

## ORIGINAL ARTICLE

# Avoidance of dental appointment due to cost and consequences for oral health-related quality of life: 25-yr follow-up of Swedish adults

Anne Nordrehaug Åstrøm<sup>1</sup>  | Stein Atle Lie<sup>1</sup>  | Berit Mastrovito<sup>2</sup>  | Josefin Sannevik<sup>3</sup> 

<sup>1</sup>Department of Clinical Dentistry, Faculty of Medicine, University of Bergen, Bergen, Norway

<sup>2</sup>Region Östergötland, Tandvårdsenheten, Linköping, Sweden

<sup>3</sup>Region Örebro län, Tandvårdsenheten, Örebro, Sweden

## Correspondence

Anne Nordrehaug Åstrøm, Department of Clinical Dentistry, University of Bergen, Bergen, Norway.

Email: anne.aastrom@uib.no

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## Abstract

We explored how socio-demographic and personal characteristics contribute to avoidance of dental appointment due to cost over time from age 55 (in 1997) to 75 (in 2017) and assessed the implications for oral health-related quality of life. In 1992, 6346 residents born in 1942 consented to participate in a prospective questionnaire survey, and 3060 (48.2%) of them completed postal follow-ups every fifth year until 2017. Oral health-related quality of life was assessed using the Oral Impact on Daily Performance inventory. The frequency of avoidance of dental appointment due to cost declined from 7.0% (in 1997) to 5.4% (in 2017), whereas the frequency of oral impacts declined from 26.0% in 2007 to 24.0% in 2017. Generalized Estimating Equation models revealed that avoidance of dental appointments due to cost was more likely reported in 1997 (OR: 1.5: 1.2–1.8) than in 2017, more likely in low educated people, and less likely in those using private dental care services. Avoidance of dental appointment due to cost was associated with impaired oral health-related quality of life. Social inequalities in avoidance of dental appointment due to cost and oral impacts did not vary across time but persisted into older ages despite the dental health care reforms that had been implemented.

## KEY WORDS

avoidance of dental care due to cost, oral health, older adults, prospective

## INTRODUCTION

The unmet need for health care is an under-researched field in the Nordic and European contexts [1]. According to Carr and Wolfe [2], the unmet need for health care is the difference between services judged necessary to deal with a problem and those actually received, so it may be conceived as the subjective perception of not having obtained appropriate health care services. Unmet need for health care is related to problems

with *availability of dental care* in the residence area, *acceptability of health care services* in terms of its adequacy, and *accessibility*, such as cost of services and transportation [3,4]. Access has been conceptualized as the opportunity that people have to use health care services in relation to their needs [5]. Having a high-quality primary care service that is financially and physically accessible is considered necessary to tackle non-communicable diseases, including caries and periodontal disease [6].

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Research considering unmet need has mainly focused on general health issues in the United States and Canada [1,4,7]. A Canadian study ranked the frequency of reported reasons for unmet health care needs, with the highest being problems with availability, followed in descending order by constraints with acceptability, and accessibility [4]. In the United Kingdom and the United States, the cost of care and anxiety have been identified as the main reasons for failure to seek dental care in spite of perceived treatment need [8,9]. The European Social Survey of 2014/15 revealed that, despite the presence of universal health care coverage in many welfare states (i.e., all people obtain the health services they need without risking unaffordable out of pocket payment), financial problems were a major determinant for all types of unmet need [10].

The welfare state model of the Nordic countries features the concept of universal dental health care coverage [10]. Evidence suggests, however, that the utilization of dental care is unequally distributed across age and subgroups in the adult populations [11–14]. In Sweden, dental care for adults is based on fees for services, supported by the Social Insurance Agency initiated in 1974 and by a dental care reform implemented in 2008 that aimed to provide treatment for those with extensive needs at reasonable subsidized cost [15,16]. This general dental care reform consists of dental care support amounting to 150–300 Swedish kroner. In addition, a high-cost support was implemented for when the treatment cost amounts to 3000 Swedish kroner and above, covering from 50% to 85% of the total treatment costs. Although roughly 80% of the Swedish adult population is enrolled in a recall system somewhere in the public-and private dental health care services, some older people seem to lose their regular dental contact for numerous reasons [15]. Financial limitations have been suggested as a barrier to routine dental check-ups in the Swedish context [17–19]. In 2019, the Swedish National Board of Health and Welfare reported that 21% of 80-yr-olds abandoned dental care due to financial constraints [17].

