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Oral health equality during 30 years in Norway

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Abstract – *Objectives:* To study the relationship between income and edentulousness and having a functional dentition from 1975 to 2002, and to examine whether or not the findings can be characterized as a social gradient. *Methods:* Four datasets were collected by personal interviews and precoded questionnaires by Statistics Norway in 1975, 1985, 1995 and 2002. The datasets were representative of the non-institutionalized adult population in Norway. Each year, the sampled persons were distributed into five income quintiles. Four effects were examined of the relationship between income quintiles and edentulousness and functional dentition (1) the absolute equality effect, (2) the period effect, (3) the relative equality effect, and (4) the gradient effect. *Results:* The main finding is that in absolute terms oral health is more equally distributed in 2002 than in 1975, and the lowest income groups benefited the most in oral health. Among the elderly, however, having a functional dentition was less equally distributed in 2002. The relative differences increased for the oldest for each new birth cohort; thus, the chances of being edentulous was 7.5 times higher in the lowest income group versus the highest group in 2002, whereas the chances were only two times higher in 1972. Having lost all natural teeth was infrequent in 2002, and inequality wiped out in the population below ≥60 years. A small social gradient was still in 2002. *Conclusions:* The condition of edentulousness is a result of accumulated incidences of dental diseases and fragmented access to dental care. Economic barriers and unavailability of dental care postponed necessary restorative dental care and resulted in more drastic treatment solutions previously especially in the rural areas in Norway.

Key words: endentulousness; functional dentition; oral health; social inequality

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The present work is concerned with variation in dental status related to socio-economic conditions, and questions whether this relationship has changed during the last nearly 30 years. Socio-economic conditions in a country always affect occurrence of disease and health (1). At the start of the 21st century, all European countries were faced with substantial inequalities in health and disease within their populations (1). Health and disease inequalities are mainly caused by the higher exposure to material, psychosocial and behavioural risk factors in lower socio-economic groups. A number of studies suggest that the relationship between socio-economic status and disease has the form of a social gradient from the top to the bottom of the social hierarchy (2–5). According to the gradient theory inequality of health is not only confined to the poorest members of society but runs right across the social spectrum (6). The mechanisms of the suggested gradient relationship attract attention and research many places, for review, see (4–7). To days challenge in the gradient research is to provide further evidence of the obvious interplay between psycho-social, material, cultural and behavioural explanations. In Norway, researchers and national health authorities have adopted the gradient description, and a national strategy to reduce inequalities in disease and health outcomes has been launched (7, 8).

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In this paper, socio-economic difference in dental status is defined as systematic differences in the occurrence of specific conditions of dental status between individuals with a higher and a lower socio-economic status. 'Socio-economic status' refers to the individual's relative position in the social stratification, and is usually measured with information on level of education, occupational class or income level. Our understanding of the explanations of socio-economic inequalities in health is that socio-economic status mainly affects health through a differential distribution of specific health determinants like working and living conditions, health related behaviours, access to health care, and these determinants are related to income (5). Most of the dental studies on the relationship between socio-economic indicators and oral health have been based on cross-sectional study designs (9–11) and repeated cross-sectional designs (12–14). Nearly all cross-sectional studies found a relation between social status and indicators of dental status and disease (15). There are very few if any studies where social equality in oral health has been studied by longitudinal and life course designs. Repeated cross-sectional data have a similar descriptive potential as longitudinal and life course designs, but are weaker when it comes to inferring to causal effects and age, cohort and period influences.

Oral health may be defined in several ways comprising the presence of natural teeth, the prevalence of disease or the outcome of treatment of disease in a population. In the present work, oral health is measured by two dental status indicators: Edentulousness and having ≥20 natural teeth. Edentulousness could be considered a dental mortality variable and a functional dentition an oral health variable. Both dimensions reflect aspects of underlying accumulated disease occurrence, and when and how diseases were treated or not (12). In the oral health domain, the natural history of disease and treatment consequences are intertwined as a consequence of how the conditions are usually measured in epidemiological surveys. In countries with easy access to dental care for the majority of the population it is difficult to disentangle the contributions of disease and dental care in cross-sectional epidemiological data (12).

