Tooth-loss related masticatory and aesthetic experiences among middle-aged and older adult Danes

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Objective: To determine whether tooth loss relates to patient experiences of masticatory or aesthetic problems and is a useful measure of oral health and treatment needs and to compare experiences of tooth loss among middle-aged and older Danes. ***Basic research design:*** Cross sectional online- and telephone interview questionnaire study. ***Participants:*** 1,060 Danish citizens aged 40 years or older. ***Main outcome measures:*** Experiences of difficulties eating/enjoying food or smiling/showing of teeth due to tooth related problems within the last 6 months. Data analysis used tests of proportions and ordinal logistic regression. **Results:** Half the participants had a full or almost full dentition. Among those with tooth loss, 21-44% reported difficulties eating/enjoying food. In ordinal logistic regression, difficulties eating were associated with being younger, having fewer teeth and having visibly missing teeth. Being unwilling to smile or show one's teeth was associated with being younger, having fewer teeth, having lower socioeconomic position and having visibly missing teeth. Wearing a prosthesis did not ameliorate eating difficulties or unwillingness to smile. ***Conclusions:*** Tooth loss is a meaningful measure of oral health but cannot stand alone. Many adults with even substantial tooth loss did not experience functional or aesthetic problems. Tooth loss is associated with negative masticatory and aesthetic experiences among middle-aged than older adults. Removable prostheses were not associated with better functional or esthetic outcomes.

Keywords: *Tooth loss, Patient Reported Outcome Measures, Middle aged, Aged*

Introduction

There is worldwide population growth among middle-aged and elderly adults (United Nations, 2019). Adults also retain more teeth, which both improves their chances for better oral function, but also increases their risk of more dental disease (Müller *et al.*, 2017), adding to the need for oral health care. Furthermore, evidence of interactions between oral and general health (Holmstrup *et al.*, 2017), difficulties in providing optimal care for patients burdened by complex drug regimens and multimorbidity (Wastesson *et al.*, 2018), and knowledge of the detrimental effect of poor oral health on quality of life (Øzhayat *et al.*, 2016), all point to greater need for oral health care for middle-aged and older adults.

The number of natural retained teeth (or its reciprocal, tooth loss) has traditionally and normatively been considered an important indicator of oral health. Tooth loss can be measured using self-reports (Quirino *et al.*, 2013) but does not tell health care planners anything about the need for dental care. Attention to subjective measures of oral health and treatment need, by including the patient's perspective, has added useful knowledge about Oral Health Related Quality of Life (OHRQoL). Tooth loss is associated with worse OHRQoL and the location and distribution of lost teeth affect the severity of the impairment (Gerritsen *et al.*, 2010).

Danish adults have good oral health, with the highest number of functional dentitions in the world (Guarnizo-Herreño *et al.*, 2013). Unfortunately, not everyone has a full dentition free from disease, especially among socially vulnerable middle-aged and elderly citizens (Guarnizo-Herreño *et al.*, 2013; 2019). Studies of patient-reported outcomes and symptoms among the middle-aged and elderly suggest that poor oral health negatively affects life, especially in social contexts (Øzhayat *et al.*, 2016; Rosing *et al.* 2019), and that several factors influence that relationship (Rosing *et al.*, 2019; Øzhayat, 2013). However, existing data are based on small and selected populations and have conflicting findings on the best indicators of oral health and treatment needs.

The two main indications for treatment of tooth loss are aesthetic and masticatory impairments. It thus makes sense to focus on these experiences. However, middle-aged adults may perceive aesthetic issues differently from older people, as aesthetic norms may be affected by socially constructed cohort effects. Conversely, masticatory issues may be seen as individual experiences isolated from social influence and therefore expected to be more similar across age-groups. Comparisons of whether elderly and middle-aged adults perceive tooth loss related issues similarly have, however, to our knowledge not been carried out.

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Thus, the aim of this study is to determine whether tooth loss is related to patient reported experiences of masticatory or esthetic problems. Further, we compared experiences of having a reduced dentition among middle-aged and elderly Danes to determine whether the two age-groups have different treatment needs.

