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Variation in subjective oral health indicators of 65-year-olds in Norway and Sweden

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Abstract

Objective. Guided by the conceptual framework of Gilbert and co-workers, this study assesses satisfaction with oral health as reported by 65-year-olds in Sweden and Norway, the relationship of socio-demographic factors, clinical and subjective oral health indicators with satisfaction of oral health, and the consistency of those relationships across countries. ***Material and methods.*** In 2007, standardized questionnaires were mailed to all the residents in two counties in Sweden and three in Norway who were born in 1942. Response rates were 73.1% ($n=6078$) in Sweden and 56.0% ($n=4062$) in Norway. ***Results.*** Totals of 76.8% of the Swedish and 76.5% of the Norwegian participants reported satisfaction with oral health. Corresponding figures for toothache were 48.1% (Sweden) versus 51.5% (Norway), and for temporomandibular joint symptoms, 10.9% (Sweden) versus 15.1% (Norway). Multiple logistic regression analysis revealed that subjects who perceived they had bad health, smoked daily, had missing teeth, experienced toothache, had problems with chewing, bad breath, and oral impacts were less likely than their counterparts in the opposite groups to be satisfied with their oral health status. The corresponding odds ratios (ORs) ranged from 0.08 (problems chewing) to 0.2 (oral impact). No statistically significant two-way interactions occurred and the model explained 46% of the variance in satisfaction with oral health across the two countries (45% in Sweden and 47% in Norway). ***Conclusions.*** The oral condition of 65-year-olds in Norway and Sweden produced impacts in oral symptoms, functional limitations, and problems with daily activities that varied to some extent. Satisfaction with oral health varied by socio-demographic factors and subjective oral health indicators. A full understanding of the oral health and treatment needs of 65-year-olds cannot be captured by clinical measures alone.

Key Words: *Elderly, questionnaires, satisfaction with oral health, socio-demographic factors, two countries*

Introduction

In response to concerns that clinical measures might not be adequate for assessing the oral health of the public, researchers have started to include indicators that address the social and psychological consequences or impacts of oral disorders. Those measures complement conventional clinical measures, while monitoring the oral health situation within and between populations [1–5]. Measures of the impact of oral conditions are concerned with an individual's experience and behavior with respect to disease and illness and might be referred to as subjective oral health indicators [6]. Over the years, several subjective oral health indicators have been developed, ranging from single-item global oral health indicators (e.g. satisfaction with oral health) to composite inventories and scoring systems (e.g. Oral Impacts on Daily Performances (OIDP)) [7,8]. Because of their accumulated experience of oral diseases, older adults are likely to report numerous psychological oral impacts; however, the evidence is mixed as to whether perceived oral health improves or deteriorates with increasing age [1,9,10].

Detailed assessments of subjective oral health examine several dimensions, including the effects of oral conditions on oro-facial pain, functioning, and psychosocial well-being [11–13]. A number of models are available explicitly conceptualizing the

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relationship between oral diseases and their functional, social, and psychological outcomes [14,15]. Gilbert et al. [13] have produced a multidimensional model for understanding oral disease and its consequences that is particularly adapted to the oral health context. Their model has been utilized previously in longitudinal studies of changes in oral health (Gilbert et al., 1998) (Figure 1). According to Gilbert et al. [13], studies of oral health perceptions need to address the following main concepts: biological and physiological variables in terms of oral disease and disorder, oral symptoms/discomfort and functional limitations, and oral disadvantage. Within this terminology, *oral disease and tissue damage* refers to disorders at the organic level or tissue loss. *Oral symptoms and functional limitations* denote the immediate consequences of disease and tissue damage in dysfunctions such as the inability to chew food adequately. *Oral disadvantage* refers to the psychosocial and behavioral consequences of oral disease, such as difficulties in performing daily activities. The final concept of *satisfaction with oral health* is the subject's expressed overall evaluation of their oral condition, incorporating expectations, values, and social and cultural background [16]. Specifically, this conceptual model hypothesizes a progression from distal, such as clinical measures, through intermediate and proximal indicators such as pain, functional problems, and oral disadvantages, towards overall oral health perceptions. Distal determinants (e.g. tooth decay) might influence oral health perceptions directly or indirectly through factors at the intermediate (functional limitation) and proximal (oral disadvantage) levels of the hierarchy. Finally, proximal level determinants in terms of oral disadvantages constitute immediate direct influences on overall oral health perceptions. While the model highlights the relationships between the three main adjacent dimensions (oral disease, function/symptoms, and oral disadvantage), it also recognizes direct and indirect relationships between adjacent and non-adjacent variables. It is hypothesized that individual variables from each oral health domain have differential effects on the outcome of overall oral health perceptions. Moreover, a range of external socio-behavioral factors might impact on symptom/functional status, oral disadvantages, and satisfaction with oral health status.

International comparisons of oral health surveys have facilitated the evaluation of oral health-care systems and highlighted the effects of social and cultural factors concerning oral health and oral health care [17]. Sweden and Norway represent two populations sharing a common historical and cultural heritage, although there are important differences between the two countries in oral health status of the population and in the organization of oral health-care services [18–21]. Investigations into the social and psychological effects experienced by Norwegian and Swedish older adults of poor oral health have revealed a range of impacts, e.g. oral pain, difficulty chewing, embarrassment, and social isolation [1,20–22]. So far, no study has compared subjective oral health indicators between population samples of older adults in Scandinavia using a standardized, comprehensive questionnaire technique. Few studies have included simultaneously the broad spectrum of various socio-behavioral, clinical, and non-clinical oral health indicators that might influence overall perceptions of oral health or have examined the direct and mediated linkages between those factors within a conceptual model.

