of the participants were malnourished according to MNA, and 58% were at risk of malnutrition. Poorer nutritional status and lower mean BMI were associated with a higher number of OS. A higher OS burden was associated with inadequate eating during main meals. Those with at least one OS were administered oral nutritional supplements more often than those with no OS.

The participants' crude mean 15D score in Group 0 was 0.65; in Group 1, 0.58; and in Group 2, 0.52 (p for linearity < 0.001). Table 2 shows how, in a multivariate analysis, HRQoL declined linearly with the number of OS, even after adjustment for age, sex and dependency in physical functioning, CCI, mean number of medications, teeth brushing/denture cleaning and MNA (Model 3). Figure 3 shows that all other dimensions of 15D except breathing and sleeping correlated negatively with OS burden.

Discussion

According to our findings, the OS burden (chewing problems, swallowing difficulties, dry mouth) of older residents in long-term care facilities was considerable, as 42% showed at least one OS. OS

burden was linearly associated with lower cognitive and physical functioning and morbidity. In addition, a higher number of OS was linearly associated with edentulousness without dentures and less frequent teeth brushing/denture cleaning. The more OS, the more often the residents were malnourished. In addition, a higher number of OS was associated with lower HRQoL, even when we adjusted for age, sex, dependency in physical functioning, CCI, mean number of medications, teeth brushing/denture cleaning and MNA.

One strength of the present study is its large sample of the older population living in long-term care settings in Helsinki. We also used validated instruments (MNA, CDR, 15D) for data collection, which was performed by registered nurses who were familiar with the residents. These nurses were trained in performing the assessments. We used a structured questionnaire, validated in previous nutritional studies in Helsinki in 2003–2011 (26). One limitation of the study is that it did not use formal tests to assess chewing problems, swallowing difficulties or saliva flow rate. Because of this, the true prevalence of OS may be underestimated. Another limitation of our study is its cross-sectional design, which does not allow any conclusions regarding causal relationships between OS and its associated factors or HRQoL.

In the present study, 42% of the residents suffered from at least one OS, which is in line with previous Finnish research in institutional settings (33, 34) and with a Swedish population-based study (24). The latter found that 42% of the older population had oral health problems with their voices, lips, oral mucosa, tongues, gums, teeth, saliva or swallowing. As expected, cognitive decline, dependency and prior stroke also had significant associations with a number of oral health problems (33). Teeth brushing/denture cleaning was less frequent among those with a higher OS burden. The cross-sectional nature of our study did not allow us to conclude whether poor oral hygiene leads to OS or whether, for example, neuropsychiatric symptoms are a common risk factor for both poor oral care and OS.

In addition, almost one-fifth of the long-term care residents were malnourished according to MNA, which is in line with a recent meta-analysis by Cerada and colleagues (35). The association between OS and poor nutritional status found in the current study has also been found in previous studies (23-24,33, 36). For example, a recent Dutch study (23) showed that older nursing home residents, who suffered from at least one oral health problem (artificial teeth problems, chewing problems, xerostomia) were at an almost twofold risk of malnutrition. In line with a prior study, OS led to the use of texture-modified food, when foods are chopped, mashed or puréed to compensate for chewing difficulties or to improve swallowing safety (37). Modification of food may lead to poorer quality of nutrition and may reduce enjoyment of food.

Generic HRQoL is a broad subjective construct that defines individuals' perceptions of the effect of their health status on different domains of their life (38-39). Most previous studies have explored the associations between single OS and disease-specific HRQoL i.e. OHRQoL (2, 8, 13 ,39).

However, studies exploring the association between OS burden and generic HRQoL are scarce. The 15D index was 0.65 among the residents with no OS and the score decreased linearly with as the number of OS increased. A difference of 0.02–0.03 in patient groups' 15D score has been considered clinically significant (31). OS burden had a significant independent and linear relationship with HRQoL, even when adjusted for various confounders such as age, sex, dependency in physical functioning, morbidity, number of medications, teeth brushing/denture cleaning and nutrition. It has been suggested that access to appropriate oral health care services would likely improve overall HRQoL (40), and results from various clinical and interventional research have shown that dental treatments and public health interventions may improve OHRQoL (25).

Conclusion

In this study, we found a significant relationship between OS burden and poor nutritional status, low BMI, poor eating habits and poorer HRQoL. Therefore, to support older residents' HRQoL, it is important that oral health is evaluated as part of their assessment and that attention is paid to their daily oral care.

Conflict of interest: None.

