Chapter 4

Elderly with remaining teeth or implant-supported overdentures report less frailty, better general health and quality of life than edentulous elderly

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Arie R. Hoeksema, Sophie L. Spoorenberg, Lilian L. Peters, Henny J.A. Meijer, Gerry M. Raghoebar, Arjan Vissink, Klaske Wynia and Anita Visser. Elderly with remaining teeth or implant-supported overdentures reported less frailty, better general health and quality of life when compared to edentulous elderly (submitted).

Abstract

Objective: To assess oral status and self-reported oral health in community-living elderly and determine relationship with self-reported frailty, activity of daily live (ADL), quality of life (QoL) and general health.

Subjects and methods: In this cross-sectional descriptive study 1325 Dutch community-living elderly (≥75 years of age) were asked to complete validated questionnaires on frailty, ADL, complexity of care needs and QoL. Data on oral status, self-reported oral health, dental care, general health and medication use were assessed. Differences between relevant subgroups were calculated.

Results: Data of 1026 (77%) elderly (median 80 years, IQR 77-84) were analyzed: 39% had remaining teeth, 51% were edentulous and 10% had implant-supported overdentures. Elderly with complex care needs (n=225, 22%) and frail elderly (n=217, 21%) were more often edentulous and reported more oral problems than robust elderly (n=584, 57%). Elderly persons with remaining teeth were less frail, had better QoL and ADL and used fewer medicines than edentulous elderly. Elderly with implant-supported overdentures performed better on frailty and QoL than edentulous elderly with conventional dentures.

Conclusion: Community-living elderly commonly suffer from oral health problems, in particular elderly with complex care needs. QoL, ADL and general health are higher among community-living elderly with remaining teeth and implant-supported overdentures than in edentulous elderly.

Introduction

Worldwide life expectancy has increased and birth rates have declined resulting in ageing of the society, especially in the western countries.[1] In 2060 30% of the people living in the European Union will be 65 years and older compared to 17% in 2008.[2] In the north of the Netherlands, the area where this study was performed, in 2020 already around 30% of the people will be 65 years of age or older.[3]

When elderly become frail, care-dependent and home-bound, self-care often declines, including less attention for oral care.[4] For example, when sarcopenia or mobility problems occur, daily activities such as brushing teeth or dentures, or periodic visits to the dentist can become difficult. Poor oral hygiene increases the risk of developing progressive periodontal disease and dental decay. Moreover, polypharmacy, which is commonly seen in the elderly[5], can lead to an even higher risk of developing oral problems as polypharmacy is associated with oral dryness and increased risk of developing oral infections and rampant caries.[6] Dental and periodontal diseases have been associated with severe health problems including diabetes[7], cardiovascular disease[8], atherosclerosis[9], rheumatoid arthritis[10], decreased kidney function[11], pneumonia[12], multiple sclerosis and other systemic immune problems.[13] Moreover, poor oral health has been linked to greater cognitive dysfunction in patients with Alzheimer's disease.[14,15]

Previous research has substantiated that good oral health is important, especially in care dependent elderly. However, poor oral health is commonly seen in elderly in nursing homes.[16,17] Hoeksema[18] even stated that oral health of elderly is usually already poor at admission to the nursing home. Strikingly, in contrast to the multiple publications on oral health, in nursing homes little is known regarding the oral status and oral health problems of community-living elderly (elderly who live at their own home). Poor oral health might be a hidden health hazard with an increasing, not yet fully understood, impact on frailty, activities of daily living (ADL), quality of life (QoL) and general health. The few studies published on oral health of community-living elderly suggest that many elderly face oral health problems[19], but did not report specifically on their oral status (own teeth, implant supported overdentures or edentulous) or the assocation of oral status and oral health with frailty, ADL, QoL and general health. Recently, Tôrres[20] systematically reviewed the relationship between components of frailty and poor oral health. They concluded that none of the eligible studies showed whether or not poor oral health increases the likelihood of developing signs of frailty, although the reviewed studies did suggest an assocation between frailty and oral health. Thus, there is a need for well-designed studies that give better insight in the oral status and oral health of community living elderly and also focus on the possible assocation between frailty, ADL,

QoL, general health and oral status. Therefore, the aim of this study was to assess oral status and self-reported oral health in community-living elderly (i.e., elderly who live in their own home) and determine the relationship with self-reported frailty, ADL, QoL and general health.