For the planning of future dental health care services, it is important for the authorities to monitor the development of dental attendance through the third age period (i.e., from labor market exit to the onset of physical dependency). Only a few studies have focused on avoidance of dental appointments due to cost or on the unmet need in the Nordic context, and those available have used a cross-sectional design [18–20]. Thus, it is unclear to what extent people are not receiving the oral health care needed throughout the third age period.

Assuming that avoiding dental appointments due to cost might reflect unmet need for dental care, this study explored how socio-demographic and personal circumstances contribute to self-reported avoidance of dental appointment due to cost over time from age 50 to 75 in a Swedish cohort. This study also assessed the implications of long-term avoidance

of dental appointment due to cost for oral health-related quality of life in old age.

## MATERIAL AND METHODS

Data collection for this cohort has been implemented every fifth year since the baseline survey in 1992 and details of the recruitment procedure have been published previously [21]. In 1992, all individuals born in 1942 and resident in the Örebro and Östergötland counties in Sweden were invited to participate in the study. Of the total population of 8888 adults, 6346 (71.4%) agreed to participate. The cross-sectional participation rates were 74.3% (6513/8764) in 1997 (55 yr), 75.0% (6372/8500) in 2002 (60 yr), 73.1% (6078/8313) in 2007 (65 yr), 72.2% (5697/7889) in 2012 (70 yr), and 70.6% (5092/7204) in 2017 (75 yr). Percentages of baseline respondents have been computed for the following waves: 5364 (84.5% of baseline) participated in 1992 and 1997; 4736 (74.6% of baseline) participated in 1992, 1997, and 2002; 4143 (65.0% of baseline) participated in 1992, 1997, 2002, and 2007; and 3585 (56.5% of the baseline responders) participated in 1992, 1997, 2002, 2007, and 2012. Of the 6346 participants who completed the 1992 survey, 3060 (48.2% of baseline and 34.0% of the original sample) participated in all six surveys, leaving 3286 as drop-outs from some of the postal follow-ups. Data were collected through postal questionnaires, with most questions repeated in every survey wave. Ethical clearance was approved for the surveys conducted in 1992, 1997, and 2017 by the Ethics committee of Sweden. Further approval for the follow-up questionnaires in 2002, 2007, and 2013 was not required.

The primary outcome was the time-varying variable ‘avoidance of dental appointment due to cost’, assessed repeatedly in 1997, 2002, 2007, 2012, and 2017 using the question “have you during the last 12 months been forced to cancel a scheduled dental appointment due to cost?” Response options were (1) yes and (0) no. A summary variable was constructed for the survey period 1997–2017 and coded (0) not avoided dental appointment due to cost in 1997 and 2017, (1) avoided dental appointment due to cost in 1997 but not in 2017, (2) avoided dental appointment due to cost in 2017 but not in 1997, or (3) avoided dental appointment due to cost both in 1997 and 2017. We considered being forced to cancel a scheduled dental appointment (when enrolled in a recall system) due to lack of money within the previous 12 months to reflect an unmet need for dental care due to problems with accessibility. Need for dental care according to a scheduled dental appointment might be defined mainly by dental professionals and reflect normative need. However, such decisions are mostly done in agreement with the patient in a participatory decision-making process, underlining the subjective component of need for dental care. A secondary outcome was

