The Strength of Two Indicators of Social Position on Oral Health Among Persons Over the Age of 80 Years

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Abstract

Objective: *The objective of the present study is to analyze how two dimensions of social position, education and social class, are associated with oral health among generally healthy, community-dwelling persons over the age of 80 years.* ***Methods:*** *The present investigation is based on a sample of 157 community-dwelling individuals from The Kungsholmen Elders Oral Health Study (KEOHS) and included data from interviews and oral examinations. Social position was measured by education and social class. Oral health was measured by active coronal caries, active root caries, edentulism and use of dental services.* ***Results:*** *The primary findings of the adjusted multivariate logistic regression analysis were that, compared to persons who had been in higher positions, persons who had been blue-collar/ white-collar workers had significantly greater odds of having coronal caries and high, but nonsignificant odds of being edentulous. Further, persons with elementary/ medium education tended to forego regular dental services more than persons with high education.* ***Conclusion:*** *The study identified social inequalities in oral health even in a population of independently living, generally healthy very old Swedes and in a country where the public health policies have tried to minimize these inequalities.*

Key Words: Social position, social class, education, oral health, caries, teeth, aging

Introduction

Research has consistently shown social inequalities in health within the general adult population (1). The effect of social inequalities accumulates throughout the life-course because of different exposures to social, economic and environmental circumstances, health care, nutrition and educational opportunities (2). Consequently, studies of social inequality in health among old people offer an excellent opportunity to investigate the strength of early and adult life socioeconomic exposures on health in old age.

Numerous studies have shown strong associations between aspects of social position and oral health status (3-11) as well as in the utilization of dental services among old people (3,5,8,11-13). It may be of special interest to investigate these patterns among the well functioning oldest-old because these persons may be seen as exceptional in that they have lived beyond normal life expectancy and in some ways may appear to be a "biological elite" (14).

Only a limited number of investigations, however, have included persons aged 80 and over (6,9,10,15-18), and almost all of these studies have used self-reported oral health as outcome measures. Accordingly, the measures of oral health have been limited to more "hard" measures such as number of teeth (9), anterior open tooth spaces (15), and an index based on number of teeth, dentures, fillings, crowns or bridges (10), all outcome measures which develop throughout the life-course. To the knowledge of the authors, only four studies, which included the oldest-old, based their analyses on a clinical oral examination and used current caries as an outcome measure (6, 16, 18, 19). Three of these investigations included only one measure of social position, which was education. These investigations found that education was not related to caries (6, 16, 18), while the study by Avlund *et al.* (19) included both education and social class and found an association between social class and coronal caries.

Some of the contradictory evidence may be a result of differences in the conceptualization and measurement of social position. School education and vocational training are primarily related to childhood and youth; occupation and income are more related to the working ages; while material wealth reflects the accumulation of living conditions throughout the life-course (20). The choice of conceptualization and measurement of social position in oral health research reflects the thinking about pathways between social conditions and health (21). The measurement of social position by education facilitates the identification of pathways within the individual, such as knowledge. The measurement of social class may stimulate the identification of pathways linked to the social structure of the society. The measurement of material wealth in old age may reflect both the present economic situation and the accumulation of living conditions and economic assets throughout the life course. These pathways do not exclude each other, and the use of several indicators of social position in health surveys has been recom-

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mended. (22). It may thus add to an understanding of oral health in old age to analyze how different measures of social position influence the health of the oral cavity.

It is possible that indicators of social position, which are related to living conditions throughout life, are more strongly associated with oral health in old age than are measures that primarily reflect that which occurred more recently. The overriding implication is that current social differences in oral health status are largely the result of dental health care and oral health behaviors that took place prior to the period of study. This implies that observed differences in some aspects of oral health may have their origin in socioeconomic conditions rooted in the distant past, while differences in other aspects of oral health may originate in more recent socioeconomic differences.

All of the aforementioned studies on social position and oral health (6,16,18,19) had a broader research objective: They included the social position variables as covariates and they did not have a special focus on the associations between different measures of social position and oral health. Thus, none of the studies has had direct focus on the strength of different social position variables on oral health in an old-old well-functioning population.

The aim of the present study is to analyze how two dimensions of social position, education and social class, are associated with oral health among generally healthy, community-dwelling persons over the age of 80 years. First, the analyses have been limited to a population of independent living, generally healthy old-old people. Second, two oral health measures: 1) a measure of oral health which develops throughout life (edentulism) and 2) a measure reflecting more current oral health (active caries), have been used.