Methods

Participants and study design

This cross-sectional descriptive study took place between June 2015 and November 2015. Eligible elderly (n=1325) for this study were community-living elderly aged 75 years and older and residing in the north of the Netherlands (the province of Drenthe) who participated in Embrace ('SamenOud' [aging together] in Dutch). Embrace is a person-centered and integrated care service whose primary aim is to prolong the ability of older adults to age at home for as long as possible by providing comprehensive, coherent, person-centered, proactive, and preventive care and support. Recruitment of the participants in Embrace was performed in two steps. First, general practitioners (GPs) working in the municipality Emmen were informed about the Embrace study and their consent to participate in the study was requested. Second, all patients, either healthy or unhealthy, from the participating GPs aged 75 years and older and living at home or in a home for the elderly were eligible for inclusion in Embrace. These eligible elderly were invited to participate. There were no exclusion criteria. Eligible patients finally receive a letter from their GP with general information about participating in Embrace. One week later patients received a written informed consent form accompanied by questionnaires for baseline measurements. Patients were free to ask for support in filling out the questionnaire, either from family, friends, or from a staff member of the Embrace study available via the project's helpdesk. In case of missing data elderly were interviewed via the telephone to complete the questionnaire.

For more details about Embrace, the person-centered and integrated care service, see the studies of Spoorenberg[21,22] and Uittenbroek.[23,24] The Medical Ethical Committee of the University Medical Center Groningen, Groningen, the Netherlands, assessed the study proposal and concluded that approval was not required (reference METc2011.108).

Procedure and assessments

At baseline, all participating elderly to Embrace were asked to complete questionnaires consisting of questions on demographic characteristics (age, gender, marital status, living situation, education level, income), health (underlying dis-

eases, use of drugs) and a battery of health related questionnaires:

1). Frailty was assessed with the Groningen Frailty Indicator (GFI). This instrument comprises 15 items and measures losses of functions and resources in four domains: physical, cognitive, social, and psychological.[25] Theoretical range is 0-15, whereas a higher score indicates a higher level of frailty. Score >4 is considered frail.[25]
2) Complexity of care needs was assessed with the INTERMED for the Elderly Self-Assessment (IM-E-SA).[26] IM-E-SA assesses the needs as perceived by elderly themselves by completing 20 questions in four domains: biological, psychological and social needs, and healthcare. These domains cover three different time perspectives: history, current state and prognosis. The total score of IM-E-SA ranges from 0 to 60, with a higher score indicating a more complex care needs.
3) Dependency in ADL was assessed with the Modified Katz ADL index[27] this index includes six ADL items and four instrumental ADL activities. Theoretical range is 0-10, with a higher score indicating more dependency in performing daily activities.
4) Health-related QoL was assessed with the EuroQol-5D (EQ-5D).[28] This instrument comprises five domains: mobility, self-care, pain usual activities and psychological status. An index score is calculated for each participant, ranging from 0 to 1. A higher score indicates a better perceived QoL.

Case complexity

Participants in Embrace were classified into three subgroup (Robust, Frail and Complex care needs) reflecting their case complexity based on their scores on the IM-E-SA and GFI. The group 'Robust' consisted of participants without complex care needs and relatively low levels of frailty (IM-E-SA <16 and GFI <5). These elderly experienced none or a few consequences of aging. The group 'Frail' consisted of participants at risk for developing complex care needs and had higher levels of frailty (IM-E-SA <16 and GFI ≥ 5). These elderly suffered increasingly from the consequences of aging and experience growing dependency on others. The group 'Complex care needs' consisted of participants with comprehensive care dependency (IM-E-SA ≥16 and GFI ≥5). These elderly were subjected to professional support for several aspects due to the consequences of aging and are at risk for assignment to a hospital or nursing home.

Oral status and oral health

After assessing case complexity by the Embrace team all participating elderly received an additional simple questionnaire with 13 questions on oral health with questions regarding oral status (e.g., whether they have remaining teeth, dental implants, or dentures), oral health (e.g., complaints related to pain or

dry mouth, difficulties with chewing), and oral self-care (e.g., oral cleaning habits, dental visits) Participants were also asked to mark their oral health on a 10-points scale, ranging from 0 (very poor) to 10 (very good). A higher score indicates higher satisfaction with their oral status. Before application in this study the questionnaire was field tested on feasibility and reliability among 25 elderly who visited our special dental care unit of the University of Groningen. Elderly reported no difficulty with filling in the questionnaire. We next checked the oral status and found no differences between the self-reported information on oral status and assessment by a dentist.

