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ORIGINAL ARTICLE

Changes in oral health-related quality of life (OHRQoL) related to long-term utilization of dental care among older people

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ABSTRACT

Objective: To examine whether long-term utilization of dental care, treatment with fillings and crowns and persistent tooth loss between age 50 and 65 years associate with subsequent changes in OHRQoL from age 65 to 70 years.

Method: In 1992, a census of 50-year-olds received invitation to participate in a questionnaire survey. Of 6346 respondents, 3585 completed follow-ups in 1997, 2002, 2007 and 2012. OHRQoL was measured using the Oral Impacts on Daily Performances (OIDP) inventory.

Results: Around 70.4%, 11.2% and 18.4% confirmed respectively, no change, worsening, and improvement in OIDP scores between age 65 and 70 years. Compared to those being permanent non-routine dental attenders, ORs of improving and worsening of OIDP were respectively, 0.4 and 0.6 if being a permanent routine dental attender. ORs for improving OIDP was 1.6 if reporting persistent specialist attendance and 2.5 if having received crowns and fillings. Participants with permanent tooth loss were most likely to both worsen and improve OIDP.

Conclusion: Long-term routine dental attendance and permanent tooth loss occurred as predictors simultaneously for improvement and worsening of OIDP. Accumulation of advantages and disadvantages throughout the life-course increases and decreases the probability of improvement and worsening in OIDP among older people in Sweden.

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Introduction

Assessment of changes in oral health-related quality of life (OHRQoL), indicating individuals' perspective on the impact of oral diseases and treatments, is essential for planning and evaluation of the dental health care services [1]. Traditionally, changes in any self-reported measures of oral health has been investigated using cross-sectional study designs that provide information at given points in time but are limited when it comes to evidence of time-related changes [2]. A major caveat of cross-sectional studies is that causal inferences cannot be facilitated [2]. Sequential cross-sectional studies may misinterpret cohort differences as individual changes across time [3]. Longitudinal studies provide stronger evidence regarding the evaluation of oral health and the assessment of change in oral health status. Most longitudinal studies of changes in oral health have considered treatment effects, such as outcomes of dental implants and orthognatic surgery using a randomized control trial (CRT) study design [4,5]. For ethical reasons, the gold standard RCT is not feasible for all studies of change. So far, few prospective observational studies have focused on changes in OHRQoL and investigated covariates of such changes covering the middle-aged and older adult populations [6–12].

Population surveys have shown a pattern of better OHRQoL in older compared to younger adults [13,14]. Using the oral health impact profile (OHIP-14) and data from the most recent cross-sectional national surveys of adults in UK, Tsakos et al. [15] reported significant improvements in oral impacts across time. In contrast to younger cohorts, more than half of the explained improvement in the older cohorts related to increasing age. Evidence from longitudinal studies suggest that tooth loss, financial hardship and self-perceived need for dental treatment relate to improvement as well as to worsening in self-reported oral health [11,13]. Some previous studies investigating the influence of routine dental care on OHRQoL have reported on improvements among those receiving more dental care and that this improvements varied according to people's place of residence [8]. Locker and Jakovic [11] conducted a study over a 3-year period in the older Canadian population and found that people whose oral health had improved received more dental services than those whose oral health had deteriorated. Using a global oral health transition statement to measure change, Brennan et al. [9] observed that worsening of self-reported oral health over a 2-year period was associated with extractions and dentures but inversely associated with visiting and preventive care. Improvement in self-reported oral health was associated with

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preventive care and inversely associated with endodontic treatment. Crocombe et al. [16] reported similar findings based on data from the Dunedin Multidisciplinary Health and Development Study. Focusing methodological problems associated with measures of oral health change in a 2-year follow-up study of Australian adults, Slade [10] reported that high risk groups having difficulty to pay for dental care, showed twice the rate of deterioration in self-reported oral health compared with their corresponding low-risk groups but did also show higher rates of improvement. De Andrade et al. [12] reported on bidirectional change in self-perceived oral health among Brazilian older adults with deterioration predominating and with number of missing teeth and number of diseases being the strongest predictors of both improvements and deterioration in self perceived oral health, respectively.