Methods

Cross-sectional questionnaire and interview data were collected among a sample of Danish citizens of 40 years of age or above, that was representative of the Danish population in regard to age, gender, residential area, educational level, and income. Data were collected by Epinion, a Danish data analysis company in January 2020. All participants received written and/or spoken information about the study and gave consent for participation and use of their data. Participants who answered online gave written consent and participants who answered via telephone interview gave verbal consent. Data were anonymized and handled in accordance with the European General Data Protection Regulation and the study was approved by the Danish Data Protection Agency (514-0560/20-3000) and the Research Ethics Committee for Science and Health at the University of Copenhagen (504-0219/20-5000).

The questionnaire first enquired about participants' age, gender, place of birth, region of residence, educational attainment, employment, income and marital status (Appendix 1. Available at https://erda.ku.dk/archives/39 64e72b43da76be48740228bc2b7c58/published-archive. html). Age was dichotomized as under or over 65 years of age (termed 'middle-aged and 'elderly adults').

Oral Health Related Quality of Life was recorded using the oral impact on daily performance (OIDP) inventory (Adulyanon and Sheiham, 1997), which recorded whether participants had experienced each of eight impacts on six-point ordinal scales of: never affected (1), less than once a month (2), once or twice a month (3), once or twice a week (4), three to four times a week (5) every/nearly every day (6). Two items were selected as the primary outcomes: (i) 'having had problems eating or enjoying food' and (v) 'having difficulties wanting to smile or show teeth' to represent functional and esthetic problems.

The main explanatory variable, number of teeth, was recorded in answer to the question: *"How many natural teeth do you have? (Removable prosthetic teeth are not to be counted. Normally, adults have 32 teeth including all four wisdom teeth)."*

Furthermore, participants were asked: "Do you use a prosthesis (One or more artificial teeth possible to insert/remove yourself)?" Such prostheses were termed 'removable prosthesis'.

Self-reported secondary explanatory variables can be seen in table 1.

Bivariate analyses were carried out with outcome data as binomial proportions of two independent groups and differences were tested by calculating the 95% confidence intervals for proportions. Bonferroni corrections adjusted for multiple pairwise comparisons. Cumulative odds ordinal logistic regressions with proportional odds were run to test full models. Each model was seen to fit well to the observed data and predicted dependent variables over and above the intercept-only models only.

Table 1. Characteristics of 1,060 Danish adults aged 40 years and over.

		%
Age	40-64-year-olds	58.8
	65+ year-olds	41.2
Education	Primary school	23.8
	Short education	43.6
	Longer education	31.3
	Other	1.3
Employment	Employed	47.7
	Pension	4.0
	Social benefit	3.4
	Other	2.1
Household income in DKK	0-99.999 kr.	0.7
	100.000-299.999 kr.	21.0
	300.000-499.999 kr.	24.1
	500.000-799.999 kr.	18.3
	800.000-1.099.999 kr.	6.6
	1.100.000 or more	4.2
	No wish to report	25.2
Marital status	In a relationship	65.4
	Single	34.6
Self-reported social position	Not low	89.7
	Low	10.3
Number of teeth	Full dentition (28-32 teeth)	49.5
	20-27 teeth	37.7
	19 or fewer	12.7
Removable prosthesis	Yes	11.8
	No	88.2
Visibly missing teeth	Yes	11.9
	No	88.1
Use of dental care system	Regular use	77.0
	When feeling the need	11.3
	Only for acute treatments	8.0
	No use	3.7
Dental anxiety	Not at all	63.1
	Low degree	15.9
	Some degree	10.8
	High degree	6.2
	Very high degree	3.9
Problems eating and enjoying food in past 6 months	Never affected	80.7
	Two or fewer times a month	13.2
	Weekly to daily	6.1
Difficulties smiling and showing teeth without embarrassment in past 6 months	Never affected	89.2
	Two or fewer times a month	5.0
	Weekly to daily	5.8

Results

Online questionnaires were sent to 1,296 persons of whom 545 (42%) responded. Of the 2,500 persons contacted for a telephone interview, 515 (21%) agreed to participate and completed the interview. The number of participants (1,060) corresponds to a participation rate of 28%. No data are available to determine whether those who agreed to participate differ from those who declined.