Methods

The Kungsholmen Elders Oral Health Study (KEOHS) is based on The Kungsholmen Project, which is a longitudinal, population-based study with extensive data about physical, medical, social, and psychological conditions from a cohort of older adults residing in Kungsholmen, an area in central Stockholm with a high percentage of elderly residents (23). The first and second follow-up examinations were conducted during 1991-93 and 1994-96. During the second follow-up the KEOHS enrolled generally healthy, community-dwelling older adults over the age of 80 years who were then current participants in the parent project. Generally healthy persons were defined as individuals whose physical, medical, and mental status allowed them to travel to and participate in a comprehensive oral health examination conducted in a local clinical setting. Persons who were homebound or lived in a nursing home were excluded.

As a majority of the study participants lived in this area for most of their lives, it is likely that they have had access to public dental care free of charge when they grew up, since the public school dental service was established in Kungsholmen as early as in 1918. They would also have been affected by the National Dental Health Insurance in Sweden, which was introduced in 1974.

The coordinator of the Kungsholmen Project identified a total of 296 project participants as potentially eligible for the KEOHS. Of these, 159 (54%) persons participated in the oral health study. Reasons for non-participation included refusal (n=71), illness (n=44), inability to contact the identified individual (n=5), death prior to being contacted (n=6), failure to keep scheduled appointments (n=4) and other miscellaneous reasons (n=7). The analyses are based on the 157 participants without missing data on any of the included variables.

Among the 157 study participants, 127 were dentate and 30 were totally edentate. The dentate study participants did not differ from the edentate with regard to gender, age, social class, cognitive function, functional ability. However, the edentate were significantly more likely not to use dental services regularly compared to the dentate ($p<0.001$).

The KEOHS study included an interview and a clinical oral examination. The interviews used a structured questionnaire about demographics, diet, lifestyle, and dental habits. The oral examination collected information on a wide array of clinical parameters including caries and periodontal status, occlusion and oral function, dental prosthesis status, and taste detection and recognition thresholds. Prior to the interview and examination, all eligible subjects signed a consent form approved by the Institutional Review Boards of the applicable institutions.

The caries examination was conducted by one of three standardized examiners using previously defined visual, tactile criteria for coronal and root caries (24,25). Mobile dental equipment was used, and radiographs were not obtained. The oral cavity was illuminated, and the teeth were dried using air syringes and when necessary cleaned with gauze prior to the caries examination. The examiners participated in calibration sessions before and during the data collection period. The calibration sessions were conducted by the senior dental advisor (standard) and included demonstration of the standardized diagnostic criteria prior to the beginning of the study followed by clinical practice sessions. For the calibration sessions, each examiner and the senior dental advisor examined the same subjects. Repeat examinations were performed only in a limited number of study participants because of the length of the dental examination for these very old subjects; consequently, estimates of examiner reliability are not available.

Frank carious cavitation of coronal surfaces was sufficient for a diagnosis of caries. For carious lesions without frank cavitation, additional diagnostic criteria were employed. The criteria for coronal caries in pits and fissures required that the explorer "catch" after insertion with moderate to firm pressure and that the catch can be accompanied with softness at the base of the area, opacity adjacent to the area, or softened enamel adjacent to the area. For smooth areas on the

facial and lingual surfaces, as well as proximal surfaces where there was no adjacent tooth, coronal caries was defined as a decalcified or white spot with enamel softness. For proximal coronal surfaces unavailable to direct visual-tactile examination, coronal caries was defined as a discontinuity of the enamel in which the explorer both caught and detected softness. For root surfaces, both cavitated and discolored areas without cavitation were diagnosed as carious if the soft floor or base yielded to a moderate pressure from the tip of the explorer. Care was taken to classify as carious only those root lesions that had a softness greater than the surrounding cementum.

Main Outcome Measures

Main outcome measures based on the clinical examination.

Active coronal caries (yes vs. no)
Active root caries (yes vs. no)
Edentulism (no teeth vs. teeth)

Main outcome measures based on data from the interview.