In Sweden, the availability to oral health care services is good among non-institutionalized community-dwelling middle-aged and older people [17]. Although the traditional patient financial system for adults is fee for services, benefit schemes of a more universal nature is offered in addition to social security and welfare benefits by which particular groups have their dental care expenses refunded. The implementation of dental coverage systems through the public national insurance protect from high costs and support oral examinations and the provision of preventive services [18]. Thus, significant economic resources are devoted to the provision of oral health care services for the adult population in Sweden. To optimize competency, efficiency and quality, policy decisions regarding dental health care service for middle-aged and older adults should be assisted by an evidence base as to whether or not specific service provision and patterns of dental care utilization modify people's future oral health-related quality of life.

Considering the relevance of self-reported oral health for identification of needs, selecting therapies and monitoring patient progress, too few investigators have assessed changes in OHRQoL and examined the relative contribution to such changes from long-term patterns of dental care utilization and treatment provision using a prospective cohort design. The cumulative life-course model assumes that advantages and disadvantages accumulate gradually over the life course, increasing and decreasing the probability of good oral health [19,20]. Accordingly, this study examined whether long-term utilization of dental care, treatment with fillings and crowns and persistent tooth loss between age 50 and 65 years associate with subsequent changes in OHRQoL between age 65 and 70 years.

Material and methods

This study used five consecutive data collections generated by a cohort study of people born in 1942. Details of the survey and the recruitment procedures have been published elsewhere [21]. Data collections were conducted when the participants were 50 years and again 5, 10, 15 and 20 years later. In 1992, (baseline at age 50 years), a census sample of those born in 1942 (both in Sweden and abroad) and who were currently residents in two selected counties of Sweden were invited to participate in a prospective mail administered questionnaire survey. Of the total population of 8888 people, 6346 (71.4%) participated. In 1997 (at age 55 years), 2002 (at age 60 years), 2007 (at age 65 years) and 2012 (at age 70 years), the corresponding cross-sectional participation rates (defined as the number of respondents divided with the number of eligible participants) were 74.3% (6513/8764), 75.0% (6372/8500), 73.1% (6078/8313) and 72.2% (5697/7889). Of the 6346 participants who completed the 1992 survey, 3585 participated in all five surveys, leaving 2761 drop-outs at the postal follow-ups providing a longitudinal response rate of 56.5% (3585/6346). Ethical considerations in accordance with the Declaration of Helsinki was obtained throughout the series of studies. Relevant ethical committees granted acceptance in 1992 followed with regular new acceptances.

Independent variables (1992–2007)

Similar questionnaires were used at each data collection time point for comparability. Socio-demographics were assessed in terms of marital status, sex, country of birth and smoking status in 1992. Routine dental attendance were constructed based on two questions assessed in 1992 (age 50 years) and 2007 (age 65 years). *When was your last dental visit?* Response categories were (1) <1 year ago, (2) 1–3 years ago, (3) 3–5 years ago, and (4) >5 years ago. *Who took the initiative to your last dental visit?* With response categories (1) myself because of pain, (2) my dentist based upon my decision to have regular dental check- ups, and (3) I do not remember. At each time point *routine dental attendance* were coded (1) for those who attended less than one year ago and in response to personal decision for regular check-up and (0) for those who attended more seldom than within the last year and in response to dental problems and pain. *Long-term routine dental attendance* combined the categories of routine dental attendance in 1992 and 2007 into (0) non-routine attendance in 1992 and 2007, (1) routine dental attendance in 1992 and non-routine dental attendance in 2007, (2) non-routine dental attendance in 1992 and routine dental attendance in 2007, (3) routine dental attendance in 1992 and 2007. *Long-term attendance at specialist dental care* was constructed by a sum score of two dummy variables in 1992 and 2007 and coded (0) no specialist care attendance in 1992 and 2007, (1) specialist care attendance either in 1992 or in 2007 and (2) specialist attendance both 1992 and 2007. At each time point, specialist attendance was measured by asking 'have you attended a specialist within the last year?' With response categories (1) yes and (2) no. *Treatment with fillings and crowns due to perceived problems* was assessed by a sum score of two dummy variables which were coded (1) yes and (2) no in 1992 and 2007. The sum score was coded (0) not received crowns and fillings in 1992 and 2007, (1) received crowns and fillings once either in 1992 or 2007, (3) received crowns and fillings both in 1992 and 2007. *Persistent tooth loss* was assessed by a sum score of dentition status assessed in 1992 and 2007 and coded (0) not persistent tooth loss and (1) persistent tooth loss. At each survey year