Aims

Guided by the conceptual framework of Gilbert et al. [13], this study: (1) assessed the prevalence of subjective oral health indicators as reported by 65-year-olds in Sweden and Norway, (2) examined the relationship of socio-demographic factors, behavioral and subjective oral health indicators with 65-year-olds' satisfaction with their oral health status, and (3) examined the extent to which the above-mentioned relationships are consistent across Sweden and Norway. It was hypothesized that any difference between countries in satisfaction with oral health would be related to socio-demographic differences and underlying variations in the reported number of remaining teeth.

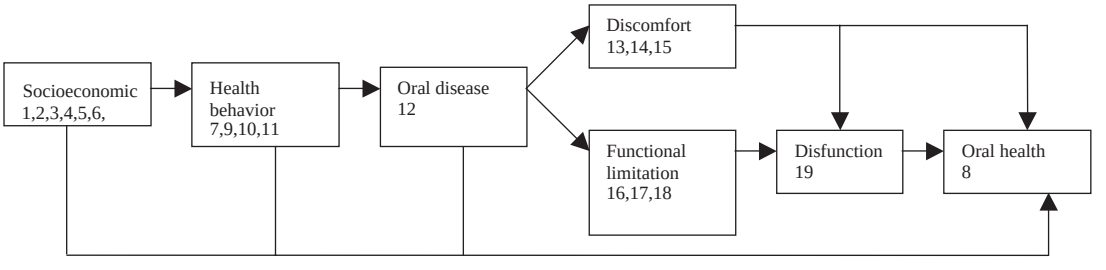

Figure 1. Conceptual model of oral health showing associations between oral health constructs adapted with revision from Gilbert et al. (1998) (multidimensionality of oral health in dentate adults). *Numbers in these boxes are explained in Table 2.

Material and methods

Population and response rate

In 2007, a questionnaire was mailed to all persons born in 1942 and currently residing in certain regions in Sweden and Norway. The questionnaire was initially developed in Swedish and was translated into Norwegian for the Norwegian sample. Individuals in Sweden and Norway who did not respond within 2 weeks were sent a reminder by letter, and those who had not answered within a further 2 weeks a further reminder comprising a letter, questionnaire, and stamped addressed envelope.

The Swedish counties studied were Örebro and Östergötland. The population of 65-year-olds numbered 3377 in Örebro and 4936 in Östergötland. The period of the study was from February to April 2007. The final response rate was 73.1% ($n=6078$ of the net population, $n=8313$). This is part of a cohort study approved by the Ethics Committee in Örebro and Östergötland when it was initiated in 1992.

The version of the questionnaire translated into Norwegian was mailed by Statistics Norway to all persons born in 1942 currently residing in three Norwegian counties: Hordaland ($n=3831$), Sogn og Fjordane ($n=975$) and Nordland ($n=2442$).

In Norway, these counties were chosen not only as representing rural and urban parts of the country, but also variability in oral conditions and dental service. There was good pre-knowledge of these aspects in Norway. Names and addresses were obtained from public population records of Statistics Norway in April 2007. The study took place from June to August 2007 and was approved by the Ethics Committee of the Norwegian Social Science Services (NSD). The final response rate was 56.0% ($n=4062$ of the net population, $n=7248$).

Measures

The questionnaires comprised 65 questions on: socio-economic status in terms of country of birth, place of residence, education, and marital status, in addition to general health, health and oral health-related behaviors, clinical and subjective oral health status, and the eight-item "oral impacts on daily performance" (OIDP) frequency inventory. The measures chosen to assess clinical oral indicators, symptoms, and functional status, oral disadvantages and satisfaction with oral health within the model of Gilbert et al. [13] are described below.

Satisfaction with oral health status was assessed using one question: "Are you in general satisfied with your teeth?", with response categories ranging from (1) Yes, very satisfied to (4) No, absolutely not satisfied. For analysis, this measure was dichotomized into (1) Satisfied with teeth (including original categories 1 and 2) and (0) Not satisfied with teeth (including original categories 3 and 4).

Socio-demographic and behavioral factors were measured in terms of country of birth, place of residence, level of education, and marital status. "Self-reported health status" was assessed with the question: "Do you consider yourself healthy?", with response categories (1) yes, absolutely, (2) yes, mainly, (3) not particularly, (4) no, absolutely not. For analysis, this measure was dichotomized into (0) healthy (including original categories 1 and 2) and (1) not healthy (including original categories 3 and 4). Smoking was assessed with the question: "What are your smoking habits?", with response categories (1) daily smoking, (2) sometimes smoking, (3) have stopped smoking, (4) have never smoked. For analysis, this measure was dichotomized and recorded as (0) less than daily (including original categories 2, 3, and 4) and (1) daily (including original category 1). Taking snuff was assessed with the question: "What are your snuffing habits", with response categories (1) use snuff daily, (2) use snuff sometimes, (3) have stopped using snuff, (4) have never used snuff. For analysis, this measure was dichotomized and recorded as (0) less than daily (including original categories 2, 3, and 4) and (1) daily (including original category 1). Brushing teeth was assessed with the question: "Indicate how often you use a toothbrush", with response categories: (1) seldom, never, (2) once a week, (3) once a day, (4) twice a day, (5) more than twice a day. For analysis, this measure was dichotomized and recorded as (0) twice a day or more often (including original categories 4 and 5) and (1) less than twice a day (including original categories 1, 2, and 3).