Regular use of dental services (one or two times every or every other year vs. less regularly)

Social position was measured by:

School education: Low (2-7 years), medium (8-10 years) and high (11+ years). These three categories of school education were chosen for two reasons: 1) Because this gave three nearly equally sized groups, and 2) because it makes sense to make these categories. In the beginning of the 20th century a rather large proportion of persons had only elementary school education (7 years or less), others completed "high school" (8-10 years) and some had more than 10 years of education. *Social class:* The procedure for the measurement of social class was based on data about former profession, working tasks and position obtained using a standard questionnaire. Social Class 1 includes those in leading positions, professionals with university degrees and owners of business enterprises with employees. Social Class 2 is comprised by "white-collars workers" on a low and medium level and Social Class 3 includes "blue-collar workers". The measurement is based on the Swedish Classification introduced in 1974 and revised in 1982 (26). The primary aim of this classification was to distribute the economically active population by occupation and employment conditions based primarily on the normal trade-union affiliation and the customary education requirements of the respective occupation (26,27). Occupation is based on the main occupation held for most years during the person's working life. Homemakers are classified according to their husband's occupation. The main occupation of the deceased spouse was considered for widows who had not had an occupation of their own.

Covariates

The main focus of this study is on the influence of measures of social position on oral health. Consequently the following covariates, which are known to be related to social position and oral health, have been included.

Age (>85 vs. 80-85)
Gender (male vs. female)
Cognitive function was assessed by the Mini Mental State Examination (MMSE) (28), which is a brief multi-item screen with a 0-30 scoring range. It seeks information on 6 aspects of cognitive function: orientation for time and place, repetition, concentration, short term memory, language and praxis. For this study the MMSE scores were grouped into three categories 17-23, 24-26, 27-30, with higher scores indicating better cognitive functioning.
Functional ability measured at the first follow-up of the parent study by a global question about loss of ability or hobby which was managed earlier, i.e.sustained good functional ability vs. decreased functional ability.
Smoking (ever vs. never).
Number of teeth (1-13, 14-20, 21+).
Number of crowns (0-3, 4-8, 9+).

Statistical Analysis

Crude logistic regression analyses were performed with the oral health indicators as dependent variables and the individual social position measures as independent variables. The social position variables with significant ($p<0.05$) or a tendency to associations with the outcome measures ($p<0.20$) or with an odds ratio > 1.5 were then incorporated as independent variables in the multivariate logistic regression model. The potential confounders were then added groupwise to the model. The SAS procedure PROBIT with the logit link function was used for all logistic regression analyses. Cochrans test for linear trend was used to test for trend using the absolute prevalences.

Results

Table 1 shows the distribution of education and social class among the old men and women. Significantly more men had a higher education and were in the upper social class compared to women.

Table 2 shows the distribution of different measures of oral health by gender. The proportion of dentate

TABLE 1
Education and social class among the old men and women

	Men (n=54)	Women (n=103)	p*
Education			
Elementary	(13) 24%	(40) 39%	
Medium	(15) 28%	(37) 36%	
High	(26) 48%	(26) 25%	0.014
Social class			
Higher positions	(16) 33%	(4) 5%	
White-collar workers	(17) 35%	(31) 36%	
Blue-collar workers	(16) 33%	(51) 59%	0.001

* p describes differences between men and women by chi-square tests

TABLE 2
Distribution of the oral health variables among men and women

	Men (n=54)	Women (n=103)	p*
Active coronal caries[1]	(45) 49%	(82) 45%	0.684
Active root caries[1]	(45) 60%	(82) 60%	0.979
No teeth	(50) 18%	(97) 19%	0.934
No regular use of dental services	(51) 22%	(97) 20%	0.776

[1] dentate only
* p describes differences between men and women by chi-square tests

study participants with active coronal or root caries was relatively high. Only one fifth of the study population did not use dental services on a regular basis. There were no notable differences between men and women.

Table 3 shows the bivariate analyses of social position in relation to oral health and regular use of dental services by logistic regression analysis. The results show that more persons with only an elementary school education tended to have lost all of their teeth (OR=1.6; 95% CI=0.6-4.1) and to forego the regular use of dental services compared to subjects with higher education (OR=1.8; 95% CI=0.7-4.7). Relative to participants of higher social status, older adults who had been blue/ white-collar workers had nearly significant/ significantly higher odds of having coronal caries (OR=3.4; 95% CI=0.97-11.8/ OR=4.2; 95% CI=1.2-14.9), and tended to be completely edentate (OR=5.3; 95% CI=0.7-43.3/ OR=3.7; 95% CI=0.4-31.8). In addition, older persons who had been blue-collar workers tended to not use dental services regularly compared to persons of higher social status (OR=1.7; 95% CI=0.4-6.5). None of the social position variables were related to root caries.