tooth loss was assessed by asking 'how many of your own teeth do you still have?' Having the categories (1) all teeth (28–32 teeth), (2) missing a few teeth, (3) missing many teeth (4) have almost no teeth and (5) edentulous. This variable was dichotomized into (0) having all or almost all teeth (including the original categories 1) and (1) lost at least some teeth (including the original categories 2,3,4,5).

Dependent variable (2007–2012)

Oral health-related quality of life was assessed at age 65 and 70 years by the eight items oral impact on daily performances (OIDP) frequency inventory [22]. 'During the past 6 months how often have problems with your mouth and teeth caused you any difficulty with: (1) eating and enjoying food, (2) speaking and pronouncing clearly, (3) cleaning teeth, (4) sleeping and relaxing, (5) smiling and showing teeth without embarrassment, (6) maintaining usual emotional state, (7) enjoying contact with people and (8) carrying out major daily 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, AND (5) every/nearly every day and dichotomized into (1) affected (including the original response categories 2–5) and (0) never affected including the original category 1). A sum frequency score was constructed in 2007 and 2012 from the eight dummy variables (range 0–8) and dichotomized into (0) no daily performance affected and (1) affected on at least one daily performance. The OIDP frequency inventory has demonstrated satisfactory cross-sectional as well as longitudinal psychometric properties when applied in older populations of different ages in Sweden [6,23].

To quantify changes in OIDP scores between 2007 and 2012, net change scores were defined as the number of impacts (OIDP sum score) reported at baseline in 2007 minus the number of impacts (OIDP sum score) reported at follow-up in 2012. A negative change score indicated worsening (increments) and a positive change score indicated improvements (decrement). A zero change score indicated no change in OIDP score. The change OIDP score was categorized into (1) worsening (including change scores in the range −8 to −1), (2) no change (including change scores 0), and to (3) improvement (including change score 1–8).

Statistical analysis

Data were analyzed using the statistical package of SPSS (IBM, New York, NY) version 20.0 and STATA version 13.1 (STATA, College Station, TX). All analyses included individuals participating at each survey year. Inverse probability weighting accounted for missing responses and loss to follow-up. Descriptive statistics were performed with frequency distributions, means and standard deviations (SD). Cochrane's Q for repeated measures was used to calculate the difference in prevalence of oral impacts in 2007 and 2012. Unadjusted bivariate associations of worsened and improved oral impacts by socio-demographics, long-term dental attendance, long-term specialist attendance, treatment with fillings and crowns and persistent tooth loss was tested using Chi-square statistics. Multiple variable logistic regression was conducted with odds ratios (OR) and 95% confidence interval (CI) using worsened and improved oral impacts as outcome variables. Two-way interactions between independent variables upon worsened and improved oral impacts were tested for statistical significance. General linear model (GLM) repeated measure analyses were conducted with OIDP as within subject factor (time) and long-term dental attendance, long-term specialist attendance, treatment with fillings and crowns and persistent tooth loss as between subject factors. Between group differences in OIDP change scores were tested using *post hoc* Bonferroni multiple comparison test, whereas within group changes in OIDP from 2007 to 2012 was tested using paired *t*-test.