The focus of the present work was to investigate the equality of oral health and patterns of deviation from equality. More precisely, the purpose of the present paper was to study the relationship between income and edentulousness and having a functional dentition from 1975 to 2002, and to examine whether or not the findings can be characterized as a social gradient. Not all social differences between subgroups in a population are signs of inequality. The notion of equality covers the phenomenon being studied. In the discussion part, obvious social differences will be interpreted as signs of inequality.

Material and methods

Four different datasets were collected by personal interviews and precoded questionnaires by Statistics Norway in 1975, 1985, 1995 and 2002 (16–19). The first three datasets were from national health surveys and the fourth was from a national survey of living conditions (16–19). In 2002, only persons in the main sample were included. The datasets are representative of the non-institutionalized adult population in Norway. Table 1 shows the total the number of persons 20 years or more in the samples and included in the present analyses, and distributions of participants according to age.

The respondents were asked questions about their oral health status. In 1975, a question was asked about edentulousness. In the later surveys, a question was added about number of natural teeth present in the mouth in four categories: 0 teeth, 1–9 teeth, 10–19 teeth, and ≥20 teeth. Both questions have been validated previously against clinical examination (20–22). The number of teeth variable was recoded into functional dentition (≥20 natural teeth) and partial dentition (< than 20 natural

Table 1. Distribution of persons according to age in four datasets from 1975 to 2002

	Health Survey 1975		Health Survey 1985		Health Survey 1995		Survey of living conditions 2002	
Age (years)	Number	Percent	Number	Percent	Number	Percent	Number	Percent
20–34	2162	28.8	2185	29.4	1990	26.6	843	26.4
35–59	3217	42.8	3064	41.2	3335	44.6	1561	48.9
≥60	2131	28.4	2195	29.5	2149	28.8	790	24.7
Total	7510	100.0	7444	100.0	7474	100.0	3194	100.0

Table 2. Dental status according to year and age

Year	Age (years)	(*n*)	% Edentulous	% ≥ 20 teeth[a]
1975	20–34	2152	0.5	
	35–59	2713	15.7	
	≥60	2131	52.9	
1985	20–34	2177	0.1	98.1
	35–59	3041	6.6	78.2
	≥60	2188	41.7	28.6
1995	20–34	1989	0.0	99.5
	35–59	3335	1.6	89.3
	≥60	2142	32.5	37.4
2002	20–34	842	0.1	99.3
	35–59	1561	0.7	91.7
	≥60	783	16.4	51.5

[a]The question not asked in 1975.

teeth). The distribution of the samples according to year, age and edentulousness and functional dentition is given in Table 2.

Total household income per household member was chosen as an indicator of socio-economic position. Each year the sampled persons were distributed into five income quintiles. The 0–20 quintile comprised the 20% of the sample with the lowest income, the 21–40 quintile the 20% of the sample with the second lowest income and accordingly the 81–100 quintile comprised the 20% of the sample with the highest income. The quintiles thus represent the income distribution in equal sized groups from the lowest quintile to the highest. Using quintiles eliminates the problem often met with the variable income that the proportion of the population with a certain income changes over time. Neither change in purchasing power from year to year affects the quintile classification.

In the analyses, the rate of edentulousness and of functional dentition was calculated as a percentage of the whole age group and of the quintile groups in each year. A rate ratio was calculated by dividing the lowest income quintile rate with the highest income quintile rate in each age group and for each year (1, 23). The number of persons is not exactly the same in each quintile due to missing observations on the included variables. The difference in rates between quintiles in each age group represents inequality in absolute terms, whereas the rate ratio shows inequality in relative terms.

According to the concept of the social gradient, the gradient variable has an ordinal measurement nature. A gradient is present if the outcome variable changes systematically from one quintile within the same year to the next in an either upward or downward manner. Whether or not the relationship between household income and dental status takes the form of a gradient will be inspected in graphical presentations.