Table 4 shows the crude and adjusted odds ratios for education and social class on coronal active caries. The crude analyses show nearly significant and significant positive associations between low/ intermediate social class and active coronal caries (OR=3.4; 95% CI=0.97-11.8/ crude OR=4.2; 95% CI=1.2-14.9). The associations show little attenuation when adjusted by age, gender, functional ability, cognitive function, smoking, number of teeth, number of crowns and regular use of dental services (adjusted OR=5.9; 95% CI=1.3-26.5/ adjusted OR=5.4; 95% CI=1.3-22.6). Education was not positively related to active coronal caries. The final model includes variables which were related to active coronal caries in one of the preceding models ($p<0.2$ or OR=> 1.5) or which attenuated the association between the social position variables and coronal caries. The result is that social class, but not education, is significantly related to coronal caries in this population of old-old people.

The adjusted estimates in Table 5 show that persons with low education and low social class tended to be more likely to be edentate compared to persons with high education (OR=1.9; 95% CI=0.6-6.2) and to persons in higher social classes (OR=5.6; 95% CI=0.6-55.6). Although the association between social class and edentulism was insignificant and with very large confidence intervals a linear trend test showed a marginally significant dose-response relationship ($p = 0.086$), i.e. that persons in blue-collar jobs had the highest odds ratio and persons with white-collar jobs an intermediate odds ratio of edentulism compared to persons in leading positions.

Table 6 shows the crude and adjusted odds ratios for education and social class on no regular use of dental services. Although the estimates are non-significant with very large confidence intervals, the results consistently show that people with low education have higher odds of not using dental services regularly than persons with higher education. The associations varied little when adjusted by age, gender, functional ability, cognitive function, smoking and edentulism. Compared to persons with high education the adjusted odds ratios for persons with elementary /medium education on regular use of dental services are: OR=2.3; 95% CI=0.5-11.5/ OR=2.7; 95% CI=0.5-13.7. No consistent association was seen between social class and regular use of dental services.

TABLE 3
Crude odds ratios (95% CIs) for indicators of social position on poor oral health and no regular use of dental services

	Active coronal caries	Active root caries	No teeth	No regular use of dental services
Education				
Elementary	0.6 (0.3-1.5)	1.1 (0.5-2.7)	1.6 (0.6-4.1)	1.8 (0.7-4.7)
Medium	1.0 (0.4-2.3)	0.7 (0.3-1.7)	0.5 (0.2-1.6)	1.1 (0.4-3.1)
High	1.0	1.0	1.0	1.0
Social class				
Blue-collar workers	3.4 (0.97-11.8)	1.2 (0.4-3.6)	5.3 (0.7-43.3)	1.7 (0.4-6.5)
White-collar workers	**4.2 (1.2-14.9)**	0.8 (0.3-2.6)	3.7 (0.4-31.8)	0.8 (0.2-3.7)
Higher positions	1.0	1.0	1.0	1.0

TABLE 4
Odds ratios (95% CIs) for education and social class on active coronal caries by multivariate logistic regression analysis (n = 127)

