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ORIGINAL ARTICLE



# Exploring the association of dental care utilization with oral impacts on daily performances (OIDP) – a prospective study of ageing people in Norway and Sweden

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**ABSTRACT**

**Objectives:** To explore the association of dental health care utilization with oral impacts on daily performances (OIDP) across time focusing ageing Norwegian and Swedish adults adjusting for predisposing, enabling, and need related-factors as defined by Andersen's model.

**Methods:** Data were based on Norwegian and Swedish 1942 birth-cohorts conducted in 2007 (age 65) and 2012 (age 70). In Norway, the response rates ranged from 54% to 58%. Corresponding figures in Sweden were from 72% to 73%. Self-administered questionnaires assessed OIDP, dental care utilization and predisposing, enabling and need related factors. Logistic regression with robust variance estimation was used to adjust for clustering in repeated data.

**Results:** Significant covariates of OIDP were satisfaction with dental services, dental care avoidance due to financial constraints, frightening experience with dental care during childhood and patient initiated dental visiting. Frequency and regularity of dental attendance were associated with OIDP in the Swedish cohort, only.

**Conclusions:** In spite of country differences in the public co-financing of dental care, dental care utilization indicators were associated with OIDP across time in both cohorts. Encouraging regular and dentist initiated visiting patterns and strengthening beliefs in keeping own teeth could be useful in attempts to reduce poor oral health related quality of life in ageing people.

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## Introduction

The percentage of older people is growing [1]. Worldwide, about 800 million people are 60 years and above, a figure that will be tripled by 2100 [1]. A reduction in tooth loss has occurred across time, and higher rates of ageing dentate people imply increasing demand for oral health care services [2–6]. As demand for dental health care grows, policy makers' treatment priorities and resource allocation for the dental health care sector as well as their decision about the appropriateness of dental care for ageing people becomes important.

In Norway and Sweden, dental health care services are divided into a public and a private sector [7]. The public dental service (PDS) is financed by taxes with the main principle that children and adolescents, institutionalised elderly and those who receive home nursing care, have the right to free dental care from the PDS [7,8]. In Norway, the private dental services for the general adult population, including non-institutionalized older people, are organized according to market mechanisms, with dental fees determined by supply and demand and with very limited private or public insurance arrangements [9]. In Sweden, the public national insurance is a substantial source of financing public and private dental care for all adults [7,10]. Regardless of the disparity in dental coverage between Norway and Sweden, studies from both countries have revealed a dental attendance rate of about 70% of the adult populations [11,12].

Gilbert et al. [13] characterized dental attendance as routine-, preventively oriented and non-routine-, problem-oriented. Preventively oriented routine dental attendance is motivated by a positive attitude towards avoidance of dental problems, whereas non-routine problem oriented attendance is characterized by visiting dentists episodically and only when symptoms indicate impairments [13]. Evidence suggests that people who attend episodically for dental problems are more likely to suffer from oral symptoms and tooth loss and less likely to have good oral health-related quality of life compared with those who attend routinely for dental check-ups, even after adjustment for confounding factors [14,15]. Routine dental attendance tends to be associated with better dentition status and oral health-related quality of life, most frequently so in higher income countries where availability of dental care services is the norm [16,17]. Using data from a prospective cohort study, Crocombe et al. [14] found that long-term post-childhood dental attendance

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patterns was associated with good clinical and self-perceived oral health in adulthood. According to Petersen and Nortov [18], Danish pensioners aged 67–70 years who received dental care improved their oral health-related quality of life and denture function after a period of three years. Also, not visiting a dentist for a routine dental check-up have shown to increase the probability of reporting bad oral health [19–21]. There are conflicting views, however, as to the oral health benefits of attending dental care [22]. Zini et al. [23] reported no association between dental care utilization and oral health-related quality of life. Studies conducted in the United Kingdom reported that annual attenders had higher dental caries experience and fewer sound untreated teeth than those who attended less often [24,25]. Baker [26] utilized Andersen's behavioural model to predict oral health-related quality of life among adults and found that less frequent dental attendance associated with better oral health-related quality of life after adjustment for predisposing, enabling and need related factors. She recognized a need for further theory based studies of longitudinal design focusing populations in countries with various structures of the dental health care services and various social policies. Little evidence is available as to whether dental attendance contributes similarly to oral health independent of the type of treatment sector and dental coverage provided. Most evidence on the association between dental attendance and oral health comes from cross-sectional studies. This study aimed to explore the association of dental health care utilization with oral impacts on daily performances (OIDP) across time focusing ageing Norwegian and Swedish adults and adjusting for predisposing, enabling, and need related factors as defined by Andersen's behavioural model.