Statistical analyses

Differences in baseline characteristics between the respondents and non-respondents were calculated with the Chi-square tests and Mann Whitney U tests. A p-value <0.05 was defined as significant. Descriptive statistics were used to provide an overview of demographic characteristics, health and oral health for the total population as well as for subgroups of elderly who differed regarding oral status (elderly with remaining teeth, implants or prosthesis) or case complexity (Complex care needs, Frail or Robust). For all variables that were not normally distributed, median scores and interquartile ranges (IQR) were reported. Chi-square tests and Mann Whitney U tests were used to asses differences between subgroups that differed regarding oral status or case complexity (**Tables 2 and 3**). In addition, subgroups based on case complexity were likewise compared per oral status subgroup (**Table 4**). For these analyses a p-value of ≤0.0167 (0.05/3) was defined as significant according to the Bonferroni principle. All statistical analyses were performed with SPSS Statistics 22.0 (SPSS inc. Chicago, Illinois).

Results

Respondents

In total 1325 of the 2752 eligible elderly (48% response rate) of the thirteen participating GP-practices decided to participate in Embrace. Non-respondents differed from respondents regarding gender (more women declined to participate, p-value <0.05) and age (older participants consented less often, p-value ,0.01). Of the oral health status questionnaires sent to the 1325 participants in Embrace, 1041 questionnaires were returned (response rate of 79%). Due to missing values, 15 questionnaires were excluded from analysis. As a result, finally 1026 (77%) respondents were included in the analysis (**Fig. 1**). Respondents had a median age of 80 years (IQR 77-84) years and 59% (n=602) was female (**Table 1**). Non-respondents of the oral status questionnaires (these el-

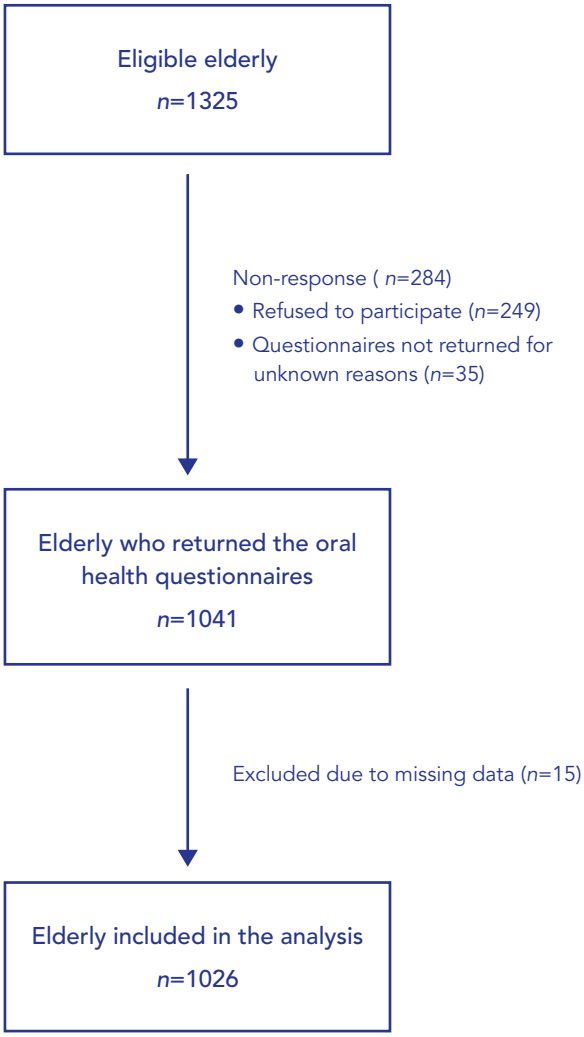

Fig. 1 Flowchart of subjects invited to participate and those who completed the questionnaires.

derly were interviewed at baseline by coworkers of Embrace) were older, lower educated, lived more often in a sheltered accommodation for the elderly, had a lower monthly income, and used more medicines when compared to respondents (all p-values <0.05).

The validated questionnaires (GFI, EQ-5D etc) as pointed out in the materials and methods session are common and frequently used questionnaires in

Table 1 Characteristics of respondents and non-respondents (n=1026).

	Respondents *n*=1026	Non-Respondents *n*=299	Dif. between subgroups p-value
DEMOGRAPHIC CHARACTERISTICS			
Age (median, IQR)	80 (77-84)	81 (78-85)	0.04
Female (n, %)	602 (59)	189 (63)	0.07
Widowed/divorced/single (n,%)	463 (45)	147 (49)	0.13
In sheltered accommodation/home for the elderly (n, %)	103 (10)	43 (14)	0.03
Low education level (n, %)[1]	418 (41)	176 (59)	≤ 0.001
Low income (n, %)[2]	321 (31)	112 (38)	0.03
MEASURES (median, IQR)			
Frailty (GFI)[3]	4 (2-6)	4 (2-7)	≤ 0.001
Complexity of care needs (IM-E-SA)[4]	10 (6-15)	11 (7-18)	≤ 0.001
Activities of daily living (Katz-15)[5]	1 (0-3)	2 (0-5)	≤ 0.001
Quality of life (EQ-5D)[6]	0.81(0.69-0.86)	0.78 (0.65-0.84)	≤ 0.001
CASE COMPLEXITY (n, %)			
Complex care needs	217 (21)	93 (31)	≤ 0.001
Frail	225 (22)	62 (21)	0.85
Robust	584 (57)	144 (48)	0.003
GENERAL HEALTH (n,%)			
Number of chronic conditions[7]	2 (1-3)	2 (1-4)	0.06
Polypharmacy[8]	583 (57)	194 (65)	0.004