	Crude	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Final model
Education								
Elementary	0.6 (0.3-1.5)	0.5 (0.2-1.5)	0.6 (0.2-1.5)	0.5 (0.2-1.5)	0.6 (0.2-1.6)	0.6 (0.2-1.8)	0.6 (0.2-1.8)	0.5 (0.2-1.6)
Medium	1.0 (0.4-2.3)	0.8 (0.3-2.0)	0.9 (0.3-2.4)	0.8 (0.3-2.1)	0.8 (0.3-2.1)	0.8 (0.3-2.2)	0.9 (0.3-2.5)	0.9 (0.3-2.5)
High	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Social class								
Blue-collar	3.4 (0.97-11.8)	**4.2 (1.1-15.5)**	**6.7 (1.5-29.2)**	3.0 (0.8-11.6)	**4.1 (1.1-15.4)**	3.6 (0.9-13.9)	3.6 (0.96-13.4)	**5.9 (1.3-26.5)**
White-collar	**4.2 (1.2-14.9)**	**4.4 (1.2-16.3)**	**6.2 (1.5-25.1)**	3.2 (0.8-12.5)	**4.4 (1.2-18.2)**	**3.9 (1.0-15.1)**	3.7 (0.98-13.7)	**5.4 (1.3-22.6)**
Higher positions	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Age (older vs. younger)			1.2 (0.5-2.7)	-	-	-	-	-
Gender (men vs. women)			2.1 (0.8-5.5)	-	-	-	-	2.1 (0.8-5.6)
Decreased functional ability vs sustained good				0.6 (0.2-1.4)	-	-	-	-
Cognitive function								
Poor: 0-23				3.2 (0.9-11.8)				2.5 (0.7-8.8)
Medium:24-26				2.0 (0.7-6.1)				1.7 (0.6-5.3)
High: 27-30				1.0				1.0
Smoking (ever vs. never)					1.1 (0.5-2.5)		-	-
Number of teeth								
1-13						0.6 (0.2-1.8)		
14-20 teeth						1.3 (0.5-3.8)		
21+ teeth						1.0	-	
Crowns								
0-3						2.1 (0.7-6.1)		1.2 (0.5-3.2)
4-6						1.1 (0.4-2.9)		0.9 (0.3-2.3)
9+						1.0	-	1.0
Regular use of dental services (no vs. yes)							0.6 (0.1-2.6)	-

Model 1: Includes both measures of social position
Model 2: Adjusted by age and gender
Model 3: Adjusted by functional ability and cognitive function
Model 4: Adjusted by smoking
Model 5: Adjusted by number of teeth and number of crowns
Model 6: Adjusted by use of dental services

TABLE 5
Odds ratios (95% CI) for education and social class on edentulism by multivariate logistic regression analysis (n = 157)

	Crude	Model 1	Model 2	Model 3	Model 4
Education					
Elementary	1.6 (0.6-4.1)	1.4 (0.5-4.3)	1.8 (0.6-5.9)	1.7 (0.5-5.8)	1.9 (0.6-6.2)
Medium	0.5 (0.2-1.6)	0.3 (0.1-1.1)	0.3 (0.1-1.3)	0.2 (0.0-1.1)	0.3 (0.1-1.5)
High	1.0	1.0	1.0	1.0	1.0
Social class					
Blue-collar	5.3 (0.7-43.3)	5.2 (0.6-45.1)	7.1 (0.8-67.0)	5.6 (0.6-56.6)	5.6 (0.6-55.6)
White-collar	3.7 (0.4-31.8)	4.4 (0.5-39.4)	6.1 (0.6-57.7)	4.3 (0.4-43.8)	5.0 (0.5-49.3)
Higher positions	1.0	1.0	1.0	1.0	1.0
Age (older vs. younger)			1.6 (0.6-4.2)	1.6 (0.6-4.7)	1.5 (0.5-4.0)
Gender (men vs. women)			1.9 (0.7-5.2)	1.6 (0.5-4.9)	1.5 (0.5-4.6)
Decreased functional ability vs. sustained good				1.3 (0.4-4.0)	-
Cognitive function					
Low: 0-23				1.1 (0.3-4.0)	
Medium: 24-26				1.2 (0.3-4.6)	
High: 27-30				1.0	-
Smoking (ever vs. never)					1.7 (0.6-4.9)

Model 1: Includes both measures of social position
Model 2: Adjusted by age and gender
Model 3: Adjusted by age, gender, functional ability and cognitive function
Model 4: Adjusted by smoking

Discussion

The primary finding of the present study is that two measures of social position are differently related to active caries and to regular use of dental services. A measure of education reflecting early life experiences tends to be related to regular use of dental services, while a measure of social class reflecting the working ages is significantly related to coronal caries.

The findings suggest that very old Swedes with low education tend to be less likely to visit the dentist regularly compared to their more educated counterparts. The estimates are not significant, but the strength of the findings are supported by the agreement with several other studies (12,29,30).

From a life-course perspective, the level of education usually reflects a characteristic representing the transition from a social position largely received from parents to an achieved social position as an adult. Educational success also provides information about the likelihood of future success, as higher levels of education generally are predictive of better jobs, higher incomes, better housing and better working conditions (20). It is likely that education reflects other important factors related to orientation toward preventive dental services such as knowledge, attitudes and the value placed on oral health, factors which are known to be related both to education and use of services (12). Further, education may serve as an indicator of life-course socioeconomic position and may determine individual membership in certain subcultures of societies with their own norms about oral health, not governed by individual knowledge (30). It is of special interest that education early in life may play such an important role in the use of services even more than half a century later.