Ethical standards: The local ethics committee of Helsinki University Hospital and the City of Helsinki approved the study.

References:

1. Kotzer RD, Lawrence HP, Clovis JB, Matthews DC. Oral health-related quality of life in an aging Canadian population. *Health Qual Life Outcomes* 2012;10:50-7525-10-50.
2. Porter J, Ntouva A, Read A, Murdoch M, Ola D, Tsakos G. The impact of oral health on the quality of life of nursing home residents. *Health Qual Life Outcomes* 2015; doi:10.1186/s12955-015-0300-y
3. Gil-Montoya J, Ferreira de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. *Clin.Interv.Aging* 2015;10:461-467.
4. Liu B, Dion MR, Jurasic MM, Gibson G, Jones JA. Xerostomia and salivary hypofunction in vulnerable elders: prevalence and etiology. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;114:52-60.
5. Viljakainen S, Nykanen I, Ahonen R, Komulainen K, Suominen AL, Hartikainen S, Tiihonen M. Xerostomia among older home care clients. *Community Dent Oral Epidemiol* 2016;44:232-238.
6. Cassolato SF, Turnbull RS. Xerostomia: clinical aspects and treatment. *Gerodontology*, 2003;20:64-77.
7. Turner MD, Ship JA. Dry mouth and its effects on the oral health of elderly people. *J Am Dent Assoc* 2007;138 Suppl:15S-20S.
8. Hahnel S, Schwarz S, Zeman F, Schafer L, Behr M. Prevalence of xerostomia and hyposalivation and their association with quality of life in elderly patients in dependence on dental status and prosthetic rehabilitation: a pilot study. *J Dent* 2014;42:664-670.
9. Einarson S, Gerdin EW, Hugoson A. Oral health-related quality of life and its relationship to self-reported oral discomfort and clinical status. *Swed Dent J* 2014;38:169-178.

10. Niklander S, Veas L, Barrera C, Fuentes F, Chiappini G, Marshall M. Risk factors, hyposalivation and impact of xerostomia on oral health-related quality of life. *Braz Oral Res* 2017; Jan 16;31:e14. doi: 10.1590/1807-3107BOR-2017.vol31.0014.
11. Budtz-Jorgensen E, Chung JP, Rapin CH. Nutrition and oral health. *Best Pract Res Clin Gastroenterol* 2001;15:885-896.
12. Gil-Montoya JA, Subira C, Ramon JM, Gonzalez-Moles MA. Oral health-related quality of life and nutritional status. *J Public Health Dent* 2008;68:88-93.
13. Ikebe K, Hazeyama T, Morii K, Matsuda K, Maeda Y, Nokubi T. Impact of masticatory performance on oral health-related quality of life for elderly Japanese. *Int J Prosthodont* 2007;20:478-485.
14. Kim HY, Jang MS, Chung CP, Paik DI, Park YD, Patton LL, Ku Y. Chewing function impacts oral health-related quality of life among institutionalized and community-dwelling Korean elders. *Community Dent Oral Epidemiol* 2009;37:468-476.
15. Ostberg AL, Hall-Lord ML. Oral health-related quality of life in older Swedish people with pain problems. *Scand J Caring Sci* 2011;25:510-516.
16. Rofes L, Muriana D, Palomeras E, Vilardell N, Palomera E, Alvarez-Berdugo D, Casado V, Clavé P. Prevalence, risk factors and complications of oropharyngeal dysphagia in stroke patients: A cohort study. *Neurogastroenterol Motil* 2018 Mar 23:e13338. doi: 10.1111/nmo.13338. [Epub ahead of print].
17. Nogueira D, Reis E. Swallowing disorders in nursing home residents: how can the problem be explained? *Clin Interv Aging* 2013;8:221-227.