[1] Low: (Less than) primary school or low vocational training
[2] Low: <€1450 per month
[3] GFI (Groningen Frailty Indicator)
[4] IM-E-SA (INTERMED for the Elderly Self-assessment)
[5] Katz extended
[6] EQ-5D (EuroQoL-5D)
[7] Presence or absence of 18 chronic diseases (e.g., diabetes mellitus, pulmonary emphysema, osteoporosis, hearing disabilities)
[8] More than four medications

geriatric medicine and comprise also questions related to confounders such as diabetes, smoking and drinking habits, mobility problems etc. Based on these items patients are stratified into one of the 3 groups (robust, frail, complex care needs) as explained above). No further analyses on confounders was performed.

Oral status and self-reported oral health

Table 2 shows the results for the whole sample and oral status subgroups (for significance levels see the various Tables). Thirty-nine percent of the respondents had remaining teeth, 10% had implant-supported overdentures and 51% were edentulous. Elderly with remaining teeth were significantly higher educated and had better incomes when compared to edentulous elderly and those with implant-supported overdentures. Overall, 12% of the elderly revealed to have chewing problems and 22% reported to have oral pain complaints. These pain complaints were most reported by elderly with remaining teeth (33% reported pain) and elderly with implants (23%), and significantly less reported by edentulous elderly (12%). The reported chewing complaints were comparable for the three oral status subgroups. More than 90% of the elderly with remaining teeth continued to visit their dentist for periodic visits, which was significantly higher when compared to elderly with implants (69%) and edentulous elderly (20%). Notwithstanding the more frequent pain complaints of elderly with remaining teeth, they were significantly less frail, had higher QoL and better ADL functioning compared to edentulous elderly. Furthermore, elderly with remaining teeth used significantly fewer medicines (50% vs 62%). The overall results, of the oral status questionnaires, for elderly with implant-supported overdentures resembled, to a large extent, those of elderly with remaining teeth rather than those of edentulous elderly with conventional dentures.

Case complexity

Table 3 shows the results per subgroup based on case complexity. Robust elderly were significantly younger, more often male, and had a higher income and educational level than frail elderly or elderly with complex care needs. Furthermore, frail elderly and elderly with complex care needs were significantly more often edentulous than robust elderly. Frail elderly and elderly with complex care needs also reported significantly more oral health-related problems than robust elderly, such as dry mouth during the night (30% and 25% vs 14%) and chewing problems (20% and 14% vs 7%). Furthermore, significantly more elderly with complex care needs had pain complaints than robust elderly (30% vs 19%). Also, the percentage elderly with complex care needs experiencing a dry mouth during the day was higher compared to frail and robust elderly (17% vs 8% and 4%). No substantial differences were found between the subgroups with respect to dental visits (overall, 53% had visited a dentist in the last 2 years) or the self-reported mark for oral health status (overall, median 8).

Case complexity and oral status

Table 4 gives an total overview of the demographics and outcomes per risk profile for each oral status subgroup, applied measures, health and oral health

Table 2 Overview of demographic characteristics, measures, health, oral health and case complexity for the total population and subgroups of oral status.