Results

A total of 3585 (47.6% men) individuals participated in 1992, 1997, 2002, 2007 and 2012. Comparison of baseline (1992) characteristics between those who were followed-up across 20 years and those who dropped out revealed that 47.3% of the 2761 drop-outs and 52.4% of the 3585 cohort participants were women ($p < .001$). Drop-outs were more likely to be of non-native Swedish origin, dissatisfied with oral health, be of single civil status (not married) and unemployed in 1992 ($p < .001$) (not shown in tables). Table 1 depicts the frequency distributions, means and standard deviations of the OIDP sum scores in 2007 and 2012 and the frequency distribution of the OIDP change scores. Mean OIDP scores in 2007 and 2012 were 0.7 (SD 1.5) and 0.5 (SD 1.3), respectively. The proportions of subjects who either improved or declined were quite similar in size and the mean change OIDP score (arithmetic difference between 2007 and 2012) was small, amounting to 0.2 (SD 1.3, range −8, 8). Totals of 11.2%, 70.4% and 18.4% confirmed respectively, worsening, stability and improvement in OIDP. Of those with OIDP > 0 in 2007, 52.7% were without impacts in 2012. Of those with OIDP = 0 in 2007, 10.2% reported at least one impact in 2012. Totals of 66.8% and 12.1% had respectively, OIDP = 0 and OIDP > 0

Table 1. Distribution of OIDP sum score ratings in 2007 and 2012 and change scores in OIDP across 2007 and 2012 ($n = 3585$).

OIDP scores	2007, % (*n*)	2012, % (*n*)	Change OIDP scores	2007–2012, % (*n*)
0	73.7 (2538)	80.0 (2731)	−8	0.0 (1)
1	10.5 (361)	9.8 (333)	−7	0.2 (6)
2	5.4 (186)	4.1 (140)	−6	0.1 (4)
3	4.0 (139)	1.9 (66)	−5	0.3 (10)
4	2.3 (78)	1.4 (49)	−4	0.8 (26)
5	1.8 (63)	1.0 (33)	−3	1.9 (31)
6	1.0 (34)	0.5 (18)	−2	2.1 (69)
7	0.5 (18)	0.7 (23)	−1	6.7 (221)
8	0.8 (27)	0.6 (20)	0	70.4 (2319)
Mean (SD)	0.7 (1.4)	0.5 (1.3)	1	7.9 (260)
			2	4.8 (158)
			3	2.9 (96)
			4	1.4 (46)
			5	0.7 (24)
			6	0.2 (6)
			7	0.2 (8)
			8	0.2 (7)
			Mean change (SD)	0.2 (1.3)

Table 2. Descriptive data on independent variables in 1992 and 2007 and of OIDP change from 2007 to 2012 ($n = 3585$).

Variables	Total, % (*n*)
Independents 92	
Sex	
Men	47.6 (1707)
Women	52.4 (1878)
Marital status	
Married	84.6 (3029)
Single	15.4 (550)
Country of birth	
Native	95.3 (3409)
Foreign	4.7 (170)
Smoking	
Yes	26.9 (960)
Not	73.1 (2606)
Independents 92-07	
Routine dental attendance	
No routine 92 & 07	13.3 (464)
Routine 92 & no routine 07	21.5 (752)
No routine 92 & routine 07	16.9 (592)
Routine 92 & 07	48.3 (1689)
Specialist care	
No specialist care 92 & 07	61.5 (2153)
Specialist care once 92 or 07	16.4 (575)
Specialist care twice 92 & 07	22.0 (771)
Crowns and fillings	
No crowns and fillings 92 & 07	83.2 (2903)
Crowns and fillings once	15.1 (528)
Crowns and fillings 92 & 07	1.6 (57)
Tooth loss	
No persistent tooth loss	28.6 (987)
Persistent tooth loss	71.4 (2467)
Dependent 07–12	
OIDP 07-12	
OIDP improved	18.4 (605)
OIDP stable	70.4 (2319)
OIDP worsened	11.2 (368)

both in 2007 and 2012. Cochrane's Q revealed that a significantly lower proportion of the cohort participants had oral impacts (OIDP > 0) in 2012 than in 2007 (20.0 versus 26.3%, $p < .001$) (not shown in tables).

Table 2 depicts the frequency distribution of social characteristics at baseline in 1992, transition scores of long-term dental attendance patterns, long-term specialist attendance, treatment with fillings and crowns and persistent tooth loss between 1992 and 2007 and the frequency distribution of change scores in OIDP between 2007 and 2012.