Clinical oral health indicators were assessed using one question: "How many of your own permanent teeth do you have?", with response categories ranging from (1) all (28–32 teeth) to (5) edentulous. For analysis, this measure was trichotomized into (0) all teeth remaining (including original category 1), (1) all teeth remaining except some (including original category 2), and (2) missing many teeth (including original categories 3, 4, and 5).

Symptom status was assessed by three questions in terms of: "Have you had one or more of the following oral health-related problems: toothache, burning mouth, or temporomandibular joint (TMJ) pain?". Toothache was assessed with response categories (1) during the last three months, (2) during the last year, (3) more than a year ago, (4) have never had toothache, (5) don't remember. For analysis, this measure was dichotomized into (0) don't remember any toothache (including original categories 4 and 5) and (1) remember toothache (including original categories 1, 2, and 3). Burning mouth and TMJ pain were assessed with response categories (1) no problems, (2) some problems, (3) fairly big problems, (4) big problems. For analysis, this measure was dichotomized into (0) never (including original

category 1) and (1) sometimes (including original categories 2, 3, and 4).

Functional limitations were assessed in terms of problems regarding chewing food, dry mouth, and bad breath. Problems with chewing were assessed with the question: "Can you chew any kind of food", with response categories (1) very good, (2) rather good, (3) less good, (4) bad. For analysis, this measure was dichotomized into (0) good (including original categories 1 and 2) and (1) bad (including original categories 3 and 4). Dry mouth had response categories (1) often, (2) sometimes, (3) seldom, (4) never. For analysis, this measure was dichotomized into (0) never (including original category 4) and (1) sometimes (including original categories 1, 2, and 3). Problems with bad breath were recorded as (1) no problems, (2) some problems, (3) fairly big problems, (4) big problems, and was dichotomized into (0) never (including original category 1) and (1) sometimes (including original categories 2, 3, and 4).

Oral disadvantage was assessed using the 8-item OIDP [1]. "During the previous 6 months, how often have problems with teeth or mouth caused you any difficulty with": (1) eating and enjoying food, (2) speaking and pronouncing clearly, (3) tooth cleaning, (4) sleep and relaxation, (5) smiling and showing teeth without being embarrassed, (6) being emotionally stable, (7) being sociable, (8) performing daily chores.

Each item was scored from 1, i.e. every, or almost every, day, to 5, i.e. never, and was assessed using a 5-point scale: (1) "never affected", (2) "less than once a month", (3) "once or twice a month", (4) "once or twice a week", (5) "every or nearly every day". Because the prevalence of impacts was anticipated to be low, and also for practical purposes, a 5-point response scale rather than the original 6-point scale was used. Each item was dichotomized yielding the categories: (1) "affected" (including the original categories 2, 3, 4, and 5) and (0) "never affected" (the original category 1). One sum index, the extent of oral impacts or OIDP-SC, was constructed from the eight dummy variables. For the purpose of cross-tabulation analyses, the OIDP-SC score (0–8) was dichotomized as 0/1, producing the categories: (0) no daily performance affected and (1) at least one daily performance affected. The distribution of the OIDP-SC scores supported this cut-off point. The reliability and validity of a Norwegian and a Swedish version of the OIDP inventory has been established previously [1,24].

The complete questionnaire design, originally used in a study of 50-year-old Swedish subjects in 1992, has been described previously [25]. Descriptions of the 10-year follow-up examinations of these subjects in 2002 have also been published [26].

Statistical methods

Data were analyzed using the Statistical Package for Social Science (v. 15, SPSS Inc., Chicago, Ill., USA). Bivariate analyses were conducted using cross-tabulations and Chi-square statistics. Determinants of satisfaction with oral health status were examined by multiple binary logistic regression analysis using the logit model and 95% CI (confidence interval), while taking into account the hierarchical relationship between the various independent variables, as hypothesized by Gilbert's model [13]. There are four hierarchical steps of exploratory variables selected a priori for the final multiple logistic regression analysis. After controlling for socio-economic and behavioral factors at step I (i.e. country, country of birth, place of residence, sex, education, marital status, self-reported health status, smoking, snuff, and brushing habits), oral health outcomes were grouped into a hierarchy ranging from distal determinants at step II (i.e. number of remaining natural teeth), through intermediate determinants in terms of symptoms and functional status in step III (e.g. toothache, burning mouth, chewing, TMJ symptoms, dry mouth, bad breath) to proximal determinants (i.e. oral impacts on daily performance) at step IV. Initially, multiple logistic regression analyses were conducted with the variables at each step separately (including all variables that were statistically significantly associated with satisfaction with oral health in bivariate analysis). Variables to be included in the various steps of the final hierarchical model were selected if $p < 0.01$ after adjustment for all other "same step" variables. With respect to the large samples analyzed, which entails that even very small differences and weak associations can reach statistical significance, the significance level was set to 1.