	ORAL STATUS				
	Total	Remaining teeth	Implants	Edentulous	Dif. between subgroups
	n=1026 100%	*n*=401 39%	*n*=104 10%	*n*=521 51%	p-value
DEMOGRAPHICS					
Age (median, IQR)	80 (77-84)	79 (77-83) [b]	80 (76-85) [c]	81 (78-85)	≤ 0.001
Female (n, %)	602 (59)	229 (57)	60 (58)	313 (60)	0.65
Widowed/divorced/single (n,%)	463 (45)	160 (40) [b]	38 (37) [c]	265 (51)	≤ 0.001
In sheltered accommodation/ home for the elderly (n, %)	103 (10)	17 (4) [a,b]	11 (11)	75 (14)	≤ 0.001
Low education level (n, %) [1]	418 (41)	103 (26) [a,b]	44 (42)	271 (52)	≤ 0.001
Low income (n, %) [2]	321 (31)	78 (20) [a,b]	34 (33)	209 (40)	≤ 0.001
MEASURES (median, IQR)					
Frailty (GFI) [3]	4 (2-6)	3 (1-5) [b]	3 (1-5) [c]	4 (2-6)	≤ 0.001
Complexity of care needs (IM-E-SA) [4]	10 (6-15)	9 (5-14) [b]	11 (6-14)	11 (7-15)	0.01
Activities of daily living (Katz-15) [5]	1 (0-3)	1 (0-2) [b]	1 (0-3)	1 (0-3)	≤ 0.001
Quality of life (EQ-5D) [6]	0.81 (0.69-0.86)	0.81 (0.77-0.89) [b]	0.81 (0.78-0.89) [c]	0.81 (0.69-0.85)	0.004
GENERAL HEALTH					
Number of chronic conditions (median, IQR) [7]	2 (1-3)	2 (1-3) [b]	2 (1-4)	2 (1-4)	0.06
Polypharmacy (n, %) [8]	583 (57)	200 (50) [b]	60 (58)	323 (62)	≤ 0.001
ORAL HEALTH (n, %)					
Regular dentist visit (< 2 years)	540 (53)	363 (91) [a,b]	72 (69) [c]	105 (20)	≤ 0.001
Chewing complaints (fair to poor)	118 (12)	54 (14)	11 (11)	53 (10)	0.29
Pain complaints (<2 years)	221 (22)	131 (33) [b]	24 (23) [c]	66 (12)	≤ 0.001
Dry mouth during the day	78 (8)	25 (6)	8 (8)	45 (9)	0.39
Dry mouth at night	201 (20)	69 (17) [a]	30 (29) [c]	102 (20)	0.03
Insecurity related to oral status	17 (2)	8 (2)	3 (3)	6 (1)	0.36
Oral status (median, IQR)	8 (7-8)	8 (7-8) [a,b]	8 (7-9) [c]	8 (7-8)	≤ 0.001
CASE COMPLEXITY					
Complex care needs	217 (21)	76 (19) [b]	17 (16) [c]	124 (24)	0.002
Frail	225 (22)	72 (18) [b]	20 (19) [c]	133 (26)	0.002
Robust	584 (57)	253 (63) [b]	67 (64) [c]	264 (50)	0.002

[1] Low: (less than) primary school or low vocational training
[2] Low: <€1450 per month
[3] GFI (Groningen Frailty Indicator)
[4] IM-E-SA (INTERMED for the Elderly Self-assessment)
[5] Katz extended
[6] EQ-5D (EuroQoL-5D)
[7] Presence or absence of 18 chronic diseases (e.g., diabetes mellitus, pulmonary emphysema, osteoporosis, hearing disabilities)
[8] More than four medications
[a] Statistical difference (p≤0.0167) between elderly with remaining teeth and those with implants
[b] Statistical difference (p≤0.0167) between elderly with remaining teeth and edentulous elderly
[c] Statistical difference (p≤0.0167) between elderly with implants and those with prosthesis

related to oral status and case complexity. Elderly with remaining teeth succeeded to visit their dentist in more than 90% of the cases, which is significantly different when compared to edentulous elderly (22% regular dental visits). Whether elderly visited their dentist was independent of their case complexity. Chewing problems seem to extend when case complexity rises indifferent of oral status. Furthermore, subgroup analysis revealed that oral pain is reported significantly more in respondents with remaining teeth than in edentulous patients. Overall the group of robust elderly with implant-supported overdentures and the group of robust elderly with remaining teeth reported both significant more pain (25% vs 29%) than robust edentulous elderly (7%).

Overall elderly with remaining teeth and implant-supported overdentures reported less frailty, better general health, better ADL, better QoL and used fewer medicines compared to edentulous elderly with conventional dentures.

Discussion

In this cross sectional study demographics, frailty, case complexity, ADL, Qol, health and oral health of elderly with remaining teeth were compared with those of edentulous elderly and elderly with implant supported overdentures. The study results suggests that oral status and oral health are related with healthy ageing as edentulous elderly reported more frailty, used more medicines, and had a lower Qol and worse ADL. It has to be mentioned, however, that social economic status (SES) might in part underlie this observation as oral health in adults with a higher SES is generally better. For example, Vettore[29] showed in their 13 year cohort study that a poor social position and weak social ties are important predictors for tooth loss and self-rated poor oral health. In our study, elderly with complex care needs had a lower SES and were more often edentulous than robust elderly which strengthen the findings of Vetore.[29]

Table 3 Overview of demographic characteristics, measures, health, oral health and oral status for the total population and case complexity subgroups.