## Materials and methods

### Study population

The present study is based on two cohorts of individuals born in 1942 in Norway and Sweden. Previous studies have described details of the Norwegian and Swedish 1942 cohorts [27,28] which have been tracked since 2007 (age 65) and 1992 (age 50), respectively. The present study utilizes data collected by self-administered questionnaires in 2007 and 2012. In Norway the response rates were 58.0% ($n = 4211$) and 54.5% ($n = 3733$) in 2007 and 2012. Of the participants who completed the 2007 survey, 2947 (70%) participated in 2012. In Sweden, the response rates were 73.1% ($n = 6078$) in 2007 and 72.2% ($n = 5697$) in 2012. Of the participants who completed the 2007 survey, 80% ($n = 4862$) participated in 2012. Ethical approvals were obtained from the Ethics Committee of the Norwegian Social Science Services (NSD), Regional Committees for Medical and Health Research Ethics (REK) and the Ethics Committee of Uppsala, Sweden.

### Measures

At each data collection similar questionnaires were used to ensure comparability of data. The dependent variable was assessed by the eight items "oral impacts on daily performances" (OIDP) frequency inventory [29].

> During the past six months, how often have problems with your mouth and teeth caused you any difficulty with: eating and enjoying food; speaking and pronouncing clearly: cleaning teeth; sleeping and relaxing; smiling and showing teeth without embarrassment; maintaining usual emotional state; enjoying contact with people and carrying out major work?

Each item was scored on a five-point Likert scale; (1) never affected, (2) less than once a month, (3) once or twice a month, (4) once or twice a week, (5) every/nearly every day. For the purpose of analysis, the items were dichotomized into (1) affected (including original categories 2–5) and (0) never affected (including original category 1). A sum frequency score, OIDP SC, was constructed from the eight dummy variables (0–8) and dichotomized into (0) no daily performance affected and (1) at least one daily performance affected. This dummy OIDP score is an established measure of the extent of oral impacts [29]. The OIDP frequency inventory has demonstrated satisfactory psychometric properties when applied to adult populations in Norway and Sweden [30,31].

Andersen's behavioural model, assuming that people's use of health care services is a function of predisposing enabling and need related factors, guided the selection and categorization of independent variables used in the analyses [32,33]. Within the terminology of this model, predisposing factors were identified as gender, marital status, education, social network (i.e. *how many persons do you communicate with during one week*) and beliefs in keeping teeth through the life span (i.e. *do you believe that you will keep your own teeth throughout life*). Enabling factors were assessed as type of dental health care utilized (*i.e. do you attend a private or a public dental clinic*), avoiding dental care due to costs (i.e. *have you ever avoided needed dental care due to financial problems),* satisfaction with dental services and frightening experience of dental care during childhood. Need-related factors were assessed by tooth loss reflecting need for dental care due to tooth extractions and replacement of missing teeth (*how many of your own teeth have you kept*). Indicators of dental care utilization were measured as frequency of dental visits, (i.e. *how often do you visit a dentist*), regularity of dental attendance (i.e. *do you visit your dentist on a regular basis*) and initiative taken to last dental visit (*i.e. who took the initiative for your last dental visit*). Table 1 presents exposure variables with original and transformed response categories.

### Statistical analyses

Data were analysed using STATA version 13.1 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX, USA: StataCorp LP). Inverse probability weighting (IPW) was used to account for missing responses and loss to follow-up [34]. The cohort participants were weighted by the inverse of their probability of being followed-up, estimating IPW by fitting a logistic regression model with variables that contributed to follow-up. Gender, education and having frightening experience with dental care during childhood