Demographic and background characteristics of the participants are presented in Table 1. The proportions of female and male participants were similar (50.1% and 49.9%) and 95.1% had been born in Denmark. The

proportions living in the North, Central, Southern or Capital Regions and in Zealand were 10.8%, 21.5%, 21.1%, 28.2% and 18.3% respectively. More than two thirds (68.6%) reported no impacts for any item within the OIDP. One fifth (20%) experienced difficulties eating and enjoying food and 11% had difficulties smiling and showing their teeth. Approximately 6% reported such experiences weekly to daily within the last 6 months.

Tooth loss was associated with age. The proportions of 40–64-year-olds with a full dentition, 20-27 teeth or 19 or fewer teeth were 59.6%, 33.9% and 6.6% respectively. The corresponding proportions among those aged 65 or older were 35.2%, 43.2% and 21.5%. Tooth loss was also associated with educational attainment. The proportions with a full dentition in the high, medium and low education groups of the 40-64-year olds were 68.5%, 60.1% and 46.0% respectively. The corresponding proportions among those aged 65 or older were 40.9%, 39.7% and 21.7%. (Appendies 2 and 3. Available at https://erda.ku.dk/archives/3964e72b43da76be48740228 bc2b7c58/published-archive.html).

More middle-aged adults reported difficulties eating and enjoying food than their elderly counterparts. However, similar numbers (5-7%) in both age-groups, experienced weekly to daily difficulties (Appendix 4.

Available at https://erda.ku.dk/archives/3964e72b43da7 6be48740228bc2b7c58/published-archive.html). Having fewer teeth was related to a stepwise increase in difficulties eating or enjoying food (Appendix 5. Available at https://erda.ku.dk/archives/3964e72b43da76be487402 28bc2b7c58/published-archive.html).

When adjusted for number of missing teeth, difficulties eating and enjoying food were reported by more middle-aged than older adults (Figure 1), except for when having fewer than 20 teeth, when similar numbers of both age-groups reported problems.

In ordinal logistic regression analysis, more frequent difficulties eating and enjoying food was associated with being younger, having fewer teeth and having visibly missing teeth. Interestingly, wearing a prosthesis did not ameliorate eating difficulties, even when the number of teeth was accounted for (OR = 0.777, 95% CI = 0.428, 1.410) (Table 2).

In a similar model, more often being unwilling to smile or show one's teeth was associated with being younger, having fewer teeth, having lower socioeconomic position and having visibly missing teeth. Again, wearing a prosthesis was not associated with willingness to smile or show one's teeth when the number of teeth was accounted for (OR = 1.034, 95% CI = 0.506, 2.111) (Table 3).
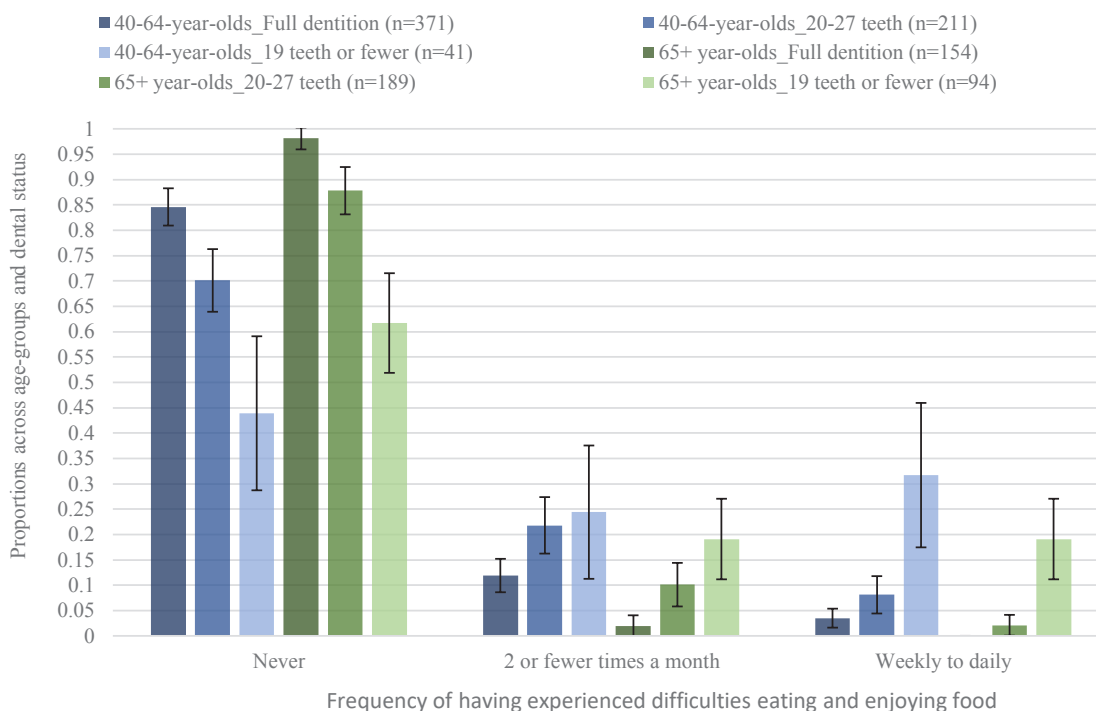
Pairwise comparisons of age-groups and number of teeth in relation to having difficulties eating or enjoying food				
Frequency of difficulties	Number of teeth	Full dentition	20-27 teeth	19 teeth or fewer
	Age-groups	40-64-year-olds versus 65+ year-olds	40-64-year-olds versus 65+ year-olds	40-64-year-olds versus 65+ year-olds
Never		*p*<0.0001	*p*<0.0001	*p*=0.0549
Two or fewer times a month		*p*=0.0003	*p*=0.0015	*p*=0.6907
Weekly to daily		*p*=0.0188	*p*=0.0078	*p*=1.5954