oral health-related quality of life, measured by the eight-item Oral Impact on Daily Performance inventory, the OIDP [22], repeatedly in 2007, 2012, and 2017. The questions were: 'During the previous 6 months how often have problems with your mouth and teeth caused you any problem with (i) eating and enjoying food, (ii) speaking and pronouncing clearly, (iii) tooth cleaning, (iv) sleep and relaxing, (v) smiling, (vi) being emotionally stable, (vii) sociability, (viii) performing daily work'. Each item was scored from (1) never affected to (5) affected every or nearly every day. Each item was assessed using a Likert scale with the response options ranging from (1) affected daily or almost every day to (5) never affected. Each item was dichotomized into (0) not affected (including the original category 5) and (1) affected at least monthly or less than monthly (including original categories 1–4). A summary score was constructed from 8 dummy variables (range 0–8) and dichotomized into (0) no daily performance affected and (1) at least one oral performance affected. Psychometric properties of the Swedish version of the OIDP inventory have been established in a previous study [23].

Time-invariant covariates, in terms of sex, country of birth (native, foreign), educational level (low, medium, high), and work status (full time, part time, and unemployed), were assessed at baseline in 1992. Time-variant covariates were assessed repeatedly at each survey from 1997 to 2017, whereas the time-varying covariates for OIDP were assessed repeatedly from 2007 to 2017. Civil status was assessed in terms of cohabiting /not cohabiting, smoking status in terms of active smoking/no smoking, and perceived health status in terms of healthy/unhealthy. The sector in which dental care was usually received was assessed as either private dental care or public dental care.

## Statistical analyses

Data were analyzed using SPSS version 22.0 (IBM) and STATA 15 (StataCorp) with the intact cohort, that is, those participating in all survey years from 1992 to 2017 ( $n = 3060$ ). The proportion of the intact cohort who reported avoidance of dental appointment due to cost and the proportion who reported oral impacts ( $\text{OIDP} > 0$ ) across the survey years was tested using Cochran's  $Q$  test for several related samples. At each survey year, avoidance of dental appointment due to cost and OIDP was compared between groups defined by time-invariant and time-varying variables using Chi-Square tests. Stability and change in avoidance of dental appointment due to cost during the period 1997–2017 was compared between groups using Chi-Square tests. Generalized Estimating Equations (GEE) with binomial logit function and unstructured correlation matrix were used to model avoidance of dental appointment due to cost and OIDP across survey years, accounting for within-individual repeated measurements. The time-invariant and

time-varying covariates that were associated ( $p < 0.05$ ) with the two outcome variables in unadjusted analyses were entered as covariates. Models were built by adding covariates to the equations; time-invariant socio-demographic factors were entered in step I followed by time-varying factors in step II. Model fit was assessed in terms of Corrected Quasi Likelihood under Independence Model Criterion (QICC). Pairwise interactions between covariates and survey year (time) were included if they met the statistical significance criterion set at  $p < 0.05$ .

## RESULTS

Baseline characteristics (1992) are presented by follow-up status in Table 1. As shown, socio-demographic characteristics (such as education and employment status) and personal features (such as smoking and perceived health) assessed in 1992 differed between participants who responded in each survey year (panel 1992–2017) and those lost to follow-up (participated in 1992 only). Being less educated, unemployed, born outside Sweden (foreign status), not cohabiting, using public dental care, and feeling not completely healthy were more common among those lost to follow-up than in their counterparts included in the panel 1992–2017.

Table 2 summarizes the prevalence of individuals reporting avoidance of dental appointment due to cost by survey year and sex. The frequency was higher in 1997 (7.0%) than in 2017 (5.4%), and there was no sex difference.

Table 3 shows the crude cross-sectional associations of avoidance of dental appointment due to cost and covariates at each survey year. As shown, avoidance of dental appointment was most prevalent among immigrants, those less educated, and those unemployed. Participants who were not cohabiting, smokers, those using public dental health care services, and those who were not completely healthy reported avoidance of dental appointment more frequently than their counterparts at each survey year. Avoidance of dental appointment due to cost was reported by 2.3% both in 1997 and 2017, by 3.1% in 1997 but not in 2017, by 4.5% in 2017 but not in 1997, and by 90.0% neither in 1997 nor 2017 (not shown in table). As shown in Table S1, participants with non-native background, low education, and those who were unemployed were more likely than their counterparts to report avoidance of dental appointment due to cost both in 1997 and 2017.