18. Lindroos E, Saarela RK, Soini H, Muurinen S, Suominen MH, Pitkala KH. Caregiver-Reported Swallowing Difficulties, Malnutrition, and Mortality among Older People in Assisted Living Facilities. *J.Nutr.Health Aging* 2014;18: 718-722.
19. Baijens LW, Clave P, Cras P, Ekberg O, Forster A, Kolb GF, Leners JC, Masiero S, Mateos-Noza J, Ortega O, Smithard DG, Speyer R, Walshe M. European Society for Swallowing Disorders - European Union Geriatric Medicine Society white paper: oropharyngeal dysphagia as a geriatric syndrome. *Clin Interv Aging* 2016;11:1403-1428.
20. Altman KW, Yu GP, Schaefer SD. Consequence of dysphagia in the hospitalized patient: impact on prognosis and hospital resources. *Arch. Otolaryngol. Head. Neck. Surg.* 2010; 136:784-789.
21. Sheiham A, Steele J. Does the condition of the mouth and teeth affect the ability to eat certain foods, nutrient and dietary intake and nutritional status amongst older people? *Public Health Nutr* 2001;4:797-803.
22. Feldblum I, German L, Castel H, Harman-Boehm I, Bilenko N, Eisinger M, Fraser D, Shahar DR. Characteristics of undernourished older medical patients and the identification of predictors for undernutrition status. *Nutr J* 2007;6:37.
23. Huppertz VAL, van der Putten GJ, Halfens RJG, Schols JMGA, de Groot LCPGM. Association Between Malnutrition and Oral Health in Dutch Nursing Home Residents: Results of the LPZ Study. *J Am Med Dir Assoc* 2017;18:948-954.
24. Lindmark U, Jansson H, Lannering C, Johansson L. Oral health matters for the nutritional status of older persons-A population-based study. *J Clin Nurs* 2018;27:1143-1152.
25. Baiju RM, Peter E, Varghese NO, Sivaram R. Oral Health and Quality of Life: Current Concepts. *J Clin Diagn Res* 2017;11:ZE21-ZE26.

26. Saarela RKT, Muurinen S, Suominen MH, Savikko NN, Soini H and Pitkala KH. Changes in malnutrition and quality of nutritional care among aged residents in all nursing homes and assisted living facilities in Helsinki 2003-2011. *Arch.Gerontol.Geriatr* 2017;72; 169-173.
27. Vellas, B. J., Guigoz, Y., & Garry, P. J. (1997). *Facts, research and intervention in geriatrics: Nutrition in the elderly. The mini nutritional assessment (MNA) (3rd ed.)*. Paris: Serdi Publishing.
28. Hughes CP, Berg L, Danziger WL, Coben LA, Martin RL. A new clinical scale for the staging of dementia. *Br J Psychiatry* 1982;140:566–572.
29. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state.” A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975;12:189-198.
30. Charlson ME, Pompei P, Ales KL, MacKenzie CR.. A new method of classifying prognostic comorbidity in logitudinal studies: Development and validation. *Journal of Chronic Diseases*1987;40:373–383.
31. Sintonen H. The 15D instrument of health-related quality of life: properties and applications. *Ann Med* 2001;33:328-336.
32. Strandberg T, Pitkälä K, Sintonen H, Huusko T, Kautiainen H, Tilvis R. Usability, discriminant and prognostic validity of 15D instrument for health related quality of life in older population samples. In: Huusko T, Strandberg T, Pitkala K, eds. *Can Older People's Quality of Life Be Measured? (in Finnish)*. Helsinki: The Central Union for the Welfare of the Aged; 2006:42–61.
33. Soini H, Muurinen S, Pitkala K. Oral health problems and quality of life: a comment. *J Am Geriatr Soc* 2008;56:1771-1773.
34. Lindroos EK, Saarela RKT, Suominen MH, Muurinen S, Soini H, Kautiainen H, Pitkala KH. Burden of Oral Symptoms and Its Associations With Nutrition, Well-Being, and Survival Among Nursing Home Residents. *J Am Med Dir Assoc*. 2019;20:537-543.

35. Cereda E, Pedrolli C, Klersy C, Bonardi C, Quarleri L, Cappello S, Turri A, Rondanelli M, Caccialanza R. Nutritional status in older persons according to healthcare setting: A systematic review and meta-analysis of prevalence data using MNA. *Clin Nutr* 2016;35: 1282-1290.
36. Kshetrimayum N, Reddy CV, Siddhana S, Manjunath M, Rudraswamy S, Sulavai S. Oral health-related quality of life and nutritional status of institutionalized elderly population aged 60 years and above in Mysore City, India. *Gerodontology* 2013;30:119-125.
37. Cichero JA, Steele C, Duivesteyn J, Clave P, Chen J, Kayashita J, Dantas R, Lecko C, Speyer R, Lam P, Murray J. The Need for International Terminology and Definitions for Texture-Modified Foods and Thickened Liquids Used in Dysphagia Management: Foundations of a Global Initiative. *Curr Phys Med Rehabil Rep* 2013;1:280-291.
38. Karimi M, Brazier J. Health, Health-Related Quality of Life, and Quality of Life: What is the Difference? *Pharmacoeconomics* 2016;34: 645-649.
39. Jones E, Speyer R, Kertscher B, Denman D, Swan K, Cordier R. Health-Related Quality of Life and Oropharyngeal Dysphagia: A Systematic Review. *Dysphagia* 2017;33:141-172.
40. Naito M, Kato T, Fujii W, Ozeki M, Yokoyama M, Hamajima N, Saitoh E. Effects of dental treatment on the quality of life and activities of daily living in institutionalized elderly in Japan. *Arch Gerontol Geriatr* 2010;50:65-68.
41. Cohen J. *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.