Results

Non-response analyses

According to the Central Bureau of Statistics of Norway and Sweden, the gender distribution of respondents and non-respondents in the Norwegian study group reflected that of the population as a whole. In Sweden, there was a small but statistically significant difference in gender distribution between participants and non-participants, with a higher level of response by females. The level of education of responders from both Norway and Sweden deviated slightly, but statistically significantly, from that of non-responders (Table I).

Participant characteristics

Table II depicts the categories, coding, and percentage distribution of independent variables in the total study group and according to country. The gender

Table I. Comparison of Norwegian and Swedish respondents with non-respondents according to gender and level of education.

	Norway			Sweden		
	Respondents *n* (%)	Non-respondents *n* (%)	Chi-square and probability (*p*)	Respondents *n* (%)	Non-respondents *n* (%)	Chi-square and probability (*p*)
Men	2047 (50.4)	1568 (49.2)	$\chi^2 = 0.99$ (1 d.f.)	2998 (49.3)	1191 (53.4)	$\chi^2 = 10.27$ (1 d.f.)
Women	2015 (49.6)	1618 (50.8)		3080 (50.7)	1044 (46.7)	
Total number*	4062 (100.0)	3186 (100.0)	$p = 0.319$	6078 (100.0)	2235 (100.0)	$p < 0.001$
Primary education	1295 (38.9)	874 (22.7)		2341 (44.1)	649 (22.1)	
Secondary education	1017 (30.6)	2622 (68.1)	$\chi^2 = 1075.91$ (2 d.f.)	1686 (32.1)	1660 (56.5)	$\chi^2 = 539.52$ (2 d.f.)
College/university	1016 (30.5)	355 (9.2)		1233 (23.4)	627 (21.4)	
Total number*	3328 (100.0)	3851 (100.0)	$p < 0.001$	5260 (100.0)	2936 (100.0)	$p < 0.001$

*The differences in total numbers between gender and education were due to information from different registers from Statistics Norway and Statistics Sweden.

distribution of the participants was 49.6% females in Norway and 50.7% females in Sweden. The country-specific percentages of subjects having all their teeth were 13.7% in Sweden and 19.6% in Norway. As given in Table II, the socio-demographic distribution of the Swedish and Norwegian participants

Table II. Frequency distribution of socio-demographic factors, clinical and non-clinical independent variables, and their categories by country ($n = 10\ 140$).

Variables	Categories (code)	Total % (*n*)	Norway % (*n*)	Sweden % (*n*)	*p*-value
1. Country	Sweden (0)	59.1 (6078)	–	–	–
	Norway (1)	40.9 (4062)			
2. Country of birth	Native country (0)	95.4 (9519)	97.8 (3942)	91.8 (5577)	<0.01
	Foreign country (1)	4.6 (461)	2.2 (87)	6.3 (374)	
3. Place of residence	Densely populated (0)	37.6 (3675)	27.4 (1093)	44.7 (2582)	<0.01
	Countryside (1)	62.4 (6093)	72.6 (2899)	55.3 (3194)	
4. Sex	Male (0)	49.8 (5045)	50.4 (2047)	49.3 (2998)	0.29
	Female (1)	50.5 (5095)	49.6 (2015)	50.7 (3080)	
5. Education	Higher (University) (0)	26.2 (2249)	30.5 (1016)	23.4 (1233)	<0.01
	Lower (less than university) (1)	73.8 (6339)	69.5 (2312)	76.6 (4027)	
6. Marital status	Married/de facto (0)	77.9 (7775)	79.4 (3197)	76.9 (4578)	<0.01
	Single (1)	22.1 (2200)	20.6 (807)	23.1 (1373)	
7. Self-reported health status	Healthy (0)	78.7 (7782)	78.4 (3118)	78.9 (4664)	0.54
	Not healthy (1)	21.3 (2105)	21.6 (859)	21.1 (1246)	
8. Self-reported satisfaction with oral health	Not satisfied (0)	23.3 (2317)	23.5 (943)	23.2 (1374)	0.70
	Satisfied (1)	76.7 (7614)	76.5 (3065)	76.8 (4549)	
9. Smoking habit	Less than daily (0)	86.4 (8627)	85.8 (3459)	86.8 (5168)	0.15
	Daily (1)	13.6 (1355)	14.2 (571)	13.2 (784)	
10. Snuff habit	Less than daily (0)	96.2 (9393)	98.9 (3817)	94.4 (5576)	<0.01
	Daily (1)	3.8 (374)	1.1 (41)	5.6 (333)	
11. Brushing	Twice a day or more (0)	79.0 (7581)	72.0 (2785)	83.6 (4796)	<0.01
	Less than twice day (1)	21.0 (2020)	28.0 (1082)	16.4 (938)	
12. Remaining own teeth	All teeth remained (0)	16.1 (1586)	19.6 (778)	13.7 (808)	<0.01
	Missing some (1)	56.9 (5614)	55.0(2184)	58.2 (3430)	
	Missing many or all (2)	27.0 (2667)	24.0(1009)	28.1 (1658)	
13. Toothache	No/do not remember (0)	50.5 (4962)	48.5 (1914)	51.9 (3048)	<0.01
	Remember toothache (1)	49.5 (4861)	51.5 (2031)	48.1 (2830)	
14. Burning mouth	Never (0)	93.1 (8655)	92.7 (3294)	93.3 (5361)	0.26
	Sometimes (1)	6.9 (645)	7.3 (260)	6.7 (385)	
15. Chewing	Good function (0)	93.5 (9325)	93.4 (3751)	93.6 (5574)	0.69
	Bad function (1)	6.5 (648)	6.6 (266)	6.4 (382)	
16. TMJ symptoms	Never (0)	87.5 (8186)	84.9 (3049)	89.1 (5137)	<0.01
	Sometimes (1)	12.5 (1169)	15.1 (541)	10.9 (628)	
16. Problem dry mouth	Never (0)	70.7 (6963)	69.8 (2773)	71.3 (4190)	0.10
	Sometimes (1)	29.3 (2886)	30.2 (1201)	28.7 (1685)	
18. Problem bad breath	Never (0)	69.3 (6483)	60.3 (2180)	74.9 (4303)	<0.01
	Sometimes (1)	30.7 (2873)	39.7 (1434)	25.1 (1439)	
19. OIDP	No impact (0)	70.9 (6825)	69.8 (2699)	71.6 (4126)	0.06
	At least one impact (1)	29.1 (2804)	30.2 (1168)	28.4 (1636)	