As shown in Table 4, a binomial GEE model was first fitted with survey year and time-invariant covariates (Model I). The model fit was  $\text{QICC} = 6781.211$  with survey year, education, country of birth, and work status being associated with avoidance of dental appointment due to cost. In Model II, time-varying covariates were added and improved the model fit to  $\text{QICC} = 5575.237$ . Relative to 2017, participants were 1.5 (OR: 1.5, 95% CI: 1.2–1.8) times more likely to report

Baseline characteristics	Total % (n)	Follow-up % (n)	Lost to follow-up % (n)	p value
Country of birth				
Native	93.5 (5914)	95.6 (2920)	91.5 (2994)	
Immigrants	6.5 (413)	4.4 (135)	8.5 (278)	<0.001
Education				
Low	40.1 (2518)	36.4 (1108)	43.5 (1410)	
Medium	39.4 (2477)	41.4 (1260)	37.6 (1217)	
High	20.5 (1290)	22.3 (678)	18.9 (612)	<0.001
Work status				
Full time	74.1 (4655)	75.2 (2288)	73.0 (2367)	
Part time	20.0 (1260)	21.4 (650)	18.8 (610)	
Out of work	5.9 (370)	3.5 (105)	8.2 (265)	<0.001
Civil status				
Cohabit	81.3 (5139)	86.8 (2622)	77.0 (2517)	
No cohabit	18.7 (1185)	14.2 (435)	23.0 (750)	<0.001
Smoke				
Smoke	32.8 (2071)	25.2 (766)	40.0 (1305)	
Not smoke	67.2 (4239)	74.8 (2279)	60.0 (1960)	<0.001
Sector of care				
Private	72.0 (4471)	75.0 (2264)	69.1 (2207)	
Public	28.0 (1741)	25.0 (754)	30.9 (987)	<0.001
Perceived health				
Healthy	88.9 (5582)	93.3 (2839)	84.8 (2743)	
Unhealthy	11.1(694)	6.7 (203)	15.2 (491)	<0.001

**TABLE 1** Comparison of baseline characteristics (1992) between subjects who participated in each survey year and those lost to follow-up

**TABLE 2** Percentage (n) of participants reporting avoidance of dental appointment due to cost by sex

Survey year (age)	Women % (n)	Men % (n)	Total % (n)
1997 (55 yr)	7.9 (128)	6.0 (84)*	7.0 (212)
2002 (60 yr)	6.4 (104)	6.8 (95)	6.6 (199)
2007 (65 yr)	6.8 (11)	6.0 (84)	6.4 (195)
2012 (70 yr)	6.1 (98)	5.5 (78)	5.8 (176)
2017 (75 yr)	5.6 (90)	5.3 (74)	5.4 (164)

Note: Each wave from age 55 to age 75.

\* $p < 0.05$  – Cochran's  $Q$  for related samples.

avoidance of dental appointment due to cost in 1997. Relative to having higher education, less educated participants were more likely to report avoidance of dental appointment due to cost. Part-time and full-time workers were less likely than those who were unemployed to report avoidance of dental appointment. Participants reporting cohabiting, receiving private dental care, and being healthy were less likely than their counterparts to report avoidance of dental appointment over time. No significant interactions of survey year and socio-demographic and behavioral covariates with avoidance of dental appointment were observed.

As shown in Table 5, the percentage of the intact cohort (panel) who confirmed oral impacts on daily performance was 25.9% in 2007 and 24.2% in 2017. In 2007 and 2017, oral impacts were, respectively, most frequent in women (26.9% versus 25.9%) and men (22.9% versus 25.7%).

Table 6 summarizes bivariate associations of OI DP in 2007, 2012, and 2017 with time-invariant and time-variant covariates. Participants born outside Sweden (foreign status), participants not cohabiting, non-smokers, those receiving public dental care, those who were not completely healthy, and those who confirmed avoidance of dental appointment due to cost were more likely than their counterparts to report oral impacts.