**Table 1.** Categories for predictor variables as originally coded and new codes after dichotomization.

| Variables [new codes] | Categories (original codes) | Dichotomization [new codes] |
|---|---|---|
| *Predisposing factors* | | |
| Gender | Male (1) | Female [0] |
| | Female (2) | Male [1] |
| Marital status | Married (1) | |
| | Unmarried (2) | Married (1) [0] |
| | Divorced (3) | Single (2,3,4) [1] |
| | Widowed (4) | |
| Education | Elementary school (1) | Higher education (4) [0] |
| | Lower school (2) | Lower education (1,2,3) [1] |
| | High school (3) | |
| | University (4) | |
| Social network | None (1) | Broad social network (6) [0] |
| | 1–2 person(s) (2) | |
| | 3–5 persons (3) | |
| | 6–10 persons (4) | |
| | 11–15 persons (5) | Narrow social network (1–5) [1] |
| | More than 15 (6) | |
| Belief of keeping teeth for life | Yes, absolutely (1) | No, I don't believe (3–5) [0] |
| | Yes, maybe (2) | Yes, I believe (1, 2) [1] |
| | Don't know (3) | |
| | No, unlikely (4) | |
| | No, absolutely not (5) | |
| *Enabling factors* | | |
| Frightening experience of dental care during childhood and adolescence | Yes, several times (1) | No (3) [0] |
| | Yes, sometimes (2) | Yes (1,2) [1] |
| | No (3) | (4) [sysmiss] |
| | Don't remember (4) | |
| Type of dental services | Private (1) | Public (2) [0] |
| | Public (2) | Private (1) [1] |
| | Didn't get treatment (3) | (3,4) [sysmiss] |
| | Other (4) | |
| Satisfaction with services | Very satisfied (1) | Satisfied (1,2) [0] |
| | Satisfied (2) | Dissatisfied (3,4) [1] |
| | Dissatisfied (3) | |
| | Very dissatisfied (4) | |
| Avoiding dental care due to cost | Yes, several times (1) | No (3) [0] |
| | Yes, sometimes (2) | Yes (1,2) [1] |
| | No (3) | |
| *Need related factors* | | |
| Tooth loss | All (28–32 teeth) (1) | |
| | Missing few teeth (2) | All or almost all teeth (1,2) [0] |
| | Missing quite few teeth (3) | Lost teeth (3,4,5) [1] |
| | Almost no teeth left (4) | |
| | Edentulous (5) | |
| *Use of dental services* | | |
| Frequency of dental attendance | Twice or more a year (1) | Once a year or more (1,2) [0] |
| | Once a year (2) | Less than once a year (3,4) [1] |
| | Every other year (3) | |
| | Less than every other year (4) | |
| Regularity of dental attendance | Yes (1) | Yes (1) [0] |
| | No (2) | No (2) [1] |
| Initiative of last visit | Patient or relatives (1) | Dentist (2) [0] |
| | Dentist (2) | Patient (1) [1] |
| | Don't remember (3) | (3) [sysmiss] |

constituted time-invariant variables, reflecting stable characteristics defined in childhood and early adult life. Marital status, social network, satisfaction with dental services and indicators of dental care utilization constituted time-variant variables or characteristics that change over time. Unadjusted bivariate analyses were performed with the intact cohorts (i.e. those who participated both in 2007 and 2012) in Norway ($n = 2947$) and Sweden ($n = 4862$). Cross-tabulation and chi-square statistics and Cochrane' Q tested bivariate relationships.

To account for the clustered structure of time-variant repeated measures, a marginal model was used taking into account the correlated observations by an empirical robust (sandwich-type) variance estimator [35]. Marginal models describe the average risk between the groups and provide population-averaged estimates. Initially, data were reshaped from wide to long format, with one row of data per occasion for each person and with time (survey year) as a fixed variable. The option "cluster (id)" was used for the correlated observations, yielding standard errors that are robust to the assumption of statistically independent observations. Multiple variable logistic regression model with robust estimation of the variances (sandwich estimators) was fitted separately for each country with odds ratios (OR) and 95% confidence interval (CI). Exposure variables were entered successively as predisposing (model 1), predisposing + enabling (model 2), predisposing + enabling + need related (model 3), predisposing + enabling + need related + indicators of dental care

utilization (model 4). Nagelkerke's $R^2$, a pseudo R square that generalizes the coefficient of determination having values between 0 and 1 where 0, was calculated for the final model.

## Results

Table 2 depicts the percentage distribution of exposure variables separately for each country in 2007 and 2012. In Norway, the prevalence of OIDP (OIDP >0) were 29.0% in 2007 and 28.4% (n.s.) in 2012. The corresponding figures in Sweden were 27.3% and 20.4% ($p < 0001$), respectively. In 2007, a majority of respondents in both countries believed that they could keep their teeth for life, amounting to 74.5% in Norway and 82.4% in Sweden. Corresponding figures in 2012 were 73.5% and 70.3%. In Norway, 86.9% and 88.2% of the respondents reported use of private dental services in 2007 and 2012. The corresponding figures in Sweden were 72.6% and 71.8%. Irregular dental attendance was stable across time in both countries whereas the frequency of attendance less than once a year varied from 14.5% to 12.2% in Norway and from 13.6% to 12.9% in Sweden. The proportions of participants who confirmed to be single, to have narrow social network and tooth loss were significantly larger in 2012 than in 2007 in both countries.