As shown in Table 3, few of the socio-demographic variables (assessed in 1992) were associated with improvement and worsening of OIDP. The proportions of participants who reported OIDP worsening were smaller among those who were long-term routine dental attenders (routine in 92 and 07) compared with those who were long-term non-routine dental attenders (non-routine in 92 and 07). A similar distribution occurred with respect to improvement in OIDP. Both improvements and worsening in OIDP were largest among participants who reported specialist attendance both in 1992 and 2007, who received fillings and crowns in 1992 and 2007 as well as among those who reported persistent tooth loss.

Socio-demographic variables that were statistically significantly associated with the outcome and main independent variables or associated with either outcome or independent variables in unadjusted analysis were included as covariates in the multiple logistic regression to adjust for confounding (Table 3). Compared to those remaining as a permanent non-routine dental attenders, the ORs of worsening OIDP were 0.6 (95% CI 0.4–0.9) if changing from non-routine in 1992 to routine dental attendance in 2007, and 0.6 (95% CI 0.4–0.8) if remaining a permanent routine dental attender in both survey years (Table 3). Compared to those remaining as non-routine dental attenders, improvement of OIDP was less likely if changing from non-routine in 1992 to routine in 2007, and less likely if remaining as a routine dental attender. The ORs for improving OIDP were 1.6 (95% CI 1.3–2.1) and 1.6 (95% CI 1.2–2.0) if respectively, having attended a specialist either in 1992 or 2007 and both in 1992 and 2007 compared to not having attended specialist care either year. The ORs of improving OIDP were 1.8 (95% CI 1.4–2.3) and 2.5 (95% CI 1.3–4.7) if respectively, having received crowns and fillings either in 1992 or 2007 and both in 1992 and 2007 compared to not having received crowns and fillings either year. Improvement as well as worsening in OIDP were most likely among those with persistent tooth loss, compared with those without persistent tooth loss in 1992 and 2007. A statistically significant interaction occurred between persistent tooth loss and treatment with fillings and crowns on improvement in OIDP, and between country of birth and specialist attendance upon OIDP improvement. For those with persistent tooth loss, stratified analysis revealed that compared to not having received crowns and fillings in either survey year, OR of improvement, if having received crowns and fillings both in 1992 and 2007, was 2.6 (95% CI 1.4–5.0). The corresponding association among those without persistent tooth loss was not statistically significant. A positive association between improvement in OIDP and long-term specialist attendance was statistically significant, but only among participants of native Swedish origin OR 1.9 (95% CI 1.5–2.3).

Table 4 depicts the mean OIDP scores at each survey year by long-term routine dental attendance, long-term specialist attendance, treatment with fillings and crowns and persistent tooth loss. Paired *t*-tests revealed that within group changes in OIDP from 2007 to 2012 were significant across all between group variables ($p < .001$). Decline in mean OIDP scores from 2007 to 2012 occurred within each category of routine dental attendance, specialist attendance, treatment with fillings and crowns and persistent tooth loss. According to GLM-repeated measures, statistically significant two-way interactions occurred between change scores of OIDP and routine dental attendance (Wilks' $\lambda = 0.994$, $p < .001$), treatment with fillings and crowns (Wilks' $\lambda = 0.998$, $p < .05$) and persistent tooth loss (Wilks' $\lambda = 0.986$, $p < .001$). *Post hoc* Bonferroni analyses revealed that within group change in OIDP (declined mean scores) was significantly more extensive among permanent non-routine dental attenders (group a) than among those who shifted from non-routine to routine (group c) and were permanent routine dental attenders (group d). Moreover, change in OIDP was significantly more extensive in (group b) compared to (group c) and more extensive in (group c) compared to (group d) (Table 4). Within group change in OIDP was significantly more extensive in those who had not received crowns and fillings (group e) compared to those who had received crowns and

Table 3. Unadjusted and adjusted association of worsening and improving of oral impacts 2007–2012 (arithmetic difference scores) by socio-behavioral factors in 1992 and patterns of dental care between 1992 and 2007. Total cohort $n = 3585$.