*With 9 pairwise comparisons, statistically significance level is Bonferroni corrected and set at *p*=0.006

Figure 1. *Experienced difficulties eating and enjoying food across age-groups and dental status.*

Table 2. Ordinal logistic regression for frequency of having difficulties eating and enjoying food.*

Parameter	Odds Ratio	95% Confidence Interval	
		Lower	Upper
Age-group			
40-64 year-olds	3.069	2.091	4.505
65+ year-olds	1		
Dental status			
19 or fewer teeth	7.846	4.081	15.086
20-27 teeth	2.051	1.384	3.040
Full dentition	1		
Educational level			
Low	1.329	0.860	2.054
Medium	1.000	0.672	1.487
High	1		
Visibly missing teeth			
Yes	2.900	1.856	4.531
No	1		
Having a prosthesis			
Yes	0.777	0.428	1.410
No	1		

* Reference category: Difficulties eating never vs. 1–2 times a month or more.

Table 3. Ordinal logistic regression analysis for frequency of being unwilling to smile or to show teeth*.

Parameter	Odds Ratio	95% CI	
		Lower	Upper
Age			
40-64 year-olds	4.285	2.237	8.208
65+ year-olds	1		
Dental status			
19 or fewer teeth	4.919	2.192	11.039
20-27 teeth	1.465	0.854	2.515
Full dentition	1		
Socioeconomic position			
Low	2.525	1.113	5.725
Medium	1.734	0.919	3.271
High	1		
Relationship status			
Single	0.882	0.555	1.401
In relationship	1		
Affiliation with job market			
Public benefit	1.411	0.554	3.591
Retired	1.509	0.822	2.769
Employed	1		
Visibly missing teeth			
Yes	2.818	1.605	4.948
No	1		
Having a prosthesis			
Yes	1.034	0.506	2.111
No	1		

* Reference category: Being unwilling to smile or to show teeth never vs. 1–2 times a month or more.

Discussion

Most people in this sample of middle-aged and elderly Danish adults had all or many retained teeth. Tooth loss was associated with age and lower educational attainment. Two thirds of participants did not report any oral impacts on daily performance. That is, despite having lost teeth, difficulties eating or smiling were not a problem for most participants in both age-groups. Nevertheless, tooth loss was related to functional and aesthetic problems and consequently people´s quality of life.

For comparison, among a sample of 60-93-year-olds in Thailand, with markedly poorer dental status (only 32% had at least 20 teeth), eating difficulties were reported by 50% and smiling/showing of teeth difficulties by 16% (Somsak and Kaewplung, 2016). In a Peruvian study, 77% of younger and middle-aged adults aged 20-59 years and 79% of people aged 60+ year-olds experienced difficulties eating and enjoying food, compared to the the 19% in our study (Guevara-Canales et al., 2018). The same study also found difficulties smiling/showing of teeth in 46% and 55%, respectively, compared to 11% in our study.