Table 3 depicts the percentage of participants confirming oral impacts (OIDP >0) according to predisposing, enabling, and need related factors and dental care utilization across survey years and countries. Cross-sectional bivariate analyses revealed that predisposing factors in terms of gender, marital status, and belief of keeping teeth for life, enabling and need – related factors and indicators of dental care utilization were significantly associated with OIDP across survey years and countries.

Findings from logistic regression analysis with robust variance estimator in terms of ORs and 95% confidence intervals (CI) are depicted in Table 4 (Swedish cohort) and Table 5 (Norwegian cohort). Nagelkerke's $R^2$ for the fully adjusted models amounted to 0.20 and 0.18, in Norway and Sweden,

**Table 2.** Characteristics of the predictor and outcome variables in 2007 and 2012, based on complete data ($n = 2947$ in Norway) ($n = 4862$ in Sweden).

| | Norway | | Sweden | |
|---|---|---|---|---|
| | 2007 % (*n*) | 2012 % (*n*) | 2007 % (*n*) | 2012 % (*n*) |
| Time-invariant | | | | |
| Gender | | | | |
| Female | 48.8 (1415) | | 51.2 (2489) | |
| Male | 51.2 (1486) | | 48.8 (2373) | |
| Education | | | | |
| Higher | 32.5 (770) | | 24.3 (1027) | |
| Lower | 67.5 (1601) | | 75.7 (3192) | |
| Frightening experience of dental care | | | | |
| No | 46.0 (1239) | | 32.3 (1470) | |
| Yes | 54.0 (1453) | | 67.7 (3076) | |
| Time-variant | | | | |
| Marital status | | | | |
| Married | 80.4 (2314) | 77.3 (2265)*** | 79.2 (3781) | 76.0 (3524)*** |
| Single | 19.6 (565) | 22.7 (667) | 20.8 (995) | 24.0 (1114) |
| Social network | | | | |
| Broad | 38.8 (1115) | 21.9 (635)*** | 39.8 (1880) | 25.6 (1185)*** |
| Narrow | 61.2 (1758) | 78.1 (2267) | 60.2 (2849) | 74.4 (3441) |
| Belief | | | | |
| No | 25.5 (725) | 26.5 (767) | 17.6 (837) | 29.7 (1410)*** |
| Yes | 74.5 (2120) | 73.5 (2122) | 82.4 (3925) | 70.3 (3332) |
| Type of dental services | | | | |
| Public | 13.1 (360) | 11.8 (324)* | 27.4 (1257) | 28.2 (1284) |
| Private | 86.9 (2392) | 88.2 (2429) | 72.6 (3334) | 71.8 (3265) |
| Satisfaction with services | | | | |
| Satisfied | 89.7 (2560) | 90.4 (2603) | 94.6 (4504) | 94.6 (4491) |
| Dissatisfied | 10.3 (294) | 9.6 (277) | 5.4 (257) | 5.4 (255) |
| Avoiding dental care due to cost | | | | |
| No | 90.3 (2601) | 91.4 (2651)* | 91.2 (4354) | 91.8 (4367) |
| Yes | 9.7 (280) | 8.6 (251) | 8.8 (422) | 8.2 (391) |
| Tooth loss | | | | |
| All or almost all teeth | 78.2 (2224) | 76.8 (2164)*** | 74.1 (3515) | 72.7 (3404)*** |
| Lost teeth | 21.8 (619) | 23.2 (655) | 25.9 (1230) | 27.3 (1276) |
| Frequency of dental attendance | | | | |
| One a year or more | 85.5 (2448) | 87.8 (2539)*** | 86.4 (4120) | 87.1 (4133) |
| Less than once a year | 14.5 (415) | 12.2 (354) | 13.6 (647) | 12.9 (610) |
| Regularity of dental attendance | | | | |
| Regular | 86.2 (2468) | 86.5 (2496) | 90.1 (4303) | 89.6 (4230) |
| Irregular | 13.8 (396) | 13.5 (388) | 9.9 (471) | 10.4 (489) |
| Initiative for last visit | | | | |
| Dentist | 64.4 (1830) | 63.8 (1830) | 71.1 (3372) | 75.4 (3521)*** |
| Patient | 35.6 (1014) | 36.2 (1036) | 28.9 (1368) | 24.6 (1418) |
| OIDP | | | | |
| OIDP = 0 | 71.0 (1975) | 71.6 (2002) | 72.7 (3375) | 79.6 (3654)*** |
| OIDP > 0 | 29.0 (806) | 28.4 (796) | 27.3 (1269) | 20.4 (935) |

Cochranes's Q-test: $^{*}p < .05$, $^{***}p < .001$.