	CASE COMPLEXITY				
	Total	Complex care needs	Frail	Robust	Dif. between subgroups
	N=1026 100%	*N*=217 21%	*N*=225 22%	*N*=584 57%	p-value
DEMOGRAPHICS					
Age (median, IQR)	80 (77-84)	81 (78-85) [b]	82 (79-87) [c]	80 (77-83)	≤ 0.001
Female (n, %)	602 (59)	151 (70) [b]	154 (68) [c]	297 (51)	≤ 0.001
Widowed/divorced/single (n,%)	463 (45)	115 (53) [b]	138 (61) [c]	210 (36)	≤ 0.001
In sheltered accommodation/ home for the elderly (n, %)	103 (10)	39 (18) [b]	32 (14) [c]	32 (6)	≤ 0.001
Low education level (n, %) [1]	418 (41)	107 (49) [b]	106 (47) [c]	205 (35)	≤ 0.001
Low income (n, %) [2]	321 (31)	89 (41) [b]	85 (38) [c]	147 (25)	≤ 0.001
MEASURES (median, IQR)					
Frailty (GFI) [3]	4 (2-6)	7 (5-8) [a, b]	6 (5-7) [c]	2 (1-3)	≤ 0.001
Complexity of care needs (IM-E-SA) [4]	10 (6-15)	19 (17-22) [a,b]	12 (10-14) [c]	7 (5-10)	≤ 0.001
Activities of daily living (Katz-15) [5]	1 (0-3)	4 (2-6) [a,b]	2 (1-3) [c]	0 (0-1)	≤ 0.001
Quality of life (EQ-5D) [6]	0.81 (0.69-0.86)	0.65 (0.57-0.78) [a,b]	0.78 (0.68-0.81) [c]	0.84 (0.81-1.00)	≤ 0.001
GENERAL HEALTH					
Number of chronic conditions (median, IQR)[7]	2 (1-3)	4 (2-5) [b]	3 (1-4) [c]	1 (1-2)	≤ 0.001
Polypharmacy (n, %) [8]	583 (57)	168 (77) [b]	163 (72) [c]	252 (43)	
ORAL HEALTH (n, %)					
Regular dentist visit (< 2 years)	540 (53)	109 (50)	109 (48)	322 (55)	0.17
Chewing complaints (fair to poor)	118 (12)	43 (20) [b]	32 (14) [c]	43 (7)	≤ 0.001
Pain complaints (<2 years)	221 (22)	65 (30) [a,b]	47 (21)	109 (19)	0.002
Dry mouth during the day	78 (8)	36 (17) [a,b]	17 (8)	25 (4)	≤ 0.001
Dry mouth at night	201 (20)	66 (30) [b]	56 (25) [c]	79 (14)	≤ 0.001
Insecurity related to oral health	17 (2)	9 (4) [b]	3 (1)	5 (1)	0.01
Oral status (median, IQR)	8 (7-8)	8 (6-8) [b,c]	8 (7-8)	8 (7-8)	0.02
ORAL STATUS					
Remaining teeth	401 (39)	76 (35) [b]	72 (32) [c]	253 (43)	0.002
Implants	104 (10)	17 (8) [b]	20 (9) [c]	67 (12)	0.002
Edentulous	521 (51)	124 (57) [b]	133 (59) [c]	264 (45)	0.002

[1] Low: (less than) primary school or low vocational training
[2] Low: <€1450 per month
[3] GFI (Groningen Frailty Indicator)
[4] IM-E-SA (INTERMED for the Elderly Self-assessment)
[5] Katz extended
[6] EQ-5D (EuroQoL-5D)
[7] Presence or absence of 18 chronic diseases (e.g. diabetes mellitus, pulmonary emphysema, osteoporosis, hearing disabilities)
[8] More than four medications
[a] Statistical difference (p≤0.0167) between elderly with complex care and frail elderly
[b] Statistical difference (p≤0.0167) between elderly with complex care and robust elderly
[c] Statistical difference (p≤0.0167) between frail and robust elderly

Oral health problems and oral pain

Frail elderly and particular elderly with complex care needs suffered the most from oral dryness, a condition that is very uncomfortable and is known to have a negative impact on oral health, QoL and oral health-related QoL.[30,31,32,] As frail elderly and elderly with complex care needs often use more medicines than robust elderly these elderly also suffered most from oral dryness (Table 4) as the usage of multiple medicines (polypharmacy) and especially the combination of several medicines often cause oral dryness.[5,31,33] In case of oral dryness the risk of denture-related problems (e.g., sore spots or retention problems), oral infections (due to accumulation of debris) and rapidly progressing dental decay (due to lack of good functioning saliva) increase significantly.[6,30,31] Thus, the side-effects of polypharmacy may, at least in part, explain the observation that elderly with complex care needs and remaining teeth reported pain and oral health problems as their oral health is more at risk.