	Unadjusted worsened OIDP 2007–2012, % (*n*)	Unadjusted improved OIDP 2007–2012, % (*n*)	Adjusted worsened OR (95% CI)	Adjusted improved OR (95% CI)
All persons socio-demographic status 92				
Males	11.7 (186)	17.7 (281)	1	1
Females	10.7 (182)	19.1 (324)	0.9 (0.7–1.1)	1.1 (0.9–1.3)
Native	11 (344)	18.2 (570)	1	1
Foreign	16.3 (24)*	23.8 (35)	1.5 (0.9–2.6.)	1.0 (0.9–1.6)
Married	10.6 (297)	17.3 (483)	1	1
Not married	14.3 (71)*	24.4 (121)**	1.3 (0.9–1.8)	1.5 (1.2–2.0)
Smoker	12.3 (107)	22.8 (198)	1	1
Not smoker	10.7 (257)	16.9 (406)**	0.9 (0.7–1.1)	0.7 (0.6–0.9)
Dentist attendance pattern				
Non-routine 92 & 07	16.8 (70)	28.1 (117)	1	1
Routine 92/non-routine 07	12.8 (88)	25.7 (177)	0.7 (0.5–1.1)	0.9 (0.7–1.2)
Non-routine 92/routine 07	9.3 (51)	15.9 (87)	0.6 (0.4–0.9)	0.5 (0.4–0.7)
Routine 92 & 07	9.5 (150)**	13.6 (215)**	0.6 (0.4–0.8)	0.4 (0.3–0.6)
Specialist care				
No specialist care 92 & 07	9.6 (191)	14.8 (295)	1	1
Specialist 92 or 07	13.2 (70)	23.0 (122)	1.2 (0.9–17)	1.6 (1.3–2.1)
Specialist care 92 & 07	13.6 (96)*	24.1 (170)**	1.4 (1.1–1.8)	1.6 (1.2–2.0)
Due to problem crowns and fillings				
No crowns and fillings 92 & 07	10.3 (278)	16.1 (435)	1	1
Crowns/fillings 92 or 07	15.5 (73)	28.0 (132)	1.4 (1.1–1.9)	1.8 (1.4–2.3)
Crowns and fillings 92 & 07	19.2 (10)**	34.6 (18)**	1.6 (0.7–3.7)	2.5 (1.3–4.7)
Tooth loss				
No tooth loss 92 & 07	6.8 (63)	12.1 (112)	1	1
Tooth loss 92 & 07	13.0 (295)**	20.9 (474)**	1.7 (1.3–3.2)	1.7 (1.3–2.1)

*$p < .05$.
**$p < .001$.

Table 4. Mean change OIDP scores and mean OIDP in 2007 and 2012 by long-term dental attendance, long-term specialist attendance, reception of crowns and fillings, and persistent tooth loss in 1992 and 2007. GLM repeated measures. Total cohort $n = 3585$.

	Non routine 92 & 07[a] M (SD)	Routine 92/non-routine 07[b] M (SD)	Non-routine 92/routine 07[c] M (SD)	Routine 92 & 07[d] M (SD)	Factor × group* *p* value
Dentist attendance					
Change OIDP	0.4 (1.8)	0.4 (1.6)	0.1 (1.1)	0.09 (1.1)	
OIDP 07	1.2 (1.9)	1.0 (1.7)	0.5 (1.2)	0.4 (1.2)	
OIDP 12	0.8 (1.8)	0.6 (1.4)	0.3 (1.0)	0.3 (1.0)	.001
07 versus 12	$p = .001$	$p = .001$	$p = .010$	$p = .001$	
Specialist attendance care	No specialist care 92 & 07	Specialist care 92 or 07	Specialist care 92 & 07		
Change OIDP	0.2 (1.2)	0.3 (1.4)	0.3 (1.5)		
OIDP 07	0.5 (1.3)	0.7 (1.4)	0.9 (1.7)		
OIDP 12	0.3 (1.1)	0.5 (1.3)	0.6 (1.5)		
07 versus 12	0.15 (1.2) $p = .001$	0.25 (1.4) $p = .001$)	0.26 (1.5) $p = 0.001$		.102
Due to problem crowns and fillings	No fillings 92 & 07[e]	Fillings 92 or 07[f]	Fillings 92 & 07[g]		
Change OIDP	0.2 (1.2)	0.3 (1.7)	0.6 (1.9)		
OIDP 07	0.5 (1.3)	1.0 (1.7)	1.7 (2.3)		
OIDP 12	0.3 (1.2)	0.8 (1.6)	1.1 (1.6)		.019
07 versus 12	$p = .001$	$p = .001$	$p = .027$		
Tooth loss	No tooth loss 92 & 07	Tooth loss 92 & 07			
Change OIDP	0.1 (0.9)	0.2 (1.5)			
OIDP 07	0.3 (0.8)	0.7 (1.6)			
OIDP 12	0.2 (0.7)	0.5 (1.4)			.040
07 versus 12	$p = .001$	$P = .001$			