**Table 3.** Percentage (*n*) OIDP (OIDP >0) by predisposing, enabling and need related factors and use of dental services in 2007 and 2012, based on complete data ($n = 2947$ in Norway) ($n = 4862$ in Sweden).

| | Norway | | Sweden | |
|---|---|---|---|---|
| | 2007 % (*n*) | 2012 % (*n*) | 2007 % (*n*) | 2012 % (*n*) |
| Gender | | | | |
| Female | 26.9 (356) | 25.2 (335) | 28.1 (664) | 20.2 (467) |
| Male | 30.9 (444)* | 31.5 (450)*** | 26.6 (605) | 20.6 (468) |
| Education | | | | |
| Higher | 27.4 (204) | 26.8 (199) | 29.4 (289) | 20.1 (200) |
| Lower | 29.8 (451) | 29.9 (452) | 26.2 (808) | 19.9 (600) |
| Marital status | | | | |
| Married | 28.5 (631) | 27.2 (589) | 25.3 (927) | 18.7 (635) |
| Single | 30.6 (160) | 32.4 (202)* | 34.7 (325)*** | 24.7 (260)*** |
| Social network | | | | |
| Broad | 25.5 (270) | 25.3 (154) | 24.7 (446) | 19.4 (222) |
| Narrow | 31.4 (526)** | 29.3 (631) | 29.0 (796)** | 20.4 (670) |
| Belief | | | | |
| No | 52.0 (349) | 56.6 (406) | 62.3 (488) | 38.5 (504) |
| Yes | 20.4 (416)*** | 18.1 (368)*** | 20.0 (762)*** | 12.8 (415)*** |
| Frightening experience of dental care during childhood/adolescence | | | | |
| No | 22.3 (264) | 22.0 (265) | 20.3 (288) | 14.5 (201) |
| Yes | 34.7 (480)*** | 33.7 (456)*** | 30.7 (911)*** | 23.2 (674)*** |
| Type of dental services | | | | |
| Public | 35.4 (122) | 33.6 (102) | 31.2 (378) | 25.2 (308) |
| Private | 26.3 (600)*** | 26.4 (614)** | 24.4 (786)*** | 16.9 (533)*** |
| Satisfaction with services | | | | |
| Satisfied | 25.9 (634) | 24.8 (620) | 25.0 (1088) | 18.1 (781) |
| Dissatisfied | 55.5 (152)*** | 59.5 (154)*** | 65.5 (156)*** | 60.9 (142)*** |
| Avoiding dental care due to cost | | | | |
| No | 25.7 (641) | 25.3 (645) | 24.4 (1029) | 17.7 (745) |
| Yes | 59.6 (152)*** | 63.2 (144)*** | 58.1 (230)*** | 50.6 (178)*** |
| Tooth loss | | | | |
| All or almost all teeth | 20.1 (428) | 18.3 (379) | 19.1 (654) | 12.7 (419) |
| Lost teeth | 61.6 (354)*** | 62.2 (385)*** | 51.8 (600)*** | 41.0 (494)*** |
| Frequency of dental attendance | | | | |
| One a year or more | 25.9 (606) | 25.2 (613) | 25.6 (1018) | 18.7 (745) |
| Less than once a year | 46.3 (182)*** | 51.8 (174)*** | 38.2 (237)*** | 30.5 (177)*** |
| Regularity of dental attendance | | | | |
| Regular | 25.1 (592) | 24.6 (589) | 24.5 (1021) | 18.1 (735) |
| Irregular | 53.0 (197)*** | 52.5 (193)*** | 52.1 (231)*** | 41.4 (192)*** |
| Initiative for last visit | | | | |
| Dentist | 22.2 (390) | 22.9 (405) | 21.3 (699) | 15.6 (533) |
| Patient | 39.8 (383)*** | 37.5 (370)*** | 42.4 (552)*** | 33.7 (366)*** |

Chi-square: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

**Table 4.** OIDP (OIDP >0) regressed on predisposing, enabling, need related factors and use of dental services in Sweden.