Occupation influences living conditions in adult life and represents the major structural link between education and income. Educational experiences are important in determining what sorts of employment are available, and this employment then largely determines level of income. In the present study, social class based on occupation was related to coronal caries after controlling for educational level, which suggests that effects beyond those of individual attributes related to education might be involved. Social class measured by occupation is indicative of health-related concomitants of the job, e.g., variations in control over the workplace or differing reward structures but may also be seen as proxy indicators of income, representing the ability to pay for restorative and prosthodontic care. Thus, social inequalities of the working ages can be associated with oral health status in old age. This suggests that the measure of social class is a stronger indicator of social position throughout life

TABLE 6
Odds ratios (95% CIs) of education and social class on no regular use of dental services by multivariate logistic regression analysis (n = 157)

	Crude	Model 1	Model 2	Model 3	Model 4	Model 5
Education						
Elementary	1.8 (0.7-4.7)	1.9 (0.6-6.2)	2.6 (0.7-9.0)	2.6 (0.7-9.2)	2.6 (0.7-9.2)	2.3 (0.5-11.5)
Medium	1.1 (0.4-3.1)	1.0 (0.3-3.4)	1.2 (0.3-4.2)	1.2 (0.3-5.2)	1.2 (0.3-4.5)	2.7 (0.5-13.7)
High	1.0	1.0	1.0	1.0	1.0	1.0
Social class						
Blue-collar	1.7 (0.4-6.5)	1.3 (0.3-5.7)	1.8 (0.4-8.5)	2.0 (0.3-12.3)	1.5 (0.3-7.4)	0.5 (0.1-3.5)
White-collar	0.8 (0.2-3.7)	0.8 (0.2-3.7)	1.1 (0.2-5.3)	1.1 (0.2-5.3)	0.9 (0.2-4.6)	0.3 (0.0-2.2)
Higher positions	1.0	1.0	1.0	1.0	1.0	1.0
Age (older vs. younger)			1.7 (0.7-4.5)	1.6 (0.5-4.5)	1.6 (0.6-4.2)	1.5 (0.5-5.1)
Gender (men vs. women)			1.9 (0.7-5.2)	1.7 (0.6-5.1)	1.5 (0.5-4.6)	1.3 (0.4-4.7)
Decreased functional ability vs. sustained good				2.1 (0.7-6.2)		-
Cognitive function						
Low: 0-23				2.4 (0.7-8.8)		
Medium: 24-26				0.9 (0.2-3.5)		
High: 27-30				1.0		
Smoking (ever vs. never)					1.7 (0.6-4.7)	
No teeth vs. teeth						30.0 (8.1-111.8)

Model 1: Includes both measures of social position
Model 2: Adjusted by age and gender
Model 3: Adjusted by age, gender, functional ability, and cognitive function
Model 4: Adjusted by age, gender and smoking
Model 5: Adjusted by age, gender and edentulousness

in relation to coronal caries than education. These findings are underlined by the fact that educational level does not even tend to be related to dental caries in the present study.

The finding that lower and intermediate social class tend to be associated with edentulism is in agreement with several other studies that included very old people (6,9,10,15). This is not surprising. It is likely that social position is related to norms and values and has had a strong influence on the choice between extraction of teeth and other types of dental care throughout life in Sweden, at least until the Dental Health Care Reform was introduced in 1974 (32).

Multivariate analyses were used, with both education and occupation as covariates. From a theoretical point of view it might be problematic to treat occupation as a confounder for the influence of education, as it is an effect of education and mediates its impact. However, the purpose of the analysis was to identify occupational effects beyond those of education. The analyses also showed that education did not modify the effect of occupation on oral health.

Several aspects of the study should be taken into consideration in the interpretation of the study's results. The study population was restricted to community-dwelling, generally healthy older adults. It is obvious that the findings regarding oral health would have been notably different had the analyses included functionally dependent or institutionalized individuals of the same age.