As mentioned above, lower SES seems to be related to general health and oral health[28], so participants with a lower SES probably had a higher risk of becoming frail and/or ending up with poor oral health. This points towards the need to urge elderly to continue to visit their dentists and to maintain an adequate level of oral care, either by themselves or, when they are not able to self-maintain their oral health, by caregivers.[34] Unfortunately, this need to safeguard a proper level of oral care was not common in our community-living participants, especially in edentulous elderly of whom only 20% visited the dentist, oral hygienist or dental technician the last two years. Not visiting the dentist by many elderly was also reported by Dolan.[35] The latter authors noted that many elderly are not regular users of dental services and that they may experience significant barriers to receive necessary dental care, although maintaining oral health is essential to an older adult's general health and well-being. Donaldsen[36] reported findings on the relationships between oral health and SES. In their study the number of sound teeth in adults was partially explained by dental attendance, which in turn was determined by the effect of SES on barriers to regular dental

Table 4 Overview of demographic characteristics, measures, health, and oral health for elderly with remaining teeth, implants or prosthesis for each of the case complexity subgroups

	REMAINING TEETH (n=401)				IMPLANTS (n=104)				EDENTULOUS (n=521)			
	Complex care needs	Frail	Robust		Complex care needs	Frail	Robust		Complex care needs	Frail	Robust	
	n=76 19%	n=72 18%	n=253 63%	P-value	n=17 16%	n=20 19%	n=67 64%	P-value	n=124 24%	n=133 26%	n=264 50%	p-value
DEMOGRAPHICS												
Age (median, IQR)	81 (78-85)[b]	80 (78-84)[c]	79 (76-82)	≤ 0.001	81 (75-86)	83 (76-88)	80 (77-82)	0.25	81 (78-85)[a,b]	83 (80-87)[c]	80 (78-83)	≤ 0.001
Female (n, %)	56 (74)[b]	49 (68)[c]	124 (49)	≤ 0.001	12 (71)	12 (60)	36 (54)	0.44	83 (67)[b]	93 (70)[c]	137 (52)	≤ 0.001
Widowed/divorced/ single (n,%)	37 (49)[b]	38 (53)[c]	85 (34)	0.003	8 (47)	13 (65)[c]	17 (25)	0.003	70 (57)[b]	87 (65)[c]	108 (41)	≤ 0.001
In sheltered accommodation/home for the elderly (n, %)	6 (8)	2 (3)	9 (4)	0.21	2 (12)	4 (20)	5 (8)	0.27	31 (25)[b]	26 (20)[c]	18 (7)	≤ 0.001
Low education level (n, %) [1]	29 (38)$_b$	23 (32)[c]	51 (20)	0.003	9 (53)	7 (35)	28 (42)	0.54	69 (56)	76 (57)[c]	126 (48)	0.13
Low income (n, %) [2]	23 (30)[b]	15 (21)	40 (16)	0.02	9 (53)[b]	10 (50)[c]	15 (22)	0.01	57 (46)[b]	60 (45)[c]	92 (35)	0.01
MEASURES (median, IQR)												
Frailty (GFI) [3]	7 (5-8)[a,b]	6 (5-7)[c]	2 (1-3)	≤ 0.001	7 (6-9)[a,b]	5 (5-6)[c]	2 (1-3)	≤ 0.001	7 (5-9)[a,b]	6 (5-7)[c]	2 (1-3)	≤ 0.001
Case complexity (IM-E-SA) [4]	18 (17-22)[a,b]	12 (9-14)[c]	7 (4-10)	≤ 0.001	20 (17-24)[a,b]	12 (9-13)[c]	8 (5-12)	≤ 0.001	19 (17-23)[a,b]	12 (10-14)[c]	7 (5-10)	≤ 0.001
Activities of daily living (Katz-15) [5]	3 (2-5)[a,b]	1 (0-2)[c]	0 (0-1)	≤ 0.001	4 (1-5)[a,b]	1 (0-3)	0 (0-1)	≤ 0.001	4 (2-6)[a,b]	2 (1-4)[c]	1 (0-2)	≤ 0.001
Quality of life (EQ-5D) [6]	0.65 (0.57-0.78)[a,b]	0.78 (0.69-0.81)[c]	0.84 (0.81-1.00)	≤ 0.001	0.65 (0.57-0.78)[a,b]	0.78 (0.74-0.81)[c]	0.84 (0.81-1.00)	≤ 0.001	0.65 (0.57-0.78)[a,b]	0.77 (0.68-0.81)[c]	0.84 (0.81-1.00)	≤ 0.001