Analytical design and effects

Four effects will be examined of the relationship between income quintiles and edentulousness and functional dentition (Table 3). (1) The absolute equality effect is measured vertically as the difference between the rates of edentulousness and functional dentition in the lowest and the highest income quintile in each age group and each year. Our main focus is with the first and the last year of observation. In 1975, the equality effect in absolute terms is Q75/1–Q75/5 and in 2002 Q2002/1–Q2002/5. The results are included in table three and four and show whether equality of oral health declines or inclines during the period. (2) The period effect is measured horizontally as the difference between rates of edentulousness and functional dentition at two points in time at the same quintile level. For the lowest income quintile in 1975 and 2002 this is Q1975/1–Q2002/1, and for the highest income quintile Q1975/5–Q2002/5. The period effect shows the effect of societal changes within the same income level. The difference between the period effect in the highest and the lowest income quintile will indicate whether people in high and low social status groups have benefited to the same extend during the period. (3) The relative equality effect is the ratio of the rates of edentulousness and functional dentition in the lowest quintile and the highest quintile within 1 year. The ratio is measured as Q75/1divided by Q75/5 and Q2002/1 divided by Q2002/5. The ratio shows for each year how much higher or lower the relative risk for a condition is in lowest income quintile relative to the highest income quintile. The ratio is thus the relative equality that each birth cohort experiences. (4) The gradient effect may be observed if within

Table 3. Quintile identification by year of study and sequence from bottom to top

Quintiles (%)	Year			
	1975	1985	1995	2002
1–20	Q75/1	Q85/1	Q95/1	Q2002/1
21–40	Q75/2	Q85/2	Q95/2	Q2002/2
41–60	Q75/3	Q85/3	Q95/3	Q2002/3
61–80	Q75/4	Q85/4	Q95/4	Q2002/4
81–100	Q75/5	Q85/5	Q95/5	Q2002/5

each study year the income quintiles differ systematically from one another in an ordinal way: Q75/1 > Q75/2 > Q75/3 > Q75/4 > Q75/5 or in the opposite direction. The gradient effects will be presented for all age groups and the two oldest separately.

Results

Table 2 shows the crude rates of edentulousness and functional dentition from 1975 to 2002. Whereas edentulousness was seldom in the age group 20–34 in the whole period, the rate declined by 36.5% in the ≥60 age group. Nearly all had a functional dentition in the age group 20–34 during the period. The rate of having a functional dentition increased by 13.5% and by 22.9% in the age groups 35–59 and ≥60 respectively.

The absolute equality effect

Tables 4 and 5 show the rate of edentulousness and having a functional dentition according to income quintiles and age group and year. The equality effect can be read vertically as the difference between the lowest and the highest quintiles within each age group and year. The rate of edentulousness decreased by increasing income quintile in each age group and year except a few and numerically minor differences (Table 4). In 1975, the equality effect was 18.4 for all age groups combined and 0.5, 9.8 and 34.7 for the age groups 20–34, 35–59 and ≥60, respectively. In 2002 the equality effects were 7.9 for all age groups combined and 0.6, 0.0, and 29.3 for the age groups. Between 1975 and 2002 inequality decreased by 10.5% for all age groups combined and by 9.8% and 5.4% in the two oldest age groups and by −0.1% in the youngest age group where the percentage edentulous was negligible already in 1975.

Table 5 shows increasing rates of having a functional dentition by increasing income quintile and year. The differences between highest and lowest quintiles were smaller in 2002 than in 1975 in the two younger age groups and increased in the oldest. The level of inequality decreased in absolute terms in the younger age groups, but increased in the oldest.