Table 1. Characteristics of residents in long-term care settings in Helsinki divided into groups according to number of oral symptoms (dry mouth, chewing problems, swallowing problems): no oral symptoms (G0), one oral symptom (G1), two or more oral symptoms (G2).

Characteristic	G0: No oral symptoms N=1392	G1: One oral symptom N=609	G2: Two or three oral symptoms N=400	P ^a	P ^b
Age, mean (SD) ^c	83 (8)	85 (8)	84 (8)	0.010	..
Female, n (%)	1033 (74)	444 (73)	293 (73)	0.59	..
Dependent in physical functioning: CDR ^d 'personal care' item ≥ 2 , n (%)	1178 (86)	551 (93)	385 (97)	<0.001	<0.001
MMSE ^e , mean (SD)	13.8 (6.8)	13.0 (7.4)	11.4 (7.6)	<0.001	<0.001
CCI ^f , mean (SD)	2.0 (1.3)	2.1 (1.4)	2.2 (1.4)	0.002	0.003
Stroke, n (%)	293 (21)	154 (25)	117 (29)	<0.001	<0.001
Dementia, n (%)	1089 (78)	467 (77)	322 (80)	0.72	0.95
Mean number of medications (SD)	9.1 (3.4)	8.5 (3.7)	8.1 (4.0)	<0.001	<0.001
Edentulous without dentures n (%)	93 (7)	119 (20)	101 (25)	<0.001	<0.001
Teeth brushing/denture cleaning daily, n (%)	1204 (87)	444 (75)	268 (69)	<0.001	<0.001
Time since last dental check-up (dentist or dental hygienist), n (%)				0.78	0.60
<1 year	471 (38)	232 (41)	150 (40)		
1–3 years	461 (37)	181 (32)	130 (34)		
>3 years	312 (25)	149 (27)	99 (26)		
MNA ^g , n (%)				<0.001	<0.001
>23.5, well-nourished	307 (24)	73 (13)	16 (4)		
17–23, at risk of malnutrition	828 (66)	358 (65)	206 (57)		
< 17, malnourished	120 (10)	123 (22)	142 (39)		
BMI ^h , mean (SD)	25.8 (5.0)	24.2 (5.1)	22.8 (5.0)	<0.001	<0.001
Consistency of food: liquid or pureed, n (%)	115 (8)	254 (42)	243 (60)	<0.001	<0.001
Eats inadequately during main meals, n (%)	273 (20)	157 (26)	134 (34)	<0.001	<0.001
Eats protein energy supplements, n (%)	224 (16)	184 (31)	125 (31)	<0.001	<0.001

^a P for linearity; ^b P-values adjusted for age and gender; ^c SD: standard deviation; ^d CDR=Clinical Rating scale (28); ^e MMSE=Mini Mental State Examination (29); ^f CCI=Charlson comorbidity index (30); ^g MNA=Mini Nutritional Assessment (27); ^h BMI=Body Mass Index (kg/m²).

Table 2. Multivariate models exploring relationship between burden of oral symptoms and HRQoL

	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)
0	Reference	Reference	Reference
1	-0.26 (-0.29 to -0.22)	-0.22 (-0.25 to -0.18)	-0.17 (-0.20 to -0.13)
2–3	-0.38 (-0.41 to -0.35)	-0.32 (-0.35 to -0.29)	-0.23 (-0.27 to -0.20)
P for linearity	< 0.001	< 0.001	< 0.001

Model 1: crude

Model 2: adjusted for age, sex, dependency in physical functioning

Model 3: adjusted for age, sex, dependency in physical functioning, CCI (Charlson comorbidity index (30)), mean number of medications, teeth brushing/denture cleaning, MNA (Mini Nutritional Assessment (27)).

Beta is measured in units of SD (standard deviation). Cohen's standard for Beta values above 0.10, 0.30 and 0.50 represents small, moderate and large relationships, respectively (41))

Figure 1. Partial correlation with 95% confidence intervals between burden of oral symptoms and dimensions of 15D.