differed to a statistically significant degree ($p < 0.01$) with respect to country of birth, place of residence, education, and marital status.

Psychometric properties of the OIDP

OIDP has previously been tested for validity and reliability in population-based studies in Sweden and Norway [1,24]. In this study, internal consistency reliability in terms of Cronbach's alpha of the 8-item OIDP score was 0.90 in Sweden and 0.89 in Norway. A total of 28.4% of the sample of Swedish 65-year-olds reported at least one oral impact. Of these, 13.7% had all their teeth, 20.3% were missing some teeth, and 53.3% were missing many or all their teeth ($p < 0.01$). The corresponding figures for 65-year-old participants in Norway were a total of 30.2% who reported at least one oral impact, comprising 13.5% who had their all teeth, 21.9% who were missing some teeth, and 62.0% who were missing many or all ($p < 0.01$). These results support the internal consistency reliability and construct validity of the OIDP when used among 65-year-olds in Sweden and Norway.

Variation in subjective oral health indicators by country

In total, 76.8% (95% CI 75.7–77.8) of the Swedish and 76.5% (95% CI 75.1–77.7) of the Norwegian participants were satisfied with their oral health situation. The regional variation of satisfaction with oral health according to place of residence was larger within each population than the variation between the countries themselves. In Sweden, 75.5% in densely populated places versus 78.0% ($p < 0.05$) in the countryside reported satisfaction with oral health. The corresponding figures in Norway were 81.5% versus 74.7% ($p < 0.01$). As given in Table II, 13.7% and 19.6% ($p < 0.01$) and 28.4% and 30.2% ($p < 0.05$) of the Swedish and Norwegian participants reported having all their teeth and OIDP ≥ 1. Totals of 48.1% (Swedish) versus 51.5% (Norwegian) participants reported toothache, 10.9% (Swedish) versus 15.1% (Norwegian) confirmed TMJ symptoms, and 25.1% (Swedish) versus 39.7% (Norwegian) reported problems with bad breath ($p < 0.01$). After controlling for variation in marital status, education, place of living, country of birth, and reported number of teeth, in multiple logistic regression analysis, statistically significant country differences persisted for the following indicators: OIDP, TMJ symptoms, toothache, and bad breath. Thus, Norwegian 65-year-olds were more likely than their Swedish counterparts to have at least one OIDP (OR 1.1, 95% CI 1.1–1.3), TMJ symptoms (OR 1.7 95% CI 1.4–1.9), problems with bad breath (OR 1.9 95% CI 1.7–2.1), and/or toothache (OR 1.2 95% CI 1.1–1.2) (not given in Table II). The country difference did not persist with respect to the number of remaining teeth after controlling for socio-demographic factors.

Determinants of oral health status within a conceptual model

As indicated in Table III, level of education, marital status, self-reported health status, smoking habits, reported problems with oral health-related symptoms and functioning, and the OIDP scores were statistically significantly associated with oral health satisfaction in Norway and Sweden combined as well as separately. All variables that were statistically significant in unadjusted (bivariate) analyses were analyzed in multiple logistic binary regression analyses, one step of the conceptual model at a time. The interrelationships among the independent variables used in the hierarchical regression analysis were as follows: SES and missing teeth ($p < 0.001$), missing teeth and variables related to perceived functional problems and symptoms ($p < 0.001$), variables related to perceived functional problems and symptoms, and OIDP score ($p < 0.001$).

Table IV depicts adjusted ORs for status by socio-demographic factors, number of remaining teeth, symptoms, functional status, and oral disadvantages. Since the validity of the measurement model of Gilbert [13] was unknown at the time of the present analyses, single variables were entered instead of summary scores at each step to clarify their relative importance as adjusted factors influencing satisfaction with oral health. Socio-demographic factors were entered in the first step, providing a model fit of Nagelkerke's $R^2 = 0.08$, model chi-square $= 428$, d.f. $= 8$, $p < 0.01$, with country of birth, education, marital status, perceived health, smoking, and brushing statistically significantly associated with satisfaction with oral health status (Table IV). Entering the reported number of remaining teeth in the second step improved the model fit to Nagelkerke's $R^2 = 0.32$, model chi-square $= 865$ d.f. $= 10$, $p < 0.01$. Country of birth (OR 0.7), perceived health (OR 0.5), and smoking (OR 0.7) maintained their statistically significant relationship with satisfaction with oral health, and number of teeth was statistically significantly related to satisfaction with oral health (OR 0.04) after controlling for all variables in step 1. Entering six measures of symptom and functional status in step III and oral disadvantages in terms of OIDP in step IV raised Nagelkerke's R^2 to 0.40 and to R^2 0.46, respectively. In the final step, subjects who perceived their health status as bad, who smoked daily, had many missing teeth, remembered having had toothache, confirmed bad chewing function, had problems with bad breath and had experienced at least one oral impact were less likely than their counterparts in the opposite groups to perceive satisfaction with oral

Table III. Satisfaction with oral health status by socio-behavioral, clinical and non-clinical oral health indicators. Percentages of those who reported good oral health status ($n = 9931$).