| | | Model 1 Adjusted OR (95% CI) | Model 2 Adjusted OR (95% CI) | Model 3 Adjusted OR (95% CI) | Model 4 Adjusted OR (95% CI) |
|---|---|---|---|---|---|
| Time | | 0.5 (0.4–0.5)*** | 0.5 (0.4–0.5)*** | 0.5 (0.4–0.6)*** | 0.5 (0.4–0.6)*** |
| *Predisposing factors* | | | | | |
| Gender | Male versus female | 1.0 (0.9–1.2) | 1.0 (0.9–1.1) | 1.0 (0.9–1.1) | 1.0 (0.9–1.2) |
| Marital status | Single versus married | 1.3 (1.1–1.5)*** | 1.1 (0.9–1.3) | 1.1 (0.9–1.3) | 1.1 (0.9–1.3) |
| Education | Lower versus higher | 0.7 (0.6–0.8)*** | 0.7 (0.6–0.8)*** | 0.6 (0.5–0.7)*** | 0.6 (0.5–0.8)*** |
| Social network | Narrow versus broad | 1.1 (0.9–1.3) | 1.0 (0.9–1.2) | 1.0 (0.9–1.2) | 1.0 (0.9–1.2) |
| Belief of keeping teeth for life | Yes versus no | 0.2 (0.1–0.2)*** | 0.2 (0.2–0.3)*** | 0.3 (0.3–0.4)*** | 0.3 (0.3–0.4)*** |
| *Enabling factors* | | | | | |
| Frightening experience of dental care | Yes versus no | | 1.6 (1.4–1.8)*** | 1.5 (1.3–1.8)*** | 1.6 (1.4–1.9)*** |
| Type of dental services | Private versus public | | 0.7 (0.6–0.9)*** | 0.8 (0.7–0.9)** | 0.8 (0.7–1.0)* |
| Satisfaction with services | Dissatisfied versus satisfied | | 3.7 (2.9–4.8)*** | 3.2 (2.5–4.2)*** | 2.9 (2.2–3.9)*** |
| Avoiding dental care due to cost | Yes versus no | | 2.7 (2.2–3.3)*** | 2.5 (2.0–3.1)*** | 2.4 (1.9–3.0)*** |
| Need related factors | | | | | |
| Tooth loss | Lost teeth versus all or almost all teeth | | | 2.6 (2.2–3.0)*** | 2.6 (2.3–3.1)*** |
| *Use of dental services* | | | | | |
| Frequency of dental attendance | Less than once a year versus once a year or more | | | | 0.6 (0.5–0.8)*** |
| Initiative of last visit | Patient versus dentist | | | | 2.0 (1.8–2.4)*** |
| Regularity of dental attendance | Irregular versus regular | | | | 1.3 (1.0–1.7)* |
| | | | | | $R^2 = 0.18$ |

Hierarchical logistic regression with robust variance estimation.
Adjusted for missing responses and loss to follow-up using inverse probability weighting (IPW).
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 5. OIDP (OIDP >0) regressed on predisposing, enabling, need related factors and use of dental services in Norway.

| | | Model 1 Adjusted OR (95% CI) | Model 2 Adjusted OR (95% CI) | Model 3 Adjusted OR (95% CI) | Model 4 Adjusted OR (95% CI) |
|---|---|---|---|---|---|
| Time | | 1.0 (0.9–1.1) | 1.0 (0.9–1.1) | 1.0 (0.9–1.2) | 1.0 (0.9–1.2) |
| *Predisposing factors* | | | | | |
| Gender | Male versus female | 1.2 (1.1–1.4)** | 1.2 (1.0–1.5)* | 1.2 (0.9–1.4) | 1.1 (0.9–1.4) |
| Marital status | Single versus married | 1.1 (0.9–1.3) | 1.0 (0.8–1.3) | 1.0 (0.8–1.2) | 1.0 (0.8–1.3) |
| Education | Lower versus higher | 0.9 (0.8–1.1) | 0.8 (0.7–0.9)** | 0.7 (0.5–0.8)*** | 0.7 (0.5–0.8)*** |
| Social network | Narrow versus broad | 1.2 (1.0–1.3) | 1.2 (1.0–1.4) | 1.1 (0.9–1.3) | 1.1 (0.9–1.3) |
| Belief of keeping teeth for life | Yes versus no | 0.2 (0.1–0.2)*** | 0.2 (0.2–0.3)*** | 0.4 (0.3–0.5)*** | 0.4 (0.3–0.5)*** |
| *Enabling factors* | | | | | |
| Frightening experience of dental care | Yes versus no | | 1.6 (1.4–1.9)*** | 1.5 (1.2–1.7)*** | 1.4 (1.2–1.7)*** |
| Type of dental services | Private versus public | | 0.9 (0.7–1.2) | 1.1 (0.8–1.4) | 1.1 (0.8–1.4) |
| Satisfaction with services | Dissatisfied versus satisfied | | 2.8 (2.1–3.5)*** | 2.6 (1.9–3.4)*** | 2.6 (1.9–3.4)*** |
| Avoiding dental care due to cost | Yes versus no | | 3.4 (2.5–4.4)*** | 3.3 (2.5–4.5)*** | 3.2 (2.4–4.3)*** |
| *Need related factors* | | | | | |
| Tooth loss | Lost teeth versus all or almost all teeth | | | 4.1 (3.3–5.1)*** | 4.3 (3.5–5.4)*** |
| *Use of dental services* | | | | | |
| Frequency of dental attendance | Less than once a year versus once a year or more | | | | 0.8 (0.6–1.1) |
| Initiative of last visit | Patient versus dentist | | | | 1.8(1.5–2.1)*** |
| Regularity of dental attendance | Irregular versus regular | | | | 0.9 (0.6–1.2) |
| | | | | | $R^2 = 0.20$ |