Interestingly, OIDP scores were not associated with clinical oral status in the Peruvian study (Guevara-Canales et al. 2018). Similar findings have been observed with other OHRQoL measures (Özhayat 2013; Øzhayat et al., 2016), emphasizing the importance of patient involvement and shared decision making in clinical practice.

A study of Norwegian adults aged 16-79 years, which might be more comparable to the Danish population and dental care system, found that 82% had no oral impacts on daily performance as compared to 69% in our somewhat older sample (Astrøm et al., 2006). The same study found that 11% and 5% experienced difficulties eating/enjoying food and smiling/showing teeth, respectively, compared to 19% and 11% in our study.

In all the above studies the relationship between clinical status (tooth loss) and OHRQoL appeared to be affected by several other factors. For example, the impacts of greater tooth loss on difficulties eating and enjoying food and on smiling were more common among middle-aged than older adults (Tables 2 and 3) even when the number of retained teeth was accounted for. Older participants' tolerance of discomfort maybe due to other competing more frequent health problems and may be a coping mechanism with the acceptance of the discomforts of older age (MacEntee et al., 1997). Likewise, interactions between age and aesthetic concerns suggest that the social stigma of tooth loss may be greater with fewer people sharing the symptom, or alternatively that older people have adapted to their changing clinical status (MacEntee et al., 1997; Gregory et al., 2005). In either case the seriousness of tooth loss and its validity as an oral health measure may increase as the prevalence of tooth loss decreases. Likewise, socioeconomic position was related to experiencing aesthetic problems, even when adjusted for number of missing teeth, especially among middle-aged adults. It may be that middle-aged adults are more prone to let social norms influence their experience of quality of life compared to the older adults. Somsak and Kaewplung (2016) also found number teeth to be associated with difficulties eating and enjoying food, but did not find a similar relationship with difficulties smiling/

showing of teeth, as we found in our study. Perhaps in poorer clinical status populations, the functional ability to eat carries more importance than aesthetic problems. Aesthetic norms may be related to the appearance of the majority. If this is the case, then in a population like the Danish, with most people having full or almost full dentitions, aesthetical concerns are stronger.

Cumulatively, all these types of complex interactions show the necessity of using comprehensive theoretical models and more sophisticated analyses when studying the effect of clinical status on OHRQoL (Baker *et al.,* 2010).

The relationship between number of teeth and difficulties eating and smiling suggests that prevention of tooth loss may benefit quality of life, and efforts toward this may be best focused on people with lower educational attainment.

Use of a prosthesis was unrelated to having functional or aesthetic problems in the regression analyses, indicating that even accounting for the number of teeth that wearing a prosthesis did not ameliorate impacts on everyday life. This was even the case for participants missing visible teeth. Somsak and Kaewplung (2016) also found that having a prosthesis did not alleviate functional and aesthetic problems. The data suggest that using a removable prosthesis is not a solution to difficulties eating. Whilst any benefits of prostheses may be masked in this study due to the small numbers of participants with very few natural teeth (Type 2 error), prostheses did not appear to alleviate functional or aesthetic problems and may be a suboptimal treatment modality.

This brings a limitation of this study. A larger sample and a better response rate may have minimised type II errors and selection bias, as we cannot know if non-participants differ from participants. The high levels of retained teeth in the sample also limits generalization to countries with similar relatively high levels of oral health and similar organization of dental care. One further limitation that while the sampling method was meant to secure a representative sample, lack of data on characteristics of non-responders makes this assumption uncertain. Other factors, not accounted for, may be associated with the study outcomes such as, for instance co-morbidities. The inherent limitations of cross-sectional studies restrict causal attribution and more follow-up studies of OHRQoL to elucidate causal relations are necessary.

In conclusion, in a population with relatively good oral health, with most people having full or almost full dentitions, few people experienced impacts from missing teeth. However, for almost a third of the population, tooth loss was associated with functional and aesthetic problems. Tooth loss was associated with older age and low educational level. Tooth loss is still a meaningful indicator of oral health, but it cannot stand alone and patients must be involved in describing their health and in deciding whether treatment is needed or not, as not everyone with even substantial tooth loss experienced functional or aesthetical problems. Prostheses did not appear to alleviate functional or aesthetic problems and may be a suboptimal treatment modality.

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Conflict of interest statement

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