Table 7 represents the GEE analysis of oral impacts across time regressed on unmet need for dental care, adjusting for time-invariant (Model I) and time-varying (Model II) covariates. The final Model II revealed that confirming oral impacts across time was less likely in 2012 than in 2017, but more likely in 2007 than in 2017. Native people were less likely to confirm oral impacts than their foreign counterparts. Relative to those who confirmed unmet need for dental care, those who did not were less likely to report oral impacts across time. Model fit in terms of QICC amounted to 9320.706 and 8251.852 in Model I and Model II, respectively. No significant interactions of survey year and socio-demographic

**TABLE 3** Frequency of reported avoidance of dental appointment due to cost according to time-variant and time-invariant covariates

	1997 % (n)	2002 % (n)	2007 % (n)	2012 % (n)	2017 % (n)
<b>Time invariant (92)</b>					
Country of birth					
Native	6.7 (192)	6.3 (183)	6.1 (177)	5.4 (157)	5.1 (146)
Foreign	15.0 (20)*	12.2 (16)*	12.8 (17)*	13.6 (18)**	12.8 (17)**
Education					
Low	9.1 (100)	9.0 (99)	8.3 (91)	7.6 (83)	7.0 (76)
Medium	6.8 (84)	5.9 (73)	6.0 (75)	5.7 (71)	4.9 (61)
High	3.7 (25)**	3.7 (25)**	4.2 (28)**	3.3 (22)**	3.7 (25)*
Work status					
Full time	6.3 (143)	5.9 (133)	5.6 (127)	5.2 (117)	5.4 (121)
Part time	7.7 (49)	7.0 (45)	7.1 (46)	5.8 (37)	5.0 (32)
Out of job	16.3 (17)**	17.3 (18)**	17.1 (18)**	18.1 (19)**	8.8 (9)
<b>Time variant (97–17)</b>					
Civil status					
Cohabit	5.7 (147)	5.7 (143)	4.9 (119)	4.2 (97)	3.9 (83)
No cohabit	13.2 (42)**	11.9 (40)**	12.6 (73)**	11.0 (71)**	9.4 (80)**
Smoke					
Smoking	13.1 (69)	10.2 (50)	11.1 (42)	12.5 (34)	12.2 (24)
No smoke	5.8 (143)**	5.9 (147)*	5.7 (149)**	5.1 (140)**	4.9 (137)**
Sector of care					
Private	5.5 (117)	4.8 (101)	4.8 (103)	3.8 (81)	3.7 (77)
Public	10.2 (86)**	9.7 (84)**	9.3 (73)**	8.9 (71)**	8.2 (68)**
Perceived health					
Healthy	6.2 (168)	4.6 (115)	5.0 (128)	4.9 (124)	4.6 (111)
Unhealthy	15.2 (42)**	16.0 (81)**	14.1 (65)**	10.6 (45)**	9.0 (51)**

Note: Cross-sectional associations at every wave reported with time-variant covariates.

\*\* $p < 0.001$ .

\* $p < 0.05$ .

and behavioral covariates with oral impacts were observed, implying that socio-behavioral differentials in OIDP did not vary across the survey years.

## DISCUSSION

This study is among the first to examine avoidance of dental appointment due to cost in a cohort followed prospectively throughout middle and older age. Overall, the findings indicate that problems with accessibility in terms of financial constraints are an important reason for avoiding dental care in the Swedish context [24]. Using a prospective cohort design, this study covers a period before and after the implementation of a special dental care allowance for adults in 2008. The percentages of respondents reporting avoidance of dental appointment due to cost amounted to 7.0% in 1997 (at age 55) and 5.4% in 2017 (at age 75), and there were no apparent sex differences. Thus, the prevalence of avoiding

dental appointments due to cost, although less substantial, was larger among the cohort participants before than after the implementation of the dental health care reform in 2008. This implies that the reform as a contextual factor may have reached, at least partly, its goal of providing dental care at reasonable cost according to people's needs. In accordance with the findings of previous surveys, avoidance of dental care due to cost was most likely to occur in socio-economically disadvantaged groups [1,19]. In addition to the traditional time-invariant socio-economic factors, time-varying covariates reflecting low material standards and less socio-economic resources were associated with avoidance of dental appointment due to cost. Finally, long-term avoidance of dental appointment from 2007 to 2017 turned out to be the strongest predictor of oral impacts across the survey years. This study supports previous evidence that social inequalities in oral health and self-reported abstention from dental care due to cost persist into older age despite the public coverage of the dental health care reforms implemented [14,19,20].