*GLM repeated measure adjusted for civil status, smoking and gender.
Post hoc Bonferroni for long-term routine dental attendance: a versus c, a versus d, b versus c, b versus d, c versus d, $p < .05$.
Post hoc Bonferroni for specialist attendance $p > .05$.
Post hoc Bonferroni for treatment with crowns and fillings: e versus f, f versus g, e versus g, $p < .05$.

fillings, either in 1992 or 2007 (group f) and both in 1992 and 2007 (group g).

Discussion

Observational, prospective studies investigating changes in OHRQoL is virtually very few. Following a Swedish cohort throughout middle and early older ages, this study confirmed disparities in changes of oral impacts between age 65 and 70 years by long-term routine dental attendance, long-term specialist attendance, treatments with fillings and crowns received and persistent tooth loss reported at age 50 and 65 years. Consistent with the cumulative life-course model, this study confirmed independent associations between changes in OIDP and long-term dental attendance (less likely to worsen), long-term specialist attendance (more likely to

improve), treatment with fillings and crowns (more likely to improve) and persistent tooth loss (more likely to worsen) [19,20]. Those having attended a specialist, received crowns and fillings and experienced tooth loss both in 1992 and 2007, were about two times more likely respectively to improve and worsen their subsequent OIDP scores compared with their counterparts in the corresponding higher and lower risk groups. Stratified analyses revealed that subsequent improvement in OIDP associated with persistent treatment with crowns and fillings only among those who reported persistent tooth loss. GLM repeated measure analyses showed consistency with some of the major trends in the logistic regression models in that the decline in mean OIDP scores (improvement) was larger among those who reported persistent treatment with crowns and fillings, long-term specialist attendance and permanent tooth loss compared with those who did not.

This study suggests moderate amounts of change in oral impacts across a 5-year survey period with about 70% of the participants reporting the same origin and destination states and with 11% and 18% reporting respectively, worsening and improvement in OIDP. A direct comparison between the present study and previous ones should be done with caution as observed divergences may be attributed to differences in change- and outcome measures as well as to variations in population characteristics. It has been suggested that changes in oral impacts may be underestimated whilst using global transition measures as compared to change scores based on repeated measures across time [24]. Nevertheless, the present study using change OIDP scores revealed smaller proportions of participants reporting improvements and worsening in oral impacts compared with other studies [10,12,24]. Dolan et al. [24] revealed that 37.0% and 24.0% of community-dwelling older people aged 75% years and above, respectively worsened and improved their self-reported oral health across a 3-year period. The corresponding prevalence rates among Brazilian elderly were 48.5% and 33.4% (12). Using a global transition item, Locker and Jakovic [11], reported 20% worsening and 10% improvement in self-perceived oral health among older Canadians. A smaller proportion of participants reporting deterioration than improvement in oral impacts by increasing age, as observed by the present study, accords with studies that consistently have revealed better subjective oral health in older compared to younger- and middle-aged adults [13].