Hierarchical logistic regression with robust variance estimation.
Adjusted for missing responses and loss to follow-up using inverse probability weighting (IPW).
*$p < .05$, **$p < .01$, ***$p < .001$.

respectively. In the Swedish cohort (Table 4), predisposing factors entered in model 1 explained 11% of the variance in OIDP (Nagelkerke's $R^2 = 0.11$). Entering enabling, need related factors and indicators of dental care utilization in respectively, Models 2–4 improved Nagelkerke's $R^2$ to 0.18. In the fully adjusted model 4, the ORs for reporting oral impacts increased if being dissatisfied with dental care, reporting patient initiated dental visits, avoiding dental care due to financial constraints, being an irregular dental attendee, being frightened of dental care as a child- and decreased if using private dental care and visiting a dentist less than once a year. The ORs and 95% CIs were, 2.9 (2.2–3.9), 2.0 (1.8–2.4), 2.4 (1.9–3.0), 1.3 (1.0–1.7), 1.6 (1.4–1.9), 0.8 (0.7–1.0) and 0.6 (0.5–0.8), respectively. In the final model, marital status that was statistically significantly associated with OIDP in model 1 did not maintain its association in the fully adjusted model 4.

In the Norwegian cohort (Table 5), predisposing factors entered in model 1, explained 11% of the variance in OIDP (Nagelkerke's $R^2 = 0.11$). Entering enabling and need related factors and indicators of dental care utilization in models 2–4, improved Nagelkerke's $R^2$ to 0.20. In the fully adjusted model 4, the ORs for reporting oral impacts increased if reporting dissatisfaction with dental services, having a frightened dental care experience as a child, avoiding dental care due to financial constraints and reporting patient initiated dental visits. The ORs and 95% CI were 2.6 (1.9–3.4), 1.4 (1.2–1.7), 3.2 (2.4–4.3) and 1.8 (1.5–2.1). Frequency and regularity of dental attendance did not show statistical significance in the fully adjusted model 4. No statistically significant two-way interactions occurred between covariates defined by the conceptual model and time on the OIDP in either country, suggesting stability of the investigated associations across time.

## Discussion

In spite of the between country variation regarding financial support of dental health care services for older people, indicators of dental care utilization were independently and consistently associated with OIDP over a five-year survey period in both cohorts investigated and after adjustment for predisposing, enabling and need related factors. Lack of effect modification by time suggested stability of associations across the survey years. Also, the fit of Andersen's behavioural model was almost as good in Sweden as in Norway. Thus, in both cohorts, predisposing, enabling, need related factors and dental health care utilization contributed moderately to the explanation of impaired oral health-related quality of life among older adults. The present findings extend previous ones by demonstrating associations between oral impacts and indicators of dental care utilization among ageing people in the context of covariates defined by Andersen's model, using a prospective, cross-national perspective.

In the Swedish cohort but not in the Norwegian, oral impacts were more likely among those who reported irregular dental attendance and less likely among older people reporting infrequent dental visits. In accordance with Gilbert's [13] conceptualisation, this may suggest that irregular and frequent dental attendance reflect non-routine problem oriented utilization of dental care among older people in Sweden. The strength of the association of dental attendance with oral impacts, both regularity and frequency, seemed to