The size of the sample sets constraints on the complexity of the analyses that could be undertaken. It should be kept in mind, however, that data of the type represented in the current study are difficult and expensive to collect and, as a consequence, are relatively rare in the literature. Despite the limitations imposed by size, the study nonetheless allows a first glimpse into the complex interaction between different measures of social position and oral health in a generally healthy very old community-dwelling population.

The statistical power was limited because of the relatively small cell sizes. Consequently, findings with high odds ratios, which did not achieve statistical significance at the 0.05 level, e.g., indicating a tendency to an association between education and regular dental visits, have been presented. It is evident that this strategy causes an increased likelihood that beta-errors occurred during the process. Therefore, the findings of the study should be taken with some caution and should be viewed in terms of hypothesis generation rather than hypothesis testing.

It is a strength of the study that the oral health measures include both clinically observed and self-report data, that the examiners of caries were standardized to caries criteria and

that they participated in calibration sessions prior to and during the survey. Oral disease is most likely to be underestimated given the stringent criteria used to diagnose coronal and root decay as well as the lack of radiographs to identify proximal lesions. The number of remaining teeth is a widely used indicator of oral health (8,33) which is considered to be reasonable, because it is easy to define and not subject to personal judgments (5). In the opinion of the authors, fillings and missing teeth reflect an old person's dental care history in a life-course perspective, whereas active caries rather reflects a disease that is present now, although it could be a slowly progressing lesion. There is a possibility of treatment bias for persons of this age. If there is a leak next to a filling with a little secondary caries, it may not necessarily warrant treatment. However, it is beyond the scope of the present paper to assess treatment need.

The two measures of education and social class based on occupation are generally recommended as useful indicators of social position in elderly populations (34,35). The measure of education is among the most widely used indicators of social position (35,36), because of its ease of measurement, applicability to persons not in the active labor force, stability over adult life span regardless of changes in life expectancy and associations with numerous health outcomes. However, educational level may be a less sensitive measure for evaluating the magnitude of social inequalities in health and it has been shown to be less predictive than social class of ownership of capital assets (35). It is obvious that higher income and financial assets during working ages also to a higher degree than education provide the opportunity for better pensions after retirement.

The used measure based on longest held occupation is rough as it includes persons who have spent all their career at the same level and persons who have worked their way up or down the career level. However, an earlier study showed that patterns of association between occupation and various health measures, including oral health, were in the same direction when longest held occupation and last held occupation were used as outcome measures (37). The measure of social class based on occupation has been widely used in European public health surveillance and research (35,36). Distinctions between social classes are based on a graded hierarchy of occupations ranked according to skills. These schemes have proven to be powerfully predictive of inequalities in morbidity and mortality. In the case of retired persons, approaches to measuring this usually rely on proxy measures, e.g., last or longest-held occupation. A British study indicates that measures based on last occupation are predictive of chronic illness in retired people (38). A recent study also showed high inter-rater agreement in measures based on occupation (39). Women who had been housewives throughout life were classified according to their husband's occupation. The authors believe that this is justified in this very old population, as studies of social class inequalities in health have shown stronger associations between married women's health and their husband's class versus their own class (40).

There is a risk of misclassification with regard to the used measures of the social position questions, because of the long time-span between the time of education/occupation and the time of the interview. It might have been better to ask more precisely about school exams or degrees or about exact jobs. On the other hand, there is no reason to believe that this possible misclassification is systematic. Another possibility could have been to get the information about the social indicators by registers. However, this information is not available for these old age groups.

Because of the small sample size the analyses were not stratified by gender, even though studies have shown different associations for men and women. In one study, Österberg *et al.* (4) found that income was only related to oral health among men. In another study Österberg *et al.* (41) found that among women education, occupation, and income were all related to oral health, whereas among men education and income were not. Avlund *et al.* (37) found that among 75-year-old men education and housing tenure, but not occupation, were related to number of teeth. Among women, education, occupation and income were all related to number of teeth. The present analyses were adjusted by gender. This did not influence the results.

In summary, the survey identified social inequalities in caries even in a population of independent living generally healthy very old Swedes and in a country where the public health policies have tried to minimize these inequalities. The finding was not explained by regular use of services. This would suggest that the amount and types of dental treatments provided per visit may be an important factor underlying this discrepancy, i.e., that cost of dental care may have influenced the consumption of dental treatments for those of limited means. From a public dental health perspective, the organization of the dental health care delivery system and price subsidy for dental treatment may be significant mitigating factors that may improve oral health care for independently living old people.

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