Variables		Satisfaction with oral health % (n)		
		Total	Norway	Sweden
2. Country of birth	Native country (0)	77.4 (7226)**	76.8 (2952)*	77.8 (4274)**
	Foreign country (1)	63.9 (289)	64.7 (55)	63.8 (234)
3. Place of residence	Densely populated (0)	77.2 (2785)	81.5 (870)**	75.5 (1915)*
	Countryside (1)	76.4 (4569)	74.7 (2110)	78.0 (2459)
4. Sex	Male (0)	77.2 (3807)	75.9 (1518)	78.0 (2289)*
	Female (1)	76.3 (3775)	77.3 (1515)	75.6 (2260)
5. Education	Higher (university) (0)	81.9 (1811)**	82.8 (821)**	81.2 (990)**
	Lower (less than university) (1)	75.0 (4660)	73.9 (1662)	75.6 (2998)
6. Marital status	Married/de facto (0)	78.7 (6009)**	78.3 (2441)**	79.0 (3568)**
	Single (1)	69.9 (1503)	70.5 (566)	68.2 (937)
7. Self-reported health status	Healthy (0)	81.0 (6201)**	81.8 (2495)**	80.5 (3706)**
	Not healthy (1)	61.1 (1252)	58.6 (486)	62.8 (766)
9. Smoking habit	Less than daily (0)	79.0 (6738)**	78.9 (2705)**	79.0 (4033)**
	Daily (1)	61.6 (816)	61.7 (345)	61.5 (471)
10. Snuff habit	Less than daily (0)	76.9 (7133)	76.7 (2898)	77.0 (4235)
	Daily (1)	73.2 (271)	75.6 (31)	72.9 (240)
11. Brushing	Twice a day or more (0)	78.3 (5886)**	79.2 (2188)**	77.8 (3698)**
	Less than twice day (1)	71.6 (1431)	69.9 (749)	73.5 (682)
12. Remaining own teeth	All teeth remained (0)	95.9(1516)**	96.3 (746)**	95.7 (770)**
	Missing some (1)	87.0 (4867)	85.1 (1853)	88.2 (3044)
	Missing many or all (2)	43.0 (1122)	41.5 (408)	43.9 (714)
13. Toothache	Do not remember (0)	82.9 (4080)**	82.9 (1576)**	82.9 (2504)**
	Remember toothache (1)	70.6 (3413)	70.9 (1433)	70.4 (1980)
14. Burning mouth	Never (0)	79.5 (6791)**	79.6 (2577)**	79.4 (4214)**
	Sometimes (1)	54.7 (343)	58.6 (146)	52.1 (197)
15. Chewing	Good function (0)	81.6 (7564)**	81.7 (3047)**	81.6 (4517)**
	Bad function (1)	5.4 (35)	3.4 (9)	6.8 (26)
16. TMJ symptoms	Never (0)	80.8 (6467)**	80.2 (2398)**	79.9 (4069)**
	Sometimes (1)	60.3 (691)	65.5 (345)	55.9 (346)
17. Dry mouth	Never (0)	80.6 (5579)**	80.2 (2208)**	80.9 (3371)**
	Sometimes (1)	67.1 (1915)	67.7 (805)	66.7 (1110)
18. Problem bad breath	Never (0)	82.1 (5258)**	83.7 (1789)**	81.4 (3469)**
	Sometimes (1)	67.2 (1900)	69.0 (969)	65.5 (931)
19. OIDP	No impact (0)	89.7 (6022)**	90.0 (2375)**	89.5 (3647)**
	At least one impact (1)	47.0 (1292)	47.2 (538)	46.8 (754)

**$p < 0.01$; *$p < 0.05$.

health. The corresponding ORs were 0.8, 0.7, 0.08, 0.7, 0.08, 0.7, and 0.2, respectively.

To assess whether or not the relationships of socio-demographic factors and oral health indicators with satisfaction of oral health status were consistent across countries, a number of logistic regression models with two-way interactions between country and all independent variables were conducted. No statistically significant two-way interaction occurred and the country-specific analyses revealed that the model explained equal amounts of variation in satisfaction with oral health in each country with Nagelkerke's R^2 0.45, model chi-square 1469.6, d.f. = 16 and Nagelkerke's R^2 0.47, model chi-square 867.1 d.f. = 16 in Sweden and Norway, respectively.

Discussion

In accordance with the propositions of Gilbert's model [13], the present results confirm the relationships between satisfaction with oral health status and socio-demographic factors, clinical and subjective oral health indicators, suggesting that responses to overall evaluation of oral health status in 65-year-old Norwegian and Swedish adults might be explained by variables organized in three conceptual domains. No statistically significant interaction between country and the other independents was identified, indicating consistent relationships across the two study sites. Thus, the model performed equally well in both study populations, explaining almost the same amount of variation in oral health satisfaction. In accordance with other studies [23,27], oral health indicators at the various levels of the conceptual hierarchy influenced the overall responses to oral health status positively and significantly, but differently.