Period effects

Tables 4 and 5 show horizontally the period effects within the same level of quintile from 1975 to 2002. All age groups combined the lowest quintile had the greatest reduction in rate of edentulousness (−25.0%) and the highest quintile had a −14.5% reduction in the rate of edentulousness. The difference was 10.5%. In the age group 20–34 years, the rate of edentulousness was low in 1975 and the period effects were −0.1 and −0.2 within the lowest and within the highest quintile level. In age group 35–59, the differences horizontally between 1975 and 2002 in the lowest and the highest quintile were −18.7% and −8.1% respectively. In the oldest age group, the difference between 1975 and 2002 in the lowest and the highest quintile was −34.9% and −29.5% respectively. Throughout the period the lowest quintile had the greatest improvement in edentulousness. The same was found for functional dentition with the exception of the oldest age group where the highest income profile had the greatest increase.

The relative equality effect

The relative equality effects are calculated in Table 6. With a rate ratio of 1 there is no difference between the lowest and highest quintile rates. A rate ratio which is higher than 1 shows that the rate was higher in the lowest than in the highest quintile. A rate ratio which is below 1 shows that the rate was lower in the lowest quintile than in the highest quintile. The relative equality effects in edentulousness decreased in the age group 20–34 and 35–59, and increased in the oldest age group. The largest relative equality effect was seen the all ages combined group in 2002 that mounted to 14.2.

The relative equality effect in functional dentition was nearly one in 1985 and 2002 in the younger age groups and was unchanged 0.3 in the oldest age group through the years.

The gradient effect

Figs 1 and 2 show the systematic pattern of edentulousness and functional dentition according to income quintiles over the study years. With a few exceptions a gradient effect in the effect of income quintile on edentulousness and functional dentition could be observed in all age groups and through the years.

Discussion

There were marked changes in edentulousness and in having a functional dentition in the non-institutionalized adult Norwegian population from 1975 to 2002. The main finding is that in absolute terms

Table 4. Percent being edentulous according to age group, income quintile and year

		1975		1985		1995		2002		
Age col 1	Quintile col 2 (%)	(*n*) col 3	% edentulous col 4	(*n*) col 5	% edentulous col 6	(*n*) col 7	% edentulous col 8	(*n*) col 9	% edentulous col 10	Period effect: 1975–2002 col 4–col 10
All	≤20	1500	33.5	1484	36.9	1492	18.7	644	8.5	25.0
	21–40	1497	19.7	1474	14.0	1491	14.9	632	6.0	23.7
	41–60	1504	23.0	1486	9.2	1488	7.9	638	5.0	18.0
	61–80	1507	18.1	1486	8.6	1496	6.2	636	1.7	16.4
	>80	1502	15.0	1476	6.5	1499	2.5	636	0.6	14.5
Equality effect: lowest -highest quintile			18.4		30.4		16.2		7.9	
20–34 years	≤20	432	0.7	428	0.2	396	0.0	170	0.6	0.1
	21–40	429	0.7	438	0.0	399	0.0	167	0.0	0.7
	41–60	434	0.2	434	0.0	396	0.0	170	0.0	0.2
	61–80	434	0.5	436	0.0	399	0.0	167	0.0	0.5
	>80	433	0.2	441	0.0	399	0.0	168	0.0	0.2
Equality effect: lowest–highest quintile			0.5		0.2		0.0		0.6	
35–59 years	≤20	643	19.0	603	11.0	666	2.1	315	0.3	18.7
	21–40	639	16.1	614	5.5	667	0.9	312	0.3	15.8
	41–60	637	19.3	605	5.6	666	1.8	311	2.3	17.0
	61–80	653	14.9	607	5.6	667	2.3	311	0.3	14.6
	>80	645	9.2	612	5.2	669	1.1	312	0.3	8.1
Equality effect: lowest–highest quintile			9.8		5.8		1.0		0.0	
≥60 years	≤20	422	68.7	439	61.1	427	51.5	157	33.8	34.9
	21–40	430	65.4	434	57.8	432	45.6	154	20.1	45.3
	41–60	426	56.3	439	42.4	422	31.0	156	18.0	38.3
	61–80	427	40.1	439	29.4	432	24.8	159	5.7	34.4
	>80	426	34.0	437	18.1	429	9.3	157	4.5	29.5
Equality effect: lowest–highest quintile			34.7		42.1		42.2		29.3	

