



Original article

# Why do some people lose teeth across their lifespan whereas others retain a functional dentition into very old age?

Helene Thorstensson<sup>1,2</sup> and Boo Johansson<sup>3,4</sup>

<sup>1</sup>Department of Periodontology/Endodontics, The Institute for Postgraduate Dental Education, Jönköping, Sweden; <sup>2</sup>Department of National Science and Biomedicine, School of Health Sciences, Jönköping University, Jönköping, Sweden; <sup>3</sup>Institute of Gerontology, School of Health Sciences, Jönköping University, Jönköping, Sweden; <sup>4</sup>Department of Psychology, Göteborg University, Göteborg, Sweden

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## Why do some people lose teeth across their lifespan whereas others retain a functional dentition into very old age?

**Objectives:** To analyse the importance of caries, periodontitis, and medical and psychosocial factors for risk of becoming edentulous across their lifespan and to examine factors critical for retaining functional dentition into very old age.

**Methods:** From the longitudinal population-based Octogenarian Twin study which analysed psychosocial and health variables, 357 individuals aged 82 + in 1995–1998 were collected. Information about number of teeth, decayed and filled surfaces percentage and periodontal disease experience were drawn from dental records. Reasons for and time of edentulousness were recorded.

**Results:** Outcome varied – depending on perspective and factors for losing or retaining teeth. Significant factors for losing teeth varied over the lifespan. Losing teeth early in life was related to lower social class; in middle age, to lower education; and in old age, to poor lifestyle factors and low social class. Caries constituted the main reason for tooth loss (about 55%). This increased substantially in the >80 year age-group (75%). Maintaining a functional dentition into old age was significantly associated with non-smoking, more education, being married and good periodontal health.

**Conclusion:** It is important to apply life-span and cohort perspectives to oral health and disease. In our sample of persons born before World War I, caries was the main reason for losing all teeth, with substantially increased prevalence by age. Lifestyle factors were significant for losing *and* for retaining teeth. Periodontal condition had a significant influence on the likelihood of retaining functional dentition, and also when taking psychosocial variables into account.

**Keywords:** oldest old, oral health, psychosocial factors, teeth.

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## Introduction

Oral well-being and functioning are crucial for quality of life. The inter-relationship between oral health and well-being may be particularly pronounced among older people who have accumulated a life-long exposure to various risk factors that contributed to losing some or many of their teeth. Despite dramatic improvements in tooth retention worldwide, a substantial proportion of the present generation of older adults have lost all their natural teeth<sup>1,2</sup>.

Reasons for losing teeth are complex and involve oral diseases and other health-related and socio-

economic factors. Data from several countries revealed edentulousness to be significantly associated with age<sup>3–8</sup>, education<sup>5,7–12</sup>, financial situation<sup>4–6,8,13</sup>, social class<sup>9,11,14</sup>, and smoking<sup>4,10,12</sup>. Copeland *et al.*<sup>15</sup> found varying risk factors for tooth loss across the studied cohorts. Age may be a significant predictor in one cohort but not in another. Furthermore, factors critical for retaining teeth across the lifespan may vary from those that influence tooth loss across the ages. A life-course perspective is therefore needed to obtain clues that indicate changing patterns of health and disease.

While the overall trend of declining edentulism in older ages is encouraging, improved

understanding of the underlying causes of tooth loss is still needed to improve interventions and especially to improve prevention. Most studies focused on the general adult population; some included adults aged 80 + . To date, even less attention is being paid to the oldest old, although this is the fastest growing age segment in modern societies. By 2050, the United Nations estimates that people older than 80 will comprise 20% of the world's elderly population<sup>16</sup>.

The aim of the study was to analyse the importance of caries, periodontitis and medical and psychosocial factors for the risk of becoming edentulous across the lifespan. For this purpose we investigated a cohort that had survived 80 or more years and examined factors of importance for retaining a functional dentition ( $\geq 20$  teeth) into very old age.

## Materials and Methods

### Subjects

The study's sample was selected from participants in the comprehensive longitudinal *Origins of Variance in the Oldest-Old: Octogenarian Twins* (OCTO Twin) study (a collaborative project between the School of Health Sciences, Jönköping, Sweden, and Pennsylvania State University, PA, USA). OCTO Twin examined monozygotic and dizygotic twins, ages 80 + , on five occasions at 2-year intervals. The OCTO Twin sample originally came from the population-based Swedish Twin Registry at Karolinska Institute. The sample consisted of all same-sex twins in complete pairs who were aged 80 + or who became 80 during the first data collection period (1991–1994), in other words, 1913 and older birth cohorts<sup>17</sup>.