Clinical status in terms of reported number of natural teeth, when used in combination with socio-demographic factors, oral symptoms, functions, and oral disadvantages, explained substantially more of

Table IV. Satisfaction with oral health status regressed on socio-demographic factors, oral-health-related behavior, and clinical and non-clinical oral health indicators. Hierarchical logistic regression analysis.

	Step 1: SES and behavioral ($n=7780$)	Step II: Distal clinical indicators ($n=7678$)	Step III: Intermediate indicators ($n=6875$)	Step IV: Proximal indicators ($n=6661$)
Variables	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Country of study				
Sweden	1	1	1	1
Norway	1.0 (0.9–1.1)	0.8 (0.7–1.0)	1.0 (0.8–1.1)	1.0 (0.8–1.2)
Gender				
Male	1	1	1	1
Women	1.0 (0.8–1.1)	0.9 (0.8–1.1)	0.9 (0.8–1.0)	0.9 (0.7–1.0)
Country of birth				
Native	1	1	1	
Foreign	0.5 (0.4–0.7)	0.7 (0.5–0.9)	0.8 (0.6–1.1)	0.8 (0.6–1.1)
Education				
Higher	1	1		
Lower	0.8 (0.7–0.9)	1.1 (0.9–1.3)	1.0 (0.9–1.2)	0.9 (0.8–1.1)
Status				
Married	1	1	1	
Single	0.8 (0.7–0.9)	0.8 (0.7–1.0)	1.0 (0.8–1.1)	1.0 (0.8–1.2)
Perceived good health				
Yes	1	1	1	1
No	0.4 (0.4–0.5)	0.5 (0.5–0.6)	0.7 (0.6–0.8)	0.8 (0.6–0.9)
Smoking				
Less	1	1	1	1
Daily	0.5 (0.4–0.6)	0.7 (0.6–0.9)	0.7 (0.6–0.8)	0.7 (0.6–0.8)
Brushing				
Twice a day or more	1	1	1	1
Less than twice day	0.7 (0.7–0.9)	1.0 (0.9–1.2)	1.1 (0.9–1.4)	1.1 (0.9–1.3)
Remaining teeth	Adj $R^2=0.08$**			
All		1	1	1
Missing some		0.3 (0.2–0.4)	0.3 (0.2–0.4)	0.3 (0.2–0.5)
Missing many		0.04 (0.03–0.05)	0.06 (0.04–0.08)	0.08 (0.05–0.10)
Toothache		Adj $R^2=0.32$**		
Cannot remember			1	1
Remember toothache			0.6 (0.5–0.7)	0.7 (0.6–0.8)
Burning mouth				
Never			1	1
Sometimes			0.7 (0.5–0.9)	0.9 (0.7–1.3)
Chewing				
Good function			1	1
Bad function			0.05 (0.03–0.08)	0.08 (0.05–0.12)
TMJ problem				
Never			1	1
Sometimes			0.6 (0.5–0.8)	0.8 (0.6–1.0)
Dry mouth				
Never			1	
Sometimes			0.9 (0.8–1.1)	1.0 (0.8–1.2)
Problem bad breath				
Never			1	1
Sometimes			0.6 (0.5–0.7)	0.7 (0.6–0.8)
			Adj $R^2=0.40$ **	
OIDP				
No impact				1
At least one impact				0.2 (0.2–0.3)
				Adj $R^2=0.46$**

**$p<0.01$.

the adults' concerns about their oral health than did the clinical measure alone. This suggests that a full understanding of older adults' oral health satisfaction cannot be captured by clinical assessment alone.

There was some support for the interrelationships between oral health outcomes at various levels of the hierarchy as predicted by Gilbert's model [13]. According to bivariate analyses, socio-demographic factors predicted the number of teeth maintained, and the number of teeth maintained predicted symptom and functional problem variables, which in turn predicted oral disadvantage in terms of OIDP. Previous studies have provided support for the relationships between oral health outcomes at various levels as proposed by Gilbert [13], Locker's model [14], and the model of Wilson & Cleary [15]. As indicated by the results presented in Table IV, the relationship between symptoms (i.e. burning mouth and dry mouth) and satisfaction with oral health was mediated through oral disadvantage (OIDP). This implies that individuals who did not experience burning mouth and dry mouth were less likely to have oral impacts, which again led to increased probability of being satisfied with oral health status.