Table 5. Percent with a functional dentition according to age, quintile and year

Age col 1	Quintile col 2 (%)	1985 (*n*) col 3	1985 % Functional dentititon col 4	1995 (*n*) col 5	1995 % Functional dentititon col 6	2002 (*n*) 7	2002 % Functional dentititon col 8	Period effect: 1985–2002 col 4–col 8
All	≤20	1484	43.3	1492	68.4	644	78.3	−35.0
	21–40	1474	70.4	1491	70.5	632	78.8	−8.4
	41–60	1486	75.0	1488	78.6	638	83.5	−8.5
	61–80	1486	77.0	1496	80.7	636	87.1	−10.1
	>80	1476	81.5	1499	87.5	636	91.5	−10.0
Equality effect: lowest–highest quintile			38.2		19.1		13.2	
20–34 years	≤20	428	95.3	396	99.8	170	98.2	−2.9
	21–40	438	98.6	399	99.8	167	99.4	−0.8
	41–60	434	98.2	396	98.7	170	99.4	−1.2
	61–80	436	98.4	399	100.0	167	100.0	−1.6
	>80	441	100.0	399	99.3	168	99.4	0.6
Equality effect: lowest–highest quintile			4.7		0.5		0.8	
35–59 years	≤20	603	71.0	666	89.9	315	92.4	−21.4
	21–40	614	79.2	667	90.6	312	91.0	−11.8
	41–60	605	79.3	666	86.5	311	90.7	−11.4
	61–80	607	79.9	667	88.5	311	91.0	−11.1
	>80	612	81.5	669	91.0	312	93.6	−12.1
Equality effect: lowest–highest quintile			11.5		1.1		1.2	
≥60 years	≤20	439	16.2	427	20.1	157	24.2	−8.0
	21–40	434	14.1	432	22.0	154	41.6	−27.5
	41–60	439	12.4	422	34.4	156	51.9	−30.5
	61–80	439	36.7	432	44.9	159	67.3	−30.6
	>80	437	54.7	429	65.7	157	72.0	−17.3
Equality effect: lowest–highest quintile			38.5		45.6		47.8	

Table 6. The relative equality effect according to age group and year

Age (years)	1975	1985	1995	2002
Edentulousness				
All	2.1	5.7	7.5	14.2
20–34	3.5	0.0	0.0	0.0
35–59	2.1	2.1	1.9	1.0
≥60	2.0	3.4	5.5	7.5
Functional dentition				
All		0.5	0.8	0.9
20–34		1.0	1.0	1.0
35–59		0.9	1.0	1.0
≥60		0.3	0.3	0.3

oral health is more equally distributed in 2002 than in 1975, and the lowest income groups benefited the most in oral health. Among the elderly, however, having a functional dentition was less equally distributed in 2002. The latter means that elderly people in highest quintile benefited the most from such societal conditions that made it possible to maintain a natural dentition. The relative differences increased for the oldest for each new birth cohort; thus the chances of being edentulous was 7.5 times higher in the lowest income group versus the highest group in 2002, whereas the chances were only two times higher in 1972. Having lost all natural teeth was infrequent in 2002, and any inequality wiped out in the population below ≥60 years. It is even more noteworthy that there is full equality in having a functional dentition up to the age of 60 years. Yet, a small social gradient was still present for these oral health conditions in 2002; smaller in absolute terms in 2002 than in 1975, but steeper relatively among the elderly.

There is no doubt that social conditions and historical context determined the high rate of edentulousness and the gradient in 1975. The inequality in edentulousness changed modestly in the oldest age group. In order to understand this, it shall be borne in mind that the condition of edentulousness is an irreversible condition. Once a person has become edentulous he or she cannot get natural teeth back, but the person stays in the statistics the rest of the life. The very person may experience better life conditions after becoming edentulous, but has no chance of benefiting from