differ according to country variation in the public co-financing of dental care. These findings accord with previous studies demonstrating more oral health disadvantages of non-routine – problem oriented compared with routine preventively oriented dental attendance [13,14,19–21]. The inverse association between less frequent dental visiting and oral impacts over the follow-up period may reflect influence of decreased demand for dental care as a consequence of a satisfactory oral condition, whereas the positive association between attendance irregularity and oral impacts may reflect influence related to the appropriateness of dental care utilization [36]. It has been suggested that survey participants with oral problems would be more likely to be problem attenders, whereas those with a satisfactory oral condition would be more likely to perform preventively oriented visiting [14,21]. In both countries, older people who initiated dental visits themselves were more likely to experience oral impacts than those who responded to calls from the dentist. Self-initiating dental visits might reflect lack of value placed on oral health and absence of a particular dentist regularly visited, thus leading to problem oriented dental attendance. The findings that oral impacts were more likely among those who confirmed avoidance of dental care due to financial constraints as well as among those who had frightened experience as a child and less likely among those with beliefs of keeping teeth for life support the distinction between problem- and preventively oriented dental attendance. Nevertheless, the previous literature is contradictory in that some studies have confirmed a positive and others a negative association between regular dental attendance patterns and self-reported oral health [26]. Consistent with the present findings, Baker [26] found that better oral health-related quality of life associated with less frequent dental attendance in adults. A population based follow-up study of 45–54 year olds in Southern Australia revealed that worsening of self-reported oral health was less prevalent for those who received cleaning services, and more prevalent among those who received extraction and denture services [36].

The present study revealed little cross-national variation in the prevalence of dental care utilization, as well as in oral impacts of daily performance across the survey year. Consistent with the present finding, previous studies from both countries have shown a dental attendance rate of 70% and above in the adult populations [11,12]. The frequency of older adults reporting irregular dental attendance, dental attendance less than once a year as well as the frequency of those who refrained from dental care due to financial reasons remained stable over the follow-up period. However, whereas the frequency of oral impacts remained at 28% in the Norwegian cohort, the corresponding figure dropped from 27% in 2007 to 20% in 2012 in the Swedish cohort. The figures presented are broadly consistent with those of other studies investigating dental care utilization and self-reported oral health in the Norwegian and Swedish adult populations [12,37–39].

Socioeconomic inequality in oral impacts of daily performance was present in both cohorts across time and accords with previous findings in countries with various redistributive oral health policies. Crocombe et al. [40] observed a social gradient in oral health-related quality of life between military ranks even under equal and optimal access to dental care. In contrast, Schulz [41] reported significant interactions between country specific supply indicators and individual educational attainment on dental visiting behaviour whereby educational differences in dental care utilization varied across different levels of the country specific supply indicators. In the fully adjusted regression models (Tables 4 and 5), marital status turned non-significant, suggesting mediation or confounding by other variables in the model. A recent cross-sectional study of Swedish adults revealed that socio-economic differences in oral health were mediated through differences in the proportions who refrained from dental care due to financial reasons [37,42,43].

A number of potential limitations should be notified. Although encompassing many of the variables suggested by Andersen's model, the concepts of predisposing, enabling and need related factors are broadly defined, and overlap to some extent [32,33]. Thus, an unambiguous selection of variables into the various concepts is not always possible. However, variables used by previous studies applying Andersen's framework were utilized for this study [26,32]. Moreover, the complex interrelationships between the key variables in the model were analysed by the conventional statistical methods only. This requires further testing to identify bidirectional and mediated associations through structural equation modelling (SEM) analyses. There is a possibility that the validity of the relationship between dental care utilization and oral impacts was damaged by a healthy user effect or unintended selection bias for regular and frequent dental attendance. This implies that the participants followed in the Norwegian and Swedish cohorts were skewed towards those being most health concerned and not representative of the general population. Although non-responses in this study may have introduced selection bias in oral impacts, IPW attached to persons included in the analyses probably restored representation of those lost to follow-up and reinforced the validity of the study. A previous study of the Swedish cohort [16] revealed that routine dental attendance also associated inversely with major tooth loss. In this study, association between dental attendance indicators and oral impacts persisted after adjustment of the healthy user effect in terms of tooth loss.

## Conclusions

This study used Andersen's behavioural model as a tool to identify covariates of oral impacts in Norwegian and Swedish older adults using a repeated measure design across a five-year period. In spite of differences between Norway and Sweden regarding the public co-financing of dental care for older people, predisposing, enabling and need-related factors and indicators of dental care utilization were associated with oral impacts in both cohorts. In terms of implications for oral health policy, social and demographic characteristics are beyond the scope of health advocates. Instead, this paper indicates that encouraging regular and dentist initiated attendance habits as well as strengthening beliefs in keeping

teeth for life could be useful in attempts to reduce poor oral health-related quality of life in the Norwegian and Swedish older population.

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No potential conflict of interest was reported by the authors.

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