**TABLE 4** Self-reported avoidance of dental appointment due to cost across time (97–17) according to time-invariant and time-variant factors

	Model I	Model II
	OR (95% CI)	OR (95% CI)
Survey year		
1997	1.3 (1.1–1.5)	1.5 (1.2–1.8)
2002	1.2 (1.0–1.4)	1.3 (1.1–1.6)
2007	1.2 (1.0–1.4)	1.3 (1.0–1.5)
2012	1.05 (0.9–1.2)	1.1 (0.9–1.3)
2017	1	1
Time invariant (92)		
Sex		
Women	1.1 (0.8–1.4)	1.0 (0.8–1.3)
Men	1	1
Education		
Low	2.3 (1.7–3.2)	1.8 (1.3–2.6)
Medium	1.6 (1.1–2.2)	1.3 (0.9–1.9)
High	1	1
Country of birth		
Native	0.4 (0.3–0.6)	0.5 (0.3–0.7)
Foreign	1	1
Work status		
Full time	0.4 (0.4–0.7)	0.4 (0.2–0.7)
Part time	0.4 (0.2–0.6)	0.5 (0.3–0.8)
Out of job	1	1
Time variant (97–17)		
Civil status		
Cohabit		0.5 (0.4–0.6)
No cohabit		1
Smoking		
Smoke		1.8 (1.4–2.2)
No smoke		1
Sector of care		
Private		0.6 (0.5–0.7)
Public		1
Perceived health		
Healthy		0.6 (0.5–0.7)
Unhealthy		1

A prospective cohort study, such as the present one or a time series of cross-sectional surveys, is recognized to be the most relevant study design for monitoring changes in population need for dental care and oral health. An important strength of this study is the use of a long-term longitudinal study following individuals throughout middle and older ages using a nuanced measurement of self-reported avoidance of dental appointment due to cost. In addition, this study

**TABLE 5** Percentage (n) of participants confirming oral impacts on daily performances at each survey by sex in waves 2007, 2012, 2017

	Oral impacts		
	Women % (n)	Men % (n)	Total % (n)
2007	26.9 (424)	24.7 (340)	25.9 (764)
2012	18.7 (290)	20.1 (278)	19.4 (568)
2017	22.9 (333)	25.7 (340)	24.2 (673)**

\*\* $p < 0.001$  Cochranes Q for related sample.

**TABLE 6** Prevalence of oral impacts on daily performances (2007–2017) according to time-invariant and time-variant covariates

	2007 % (n)	2012 % (n)	2017 % (n)
Time invariant (92)			
Country of birth			
Native	25.4 (715)	18.9 (531)	24.1 (640)
Foreign	37.7 (49)**	29.4 (37)**	28.7 (33)
Education			
Low	24.6 (265)	18.9 (198)	24.8 (239)
Medium	25.7 (312)	19.2 (234)	23.8 (278)
High	28.5 (184)	20.4 (134)	24.4 (154)
Work status			
Full time	25.5 (564)	19.0 (420)	23.9 (504)
Part time	26.4 (166)	19.8 (121)	25.7 (145)
Out of job	28.9 (28)	23.7 (23)	24.2 (668)
Time variant (07–17)			
Civil status			
Cohabit	24.5 (581)	18.3 (405)	23.0 (456)
Not cohabit	31.7 (176)	21.8 (136)*	27.5 (212)*
Smoke			
Smoke	34.4 (127)	23.4 (61)	31.2 (53)
No smoke	24.7 (634)**	18.9 (503)	23.8 (613)*
Sector of care			
Private	23.1 (485)	16.7 (345)	22.1 (429)
Public	32.0 (243)**	24.2 (185)**	28.2 (211)**
Perceived health			
Healthy	23.5 (581)	16.9 (420)	20.4 (457)
Unhealthy	40.1 (178)**	32.2 (129)**	41.7 (210)**
Avoidance of dental appointment due to cost			
No	23.9 (657)	17.6 (485)	22.7 (567)
Yes	54.8 (102)**	48.2 (79)**	50.4 (68)**

Note: Cross-sectional associations at waves 2007, 2012, and 2017 reported for time-variant covariates.