Those alive and tested on the third occasion (1995–1998) comprise the sample for the present study. In all, 357 individuals who were residing throughout Sweden participated (Table 1). Median age in the edentulous and the dentate group was 86<sup>18</sup>. Most participants lived in ordinary housing (80.6%), while 12.7% lived in service housing or institutional settings (6.7%). The edentulous group comprised 176 individuals (49%) with 52 men and 124 women. The dentate group consisted of 181 individuals (51%), 119 women and 62 men (Table 1). These individuals had, on average, 13.9 teeth (SD 6.70). Almost a quarter (24%) had 20 or more natural teeth, while 29.8% had less than 10. Of the available tooth surfaces, 9.3% (SD 18.01) had untreated carious lesions. The total proportion of decayed and filled surfaces (DFS) was 62.2% (SD

**Table 1** Number of participating edentulous and dentate individuals according to gender and age.

	Total	$\leq 85$ years	$\geq 86$ years
All	357	147	210
Women	243	90	153
Men	114	57	57
Edentulous	176	70	106
Women	124	46	78
Men	52	24	28
Dentate	181	77	104
Women	119	44	75
Men	62	33	29

26.61). Severe marginal bone loss afflicted 51% of the dentate individuals. The remaining dentate individuals had less severe bone loss. No gender differences were found in the oral health variables<sup>18</sup>.

### Ethics

The ethics committee at Karolinska Institute in Stockholm and the Swedish Data Inspection Authority in Sweden approved the study. All participants signed informed consent forms.

### The Octogenarian Twin study

The OCTO Twin study includes a broad spectrum of bio-behavioural measures of health and functional capacity, personality, well-being, and interpersonal functioning<sup>19–26</sup>. Registered Swedish medical nurses (RNs), who were specially trained for the OCTO Twin study, examined all subjects in their residences and collected all psychosocial data. During the in-person testing session, RNs screened subjects for edentulousness and asked all dentate individuals to identify their dental caregivers and to give permission to review their dental records.

### Study variables

For the present study, dental status of individuals with natural teeth was analysed using patients' records, including radiographs, and was based on the most recent, complete examination by a dentist between 1995 and 1998. Demographic, psychosocial, and medical variables and dental data that had been collected during these years in the OCTO Twin study were used in the present study. Dental data that were selected for use in the present study comprised regular dental visits, number of teeth, percent of existing tooth surfaces that were carious and filled (DFS%), and periodontal disease experience<sup>18</sup>.

Each participant's general dentist had carried out the clinical caries examination in 1995–1998. For the present study, one of the authors (HT) then used the patient's records and intra-oral radiographs to determine the number of teeth, caries and the participant's periodontal disease experience as per Hugoson and Jordan<sup>27</sup>. No individuals could be classified in periodontal disease group 1 (healthy periodontal conditions and no bone loss) or group 2 (gingivitis and no bone loss). The periodontal disease experience of all dentate participants was classified as moderate (group 3) or severe (groups 4 and 5) periodontal bone loss:

- Group 3: Alveolar bone loss around most teeth – not exceeding one-third of the normal bone height.
- Group 4: Alveolar bone loss around most teeth – reaching between one-third and two-thirds of the normal bone height.
- Group 5: Alveolar bone loss around most teeth – exceeding two-thirds of the normal bone height, presence of angular bony pockets and/or furcation defects.

All dental records were examined and independently rated on two occasions with an agreement of the ratings of  $\geq 94\%$ .

Only psychosocial variables that were significantly associated with the dental variables in the bivariate analyses were included in the multiple analyses. The psychosocial variables are:

- Household's financial situation in childhood (good or insufficient)
- Financial situation during life-long labour market participation (good, rather good, insufficient)
- Social class (group 1, large-scale employers and officials of high or intermediate rank; group 2, small-scale employers, officials of lower rank, foreman; group 3, skilled and unskilled workers)
- Education (elementary school or higher)
- Marital status (married, never married, widow/-er or divorced)
- Self-assessed healthy lifestyle in adulthood (good, rather good, rather poor)
- Health restriction on daily living (not at all, partly, to a great deal)
- Smoking habits (current smokes, former smoker; never smoked)
- Feeling comfortable (always, sometimes, or never)
- Capacity to keep oneself neat and tidy (problem, no problem)
- Overall cognitive status (no or very mild impairment versus significant and major impairment according to cognitive tests and ratings).

Medical diagnoses that were found to be significantly correlated to number of teeth among the

studied individuals were diabetes mellitus, eczema, hypertension, hypothyroidism, hip fracture, and depression. These diagnoses were included in the analyses. Edentulous individuals were asked about reasons for their edentulousness – for example, decayed teeth (caries) and loosening teeth (periodontitis), and other reasons such as tooth/root fracture, toothache, and endodontic problems – and the age when the individual became completely edentulous, this information being included in the analyses.

The present study controlled for gender and zygosity effects in all analyses.