GENERAL HEALTH												
Number of chronic conditions (median, IQR)[7]	4 (2-5)[a,b]	3 (1-4)[c]	1 (1-2)	≤ 0.001	4 (3-6)[a,b]	3 (1-4)[c]	2 (1-3)	≤ 0.001	4 (2-5)[a,b]	3 (1-4)[c]	1 (1-2)	≤ 0.001
Polypharmacy (n, %) [8]	54 (71)[b]	51 (71)[c]	95 (38)	≤ 0.001	12 (71)	15 (75)[c]	33 (49)	0.06	102 (82)[b]	97 (73)[c]	124 (47)	≤ 0.001
ORAL HEALTH (n, %)												
Regular dentist visit (< 2 years)	68 (90)	66 (92)	229 (91)	0.90	9 (53)[b]	11 (55)[c]	52 (78)	0.04	32 (26)[b]	32 (24)[c]	41 (16)	0.03
Chewing complaints (fair to poor)	21 (28)[b]	14 (19)[c]	19 (8)	≤ 0.001	1 (6)	4 (20)	6 (9)	0.29	21 (17)[b]	14 (11)	18 (7)	0.01
Pain complaints (<2 years)	32 (42)[b]	26 (36)	73 (29)	0.08	3 (18)	4 (20)	17 (25)	0.75	30 (24)[a,b]	17 (13)	19 (7)	≤ 0.001
Dry mouth during the day	10 (13)[b]	3 (4)	12 (5)	0.02	2 (12)	1 (5)	5 (8)	0.74	24 (19)[a,b]	13 (10)[c]	8 (3)	≤ 0.001
Dry mouth at night	21 (28)[a,b]	10 (14)	38 (15)	0.03	9 (53)[b]	11 (55)[c]	10 (15)	≤ 0.001	36 (29)[a,b]	35 (26)[c]	31 (12)	≤ 0.001
Insecurity related to oral status	5 (7)[b]	2 (3)	1 (0)	0.003	0 (0)	1 (5)	2 (3)	0.66	4 (3)[a]	0 (0)	2 (1)	0.04
Report mark oral status (median, IQR)	7 (6-8)[b]	7 (7-8)[c]	8 (7-8)	≤ 0.001	8 (7-9)	8 (7-8)	8 (8-9)	0.26	8 (6-8)[b]	8 (7-8)[c]	8 (8-9)	≤ 0.001

[1] Low: (less than) primary school or low vocational training
[2] Low: <€1450 per month
[3] GFI (Groningen Frailty Indicator)
[4] IE-E-SA (INTERMED for the Elderly Self-assessment)
[5] Katz extended
[6] EQ-5D (EuroQoL-5D)
[7] Presence or absence of 18 chronic diseases (e.g., diabetes mellitus, pulmonary emphysema, osteoporosis, hearing disabilities)
[8] More than four medications
a Statistical difference (p≤0.0167) between elderly with complex care and frail elderly
b Statistical difference (p≤0.0167) between elderly with complex care and robust elderly
c Statistical difference (p≤0.0167) between frail and robust elderly

attendance. Donaldson[36] stated that overcoming barriers to regular dental attendance for low-socio-economic groups may reduce oral health inequalities.

Dental implants

Edentulous elderly with implant-supported overdentures generally perform better than edentulous patients with conventional dentures. This better performance is not limited to their oral health status, but is also reflected in less frailty and higher QoL. This observation is in line with the many studies showing that patients provided with implant-supported overdentures in general perform significantly better than edentulous patients with conventional dentures with regard to their oral function and oral health-related QoL.[37,38] Our study indicates that general health status and general QoL is also better in these patients which is also in line with our previous observation that care-dependent community-living elderly with remaining teeth reported less frailty, better general health and better physical function than edentulous elderly with conventional prostheses (Chapter 3).

Conclusion

Elderly with complex care needs experience significantly more oral health problems and are more often edentulous than robust elderly. Moreover, elderly with remaining teeth and elderly with implant-supported overdentures reported less frailty and better QoL. Care givers should be aware of this phenomenon and should safeguard adequate oral health maintenance in case the patient are unable to maintain their desired level of oral independently.

Disclosure / Acknowledgements

Ethical aspects

The institutional review board of our institution provided a waiver (file number METc2011.108), as this observational study was not an experimental study with test subjects as defined in the Medical Research Involving Human Subjects Act.

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