Regarding the observed disparities in the trend of OIDP change, the present findings accord with those of other population-based studies. Atchinson and Gift [25], for instance, found that reception of dentures represented improvement in oral health among people who experienced repeated tooth problems. In this study, persistent treatment with fillings and crowns represented improvements in OIDP among individuals with persistent tooth loss. Using data from the Australian National Survey of Adult Oral Health 2004–2006, Crocombe [8] reported a positive association between a greater volume of dental treatment received and improvement in self-reported oral health. Although participants with persistent tooth loss were more likely to experience worsening in OIDP [26], they were also more likely to experience subsequent improvement. Thus, participants with persistent tooth loss were both getting worse and getting better at greater rates than their counterparts without persistent tooth loss. Similar findings have been reported among older people in Brazil [12]. The present finding of bidirectional change in OIDP is also consistent with cross-sectional studies whereby a higher number of teeth associated positively with both self-reported poor- and satisfactory oral health [27]. Slade [10] assessed change in the OHIP scores and found that three high-risk groups were more likely than their corresponding low risk counterparts to experience deterioration as well as improvement across time. One might speculate that for some people tooth loss might lead to pain relief and improved oral health, whereas others experience chewing-, social- and esthetic problems. Moreover, tooth loss may have contrasting effects within individuals providing improvements in some aspects of oral health but worsening in others.

Similarly, long-term routine dental- and specialist attendance showed contrasting effect on subsequent change in OIDP (Table 3). Thus, long-term routine attenders were less likely than non-routine attenders to report improvement as well as worsening in subsequent oral impacts, whereas long-term specialist attendance were more likely than non-long terms specialist attenders to report worsening as well as improvement in subsequent oral impacts. This contrasting effect might be attributed to the particular types of treatment provided during dental visiting. Brennan et al. [9] reported that worsening in self-reported oral health was less prevalent for those who received cleaning services during dental visiting but more prevalent among those who received extraction and dentures.

A number of methodological concerns may explain the phenomena of simultaneously improvement and deterioration in OIDP scores [10,28]. One methodological concern that might create spurious interpretations of the associations between risk groups and change scores of OIDP is the well-known regression towards the mean whereby participants with extreme scores at baseline tend to have scores closer to the population mean at follow-up [29]. In this study, within-subject variation was accounted for in the GLM repeated measure models. Moreover, calculation of OIDP change scores introduced limitations in the measurement of change because subjects with zero ratings could not improve and likewise those who had top OIDP score could not worsen at a subsequent interval. Thus, a large floor effect in the OIDP measure (high prevalence having no impacts) may have limited its sensitivity to change towards improvement [30]. Evidence suggest that routine dental attenders tend to have better oral impact scores than their non-routine attending counterparts [31]. As depicted in Table 4, baseline scores (2007) of OIDP were lowest among long-term routine dental attenders, and thus they may have less potential than their non-routine long-term dental attending counterparts for further decline or improvement. Although the literature has raised doubt about the use of difference scores to assess health change, researchers maintain that unreliability of difference scores does not rule out their use in data analysis [28].

One important strength of this study is the use of a prospective cohort design following subjects throughout middle- and early older ages. A cohort design is recognized to be the most relevant study design when measuring population changes in oral health. A second strength is the recommended use of different quantitative methods to measure change in OIDP providing consistent findings [1]. Due to selection bias with responders and non-responders being different on variables that were associated with OIDP, external validity of the results might be questionable and the improvement in OIDP observed between 2007 and 2012 could be an underestimate of what actually happened in the total sample. Moreover, only four predictors of change in OIDP scores were included in this study so the present analysis do not cover all factors that may influence change. A limitation is the lack of clinically assessed oral health measures and the fact that although socio-demographic factors were adjusted for in multiple logistic regression models, the possibility that rest confounding have biased the observed associations cannot be excluded. An alternative analytical approach to the present one would be to use all data at all measurement points for explanatory and outcome variables in a repeated measure design. However, this would not provide information about changes in OIDP.

In conclusion, this article has demonstrated that OIDP improved and worsened by increasing age in a Swedish cohort of older people. Consistent with the cumulative life course model, the present findings support the view that long-term routine dental attendance, long-term specialist attendance and persistent treatment with fillings and crowns associate with respectively, reduced possibility of worsening and increased possibility of subsequent improvement in OIDP scores. Long-term dental attendance and persistent tooth loss showed a bi-directional association, as they occurred to be predictors simultaneously of improvement and worsening of OIDP among older Swedish people.

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Disclosure statement

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