### *Statistical analyses*

Statistical analyses were performed with SPSS 13.0 for Windows. The level of significance was set at 5%. Initial analyses focused on descriptive statistics and bivariate associations between the dependent variable, number of teeth, and independent variables using the chi-square or *t*-test. Multiple regression analyses included only variables that were significant ( $p < 0.05$ ) in the bivariate analyses. Odds ratio (OR) and 95% confidence interval (CI) were calculated for each variable.

As no gender or zygosity differences were found, all edentulous and dentate individuals were pooled in subsequent analyses and comparisons.

## **Results**

### *Age becoming edentulous*

Three-quarters of the participants had lost all their natural teeth before age 70 (Table 2). More individuals lost their teeth at a young age (33.3%) than in the oldest age (11.1%).

In stepwise logistic regression analysis, with the age of becoming edentulous as an outcome, the pattern differed depending on when in life the teeth were lost (Table 3). Becoming edentulous early in life was significantly associated with social class. Losing all teeth in midlife was related to lower education. Losing teeth late in life was associated with rather poor/poor self-reported lifestyle and low social class. In the >70 age-group, social class 1 and 2 were pooled in the analysis as there were too few individuals in social class 1.

### *Odontological reasons for edentulousness*

Over the entire lifespan, tooth loss due to caries was stated as the main reason in about 55% of the individuals up to the oldest age; here, a substantial

**Table 2** Percentage of individuals losing teeth at various age intervals and reason for tooth loss according to the subjects themselves.

<i>Dental reason for tooth loss</i>	<i>Age when all teeth were lost</i>				
	<i>&lt;40</i>	<i>40–49</i>	<i>50–69</i>	<i>70–80</i>	<i>&gt; 80</i>
%	33.30%	14%	28.10%	13.50%	11.10%
Decayed teeth (Caries)	62%	58.80%	55%	55.60%	75%
Loosening teeth	18%	17.70%	22.50%	33.30%	16.70%
(Periodontitis) Other (fractures, pain etc.)	20%	23.50%	22.50%	11.10%	8.30%

increase in frequency to 75% occurred (Table 2). Periodontitis, as a reason for tooth loss, was of minor importance compared with caries but increased steadily over the lifespan from 18 to 33% and dropped in the oldest age group. Other reasons given were toothache, endodontics and tooth/root fractures.

#### *Functional dentition*

In a nominal regression analysis, including psychosocial variables and medical diagnoses, those having  $\geq 20$  teeth were compared with edentulous individuals. Smoking, education, and marital status significantly differed between the groups (Table 4). Never having been a smoker or being a former smoker, high education, and being married were significantly associated with retaining many of their teeth.

A comparison between individuals with many ( $\geq 20$ ) natural teeth and those with few (1–10) teeth showed that periodontal disease experience was the most significant factor, although all psycho-

social variables and medical diagnoses were also examined (Table 4). Never having been married and exhibiting moderate periodontal disease were associated with a functional dentition ( $\geq 20$  teeth).

Among individuals with  $\geq 20$  natural teeth, 44% had moderate (group 3) and 12% severe periodontal disease (group 4 and 5). In individuals with few (1–10) teeth, the corresponding figures were 17 and 39%.

## **Discussion**

The importance of caries, periodontitis, psychosocial and medical factors for becoming edentulous during life was examined in a sample of oldest old individuals. We also examined factors that contributed to retaining teeth into old age. Notably, the studied cohort did not benefit from organised dentistry in childhood, and they have been able to benefit from Swedish National Dental Health Insurance only during a relatively restricted period in their lifespan. At the time of the introduction of this scheme in 1974 they were all 61 years old and

	<i>&lt;40 years</i>	<i>40–70 years</i>	<i>&gt;70 years</i>
	<i>Sign OR (95% CI)</i>	<i>Sign OR (95% CI)</i>	<i>Sign OR (95% CI)</i>
Healthy life style			
Good			reference
Rather good/poor			0.014 3.3(1.3–8.6)
Social class			
1	reference		
2	0.050 7.7(1.0–59.2)		reference*
3	0.017 11.6(1.5–87.4)		0.025 3.4(1.2–10.1)
Education			
Elementary school		0.001 4.0 (1.8–8.7)	
Higher		Reference	

\*Social class 1 and 2 were pooled in the analysis due to few individuals in social class 1

**Table 3** Stepwise logistic regression analyses of the age for becoming edentulous with significant psychosocial variables.

**Table 4** Logistic regression analyses of number of teeth with significant psychosocial variables, DFS%, periodontal disease experience, and medical diagnoses.

<i>0 teeth</i>	$\geq 20$ teeth
Group of comparison	Smoking never $p = 0.019$ OR = 14.4 (1.6–133.3) former $p = 0.037$ OR = 11.6 (1.2–115.0) Education higher $p = 0.000$ OR = 5.8 (2.3–14.6) Marital status married $p = 0.013$ OR = 3.6 (1.3–9.7)
1–10 teeth	$\geq 20$ teeth
Group of comparison	Marital status never married $p = 0.016$ OR = 12.2 (1.6–94.2) Periodontal disease experience group 3 $p = 0.003$ OR = 7.2 (1.9–26.8)

older. This is likely to be a significant reason for the importance of psychosocial factors in oral health being more pronounced in this cohort.

Oral health (here defined as number of natural teeth) was analysed using two complementary perspectives: (1) factors of importance for losing teeth – a destructive, disease approach, and (2) factors contributing to retaining teeth – a positive health approach. Outcomes of these analyses varied. Interestingly, none of the analyses revealed significant gender differences.

Many psychosocial factors that operate from childhood into late life influence health and health behaviours. As a result, a need exists for a life-span perspective – looking back at various exposures of the individual – to understand the current pattern of health and disease. The studied dental variables, DFS percentage, periodontal disease experience and number of teeth reflect the effect of exposure to life-long risk factors.

The decision to extract teeth is not solely influenced by the biological conditions of the teeth. In the present study, low social class, low education, and lack of healthy living were key factors affecting

loss of teeth. These factors also reflect lifestyle, values and attitudes that may influence dental health behaviour. Interestingly, financial situations in childhood and adulthood were not significant in any of the analyses, but social class and education are closely associated with financial conditions.

Tooth loss is a traumatic experience and a serious life event that may require significant social and psychological re-adjustment<sup>28</sup>. It therefore could be surmised that the time stated for losing all their teeth was correct, even if it had happened a long time ago. However, to find predictors for edentulousness that cover the entire life span is difficult. Significant predictors vary – depending on when in a lifetime teeth were lost. Low social class was significant before the age of 40 years, low education between the ages of 40 and 70 years, poor lifestyle during mid-life, and low social class after the age of 70 years. Dental professionals and general public health information also might influence lifestyle factors. Older people are less likely than younger people to have received health education early in life, which raises questions about the need to design care interventions accordingly.

The reasons for losing teeth were obtained from the participants through interviews and the event occurred a long time ago for most of the participants. Therefore, a cautious interpretation of timing and reasons is necessary as the reliability of the responses may not be perfect. Also, awareness of the more precise reason for tooth loss may vary among individuals. Decayed teeth (caries) was the most prevalent reason stated for losing teeth – a finding confirmed in other studies<sup>29,30</sup>. Interestingly, even after the age of 80 years, tooth loss due to caries increased. This could be an indication of increased overall frailty in the oldest old and an indication that the need for dental care and supervision increases among the oldest old who have retained their teeth.

Despite the limited benefit from the National Dental Health Insurance, a substantial group of individuals in our cohort who were born before World War 1, had retained a functional dentition into very old age. However, the psychosocial effects that enable maintenance of a functional dentition ( $\geq 20$  teeth) varied – depending on whether or not oral diseases (DFS percentage and periodontal disease) were included in the analyses. Education, marital status and lifestyle factors, such as smoking, were found to be important when oral disease was not included in the analyses. These factors were also found to be positively associated with having  $\geq 20$  teeth in cohorts of 70-year-olds in a study by Österberg<sup>31</sup>. Smoking is a well-known risk factor

for oral disease and tooth loss<sup>32</sup> and when oral diseases were included in the analysis, periodontal disease experience was a significant predictor. This latter experience even outrivaled psychosocial factors and medical diagnosis. It should be noted that only present medical diagnoses were included in the analyses as access to life-long information about medical conditions was not available. This could be one reason why medical diagnoses were not significant in the analyses.

Efficient dental care during the entire life-span is crucial for the prevention and treatment of oral diseases and for engaging individuals in good oral health behaviour. Ageing may also directly or indirectly increase the risk of oral diseases. There will be a challenge for dentistry in an increasingly ageing population to meet the demand for dental care with clinical intervention and preventive care – to ensure that the dentition functions adequately and is socially acceptable in later life<sup>33–37</sup>.

## Conclusions

A life-span perspective is crucial for oral health and disease. As expected, caries was the main reason for people losing teeth and notably, among the most elderly, the prevalence increased substantially. Lifestyle factors were significant for losing *and* for retaining teeth, but could be influenced by other impacts. Periodontal disease played a significant role in a patient's ability to maintain a functional dentition, as did psychosocial variables.

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*Correspondence to:*

Helene Thorstensson, The Institute for Postgraduate Dental Education  
 Department of Periodontology/Endodontics  
 Box 1030 SE-55111  
 Jönköpings, Sweden.  
 Tel.: +46 3632 46 10  
 Fax: +46 3246 79  
 E-mail: helene.thorstensson@epost.tidanet.se