\*\* $p < 0.001$ .

\* $p < 0.05$ .

is based on predisposing (socio-demographics), enabling (socio-economic), and need-related (perceived health, smoking) covariates, as suggested by Andersen's theoretical model

**TABLE 7** Oral impacts on daily performances by unmet need for dental care due to cost across time (07–17) adjusted for time-invariant and time-variant covariates

Year	OR (95% CI)	
	Model I	Model II
2007	1.1 (1.0–1.2)	1.1 (1.0–1.2)
2012	0.7 (0.6–0.8)	0.7 (0.7–0.8)
2017	1	1
Time invariant (92)		
Country of birth		
Native	0.7 (0.5–0.8)	0.7 (0.5–0.9)
Foreign	1	1
Sex		
Women	0.9 (0.8–1.1)	0.9 (0.8–1.1)
Men	1	1
Time variant (07–17)		
Civil status		
Cohabiting		0.8 (0.7–1.0)
No cohabiting		1
Smoke		
Smoke		1.3 (1.1–1.6)
No Smoke		1
Completely healthy		
Healthy		0.5 (0.4–0.6)
Unhealthy		1
Sector of care		
Private		0.7 (0.6–0.8)
Public		1
Avoidance of dental appointment due to cost		
No		0.4 (0.3–0.5)
Yes		1

of service use [25]. However, various limitations should be noted. Focusing on a single birth cohort, this study encompasses both period and age effects but cannot uniquely distinguish between those effects without additional assumptions. The data utilized are based on self-reports and do not include normative assessments of dental conditions or received dental treatment. Thus, avoidance of dental appointment due to cost might reflect—but is not equivalent to—unmet need for dental care. This outcome measure might reflect unmet professionally defined need for dental care. However, recall intervals should also reflect the subjective need of the patients, because recall intervals are made in agreement with patients in a participatory decision-making process. Although self-reported measures may be biased by lack of recall and social desirability, previous evidence suggests that individuals are better able to estimate their own health status than others and could even be able to identify shortcomings in their

experience of dental health care services [26]. Malecki et al. [9] used both objective and subjective measures of unmet treatment need and found that predictors and social disparities were consistent across the various measures, thus suggesting that subjective measures of oral health might be fairly accurate. A time window of 12 months could affect the validity due to recall bias; however, this time reference has been widely used in previous surveys [27]. The questions used to assess unmet need for dental care differ across studies and are likely to be affected by the cultural context and differences in dental health care systems, among other things. This complicates comparisons between studies. Other caveats are the possibility of inaccuracy in the exposure variables due to the survey intervals of 5 yr, as well as not having data for the total cohort due to attrition. Although lost to follow-up might have introduced selection bias, it is less likely that sample biases have distorted the main patterns of findings. In this study, we have used the intact cohort instead of all data in a mixed effect model to avoid differential selection due to interactions between lost to follow-up, baseline characteristics, and the two outcome variables.