This study suggests that the oral condition of 65-year-olds in Norway and Sweden impacts in different ways on their well-being and that there are variations between the two countries with respect to some oral health perceptions, but not others. In contrast to what has been hypothesized, the country variation persisted in respect of oral impacts, TMJ symptoms, toothache, and bad breath after adjustment of socio-demographic factors and number of maintained teeth (results not given in the Table). The country variation is not thus an artifact of different data collection methods; instead, it might reflect some of the socio-cultural differences between the two populations studied. Specifically, problems with bad breath and TMJ symptoms showed the largest inter-country variation, followed by toothache and oral impacts on daily performance. This indicates the influence of other factors not accounted for in the present study, such as culture and aspects of dental health-care services [28,29]. In spite of shared historical and cultural heritage, there are differences between Norwegian and Swedish 65-year-olds that might facilitate interpretation of the present results. The participants of this study were born and raised during World War II, a period in history with dramatic social changes affecting the economies of the two countries differently. Moreover, there is a history of substantial differences in the level of subsidies for dental care that these cohorts have received from their respective governments. Evidently, socio-demographic inequalities during childhood, both directly and indirectly, influence health and oral health later in life, and cohort studies have shown that satisfaction with oral health in middle age is influenced by factors operating in early childhood [30–32]. Most notable was the absence of any inter-country difference regarding overall oral health perceptions, with 76.8% of the Swedish and 76.5% of the Norwegian participants reporting satisfaction with oral health. Although Norwegian 65-year-olds were more likely to have all their teeth (19.6% versus 13.7%), they were also more likely than their Swedish counterparts to report oral impacts (30.2% versus 28.4%) and oral symptoms. The prevalence of OIDP observed in the present study of 65-year-olds from counties of western and northern Norway was substantially higher than the rate of 18.4% assessed in a national sample using the same inventory [1]. Recognizing the large regional variation in oral health and oral health-related behaviors in Norway, the above findings are in accordance with previous findings suggesting that residents of northern and southwestern Norway are more likely to perceive any oral impacts than residents of other parts of this country [1].

This is the first large population-based study comparing a wide range of subjective oral health indicators across Scandinavian countries, the results being both consistent and inconsistent with what has been reported in similar studies elsewhere. Slade et al. [4] reported minor differences in oral impact when comparing adults aged 65 or older in South Australia, Ontario, and North Carolina. In a subsequent study, the percentage of dentate older people reporting oral impacts "often" or "fairly often" was reported to be similar among older adults in the United Kingdom and Australia [3]. On the other hand, Tsakos et al. [5] found prevalence rates of oral impacts to be 56.3% and 37.1% among Greek and British dentate older adults, whereas the corresponding figures among edentulous subjects were 33.5% and 25.3%.

The overall response of the participants to their oral health status was strongly influenced by their socio-demographic context, suggesting that immigrants, smokers, single persons, and those with a lower level of education were less likely than their counterparts in the opposite groups to be satisfied with their oral health. This is in line with evidence suggesting that the lower the material standard of living, the worse the oral health status, irrespective of the measure utilized to assess it [30,33]. Socio-economic inequality in oral health status has been shown to persist in the general adult population in Norway despite general efforts from the Norwegian government to reduce or eliminate it [34]. According to the results from logistic regression analysis (Table IV), only two out of six original socio-demographic variables remained statistically significantly associated with satisfaction with oral health in the final model. Irrespective of the number of teeth retained and the psychosocial consequences of oral diseases, those who perceive bad health status and daily smokers were less likely than their counterparts

to perceive satisfaction with oral health. This accords with evidence that culturally-based attitudes and perceptions influence expectations and reactions individuals have of their oral condition, thereby determining whether those conditions led to impacts and reduced well-being. Variation in satisfaction with oral health according to country of birth, education, and marital status, observed in the first step of the model, disappeared after having included number of maintained teeth, suggesting that those effects were accounted for by variation in the clinical oral health variable [35]. According to the results depicted in Table IV, 65-year-olds in both countries based their overall response to oral health more strongly on oral disadvantages than on the actual number of teeth maintained, although the latter factor remained statistically significant after controlling for a range of various subjective oral health indicators. The present finding that 65-year-olds missing many teeth were less likely to be satisfied with their oral condition than those missing only a few or none is consistent with numerous previous studies in adults of similar age [3].

The strength of the present study was the application of a conceptual framework to guide the statistical analyses and interpretation of the results. Failure to take such a conceptual framework into consideration by entering all explanatory variables at the same time might be to underestimate the effect from more distal variables in the conceptual hierarchy [36]. The independent variables chosen for the conceptual framework utilized here were based on logical reasoning as well as statistical associations [36]. Using latent constructs with Structural Equation Modeling (SEM) would have provided a stronger test of the construct validity of the model, examining its factorial structure, the equivalence of this factor structure across groups, and controlling measurement errors present in the observed variables. Such an approach is suggested for subsequent studies [37].

Comparison of the socio-demographic distributions of the study participants within each country with the corresponding population statistics indicates that, with some exceptions, the study groups were fairly representative of their respective populations (Table I). Nevertheless, a limited number of variables were compared and some discrepancies that might have influenced the results should be noted. In both countries, the participation rate for those with primary education seemed to be lower than for subjects with higher education (Table I). Since the present data rely on self-reporting, the oral health indicators recorded might have been biased by under- or over-reporting due to socially desirable responses and poor recall effect. However, the core questions utilized have shown good validity and reliability in previous national and cross-national surveys. On the other hand, there is no reason to assume that the accuracy of reported oral health aspects differed between the surveys, suggesting that the comparison of estimates presented is likely to be reasonably accurate.

Conclusions

The oral condition of 65-year-olds in Norway and Sweden produced impacts of oral symptoms, functional limitations, and problems with daily activities that, to some extent, varied between the two countries. Satisfaction with oral health varied by socio-demographic factors, clinical and subjective oral health indicators as proposed by the Gilbert model. A full understanding of the oral health and treatment needs of 65-year-olds in Norway and Sweden cannot be captured using clinical measures alone.

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