The rates of reported avoidance of dental appointment due to cost, varying from 7% to 5.4%, accord by and large with the 8% reported by Molarius et al. [19] in 2012, who used cross-sectional data and a national sample of 16–84-yr-old Swedish adults. Based on the European Social Survey including respondents in 20 countries, Fjære et al. [1] reported on an overall prevalence of unmet need for health care of 12%. During the global economic crisis (2007/2008 and 2011/2012), the level of unmet dental care needs due to cost or other barriers differed across European countries, from below 1% to 12% [28]. Studies conducted in other socio-cultural contexts have reported a much higher prevalence of unmet need for dental care due to cost or other barriers, for instance, amounting to 44% among older Korean Americans and younger adults in South Korea [7,29]. A decline in reported avoidance of dental appointment due to cost with increasing age, as observed in this study, is in line with findings from another Swedish national cross-sectional study suggesting that younger people (21–35 yr) were more likely to refrain from dental care (due to any reason) than their older counterparts aged 65–84 yr [20]. Similar findings were also reported from a prospective Finnish study, indicating that the prevalence of unmet need for dental care due to any reason declined from 25% to 20% throughout a 10-yr survey period and was less substantial in older cohorts [18]. Declining trends in reported avoidance of dental appointments might reflect an apparent reduction in needs for dental care with ageing. Studies have documented a clear relationship between increasing age and a decrease in prevalence of regular dental attendance patterns [15,30].

The relationship between age/time and the reported avoidance of dental appointment reflects factors that influence people's ability to maintain regular contact with dental care

services. One explanation might be contextual, such as the gradual removal of age limits on subsidized care to guarantee more equal access and satisfactory coverage of dentists, thus making ageing people less amenable to perceive barriers related to high service fees and transport costs. Another possibility is that the present findings might be cohort-specific, since longitudinal studies mix age and period effects. Cohort participants of this study were born in 1942 and might value oral health and dental aesthetics differently from later birth cohorts. We found that, independent of age or survey year, avoidance of dental appointment due to cost was most likely to occur among immigrants, those less educated, unemployed, non-cohabitants, smokers, those using public dental care services, and those reporting to not being completely healthy. Overall, these findings are consistent with previous Swedish studies and those in other socio-cultural contexts [1,20,28]. Thus, this study highlights the vulnerability of individuals lacking family resources, as well as those having immigrant status. Being unemployed was a strong prospective predictor, reflecting economic problems that persist into retirement in older ages. We also found an association with lower education and hypothesized that awareness and interpretation of the dental health care reforms might differ between those with different educational levels. The European Union Statistics on Income and Living Conditions (EU-SILC) surveys revealed that unmet need for dental care due to cost was more frequent in lower than in higher socio-economic status groups, and that these inequalities not only increased during the great recession (2007/2008, 2011/2012) across European countries but differed according to public coverage in dental care [28].

The present findings indicated a reasonably stable oral health-related quality of life with ageing. Self-reported oral impacts across time were most common in socially disadvantaged groups, but did not differ according to educational level and employment status. Avoidance of dental appointment due to cost was strongly associated with impaired oral quality of life across time. However, in contrast to previous findings from national Swedish surveys, avoidance of dental appointment due to cost did not explain the social gradients in oral impacts investigated in the present cohort [19,20]. This suggests that the role of dental care services in oral health inequalities is equivocal, with some observing that it plays an important role but others observing that it has no effect at all [31].

Reported avoidance of dental appointment due to cost was less substantial in this Swedish cohort and was greater in younger than in older people. Independent of time and age variation, socially disadvantaged and unhealthy participants were most likely to report avoidance of dental appointment due to cost. Impaired oral health-related quality of life declined with increasing age and was strongly associated with socio-behavioral factors and unmet need for dental care due to cost. Social inequalities in avoidance of dental appointment and in oral impacts did not vary across time but

persisted into older ages despite the dental health care reforms implemented.

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## CONFLICTS OF INTEREST STATEMENT

No potential conflict of interest was reported by the authors.

## AUTHOR CONTRIBUTION

Anne Nordrehaug Åstrøm: had the idea to this article, wrote the article and conducted statistical analyses. Stein Atle Lie (statistician) guided the statistical analyses. Berit Mastrovito and Josefin Sannevik have both contributed intellectually to the content of the manuscript and have provided the data files.

## ORCID

Anne Nordrehaug Åstrøm  <https://orcid.org/0000-0002-2707-6115>

Stein Atle Lie  <https://orcid.org/0000-0003-4374-9276>

Berit Mastrovito  <https://orcid.org/0000-0003-3644-7069>

Josefin Sannevik  <https://orcid.org/0000-0003-4645-4625>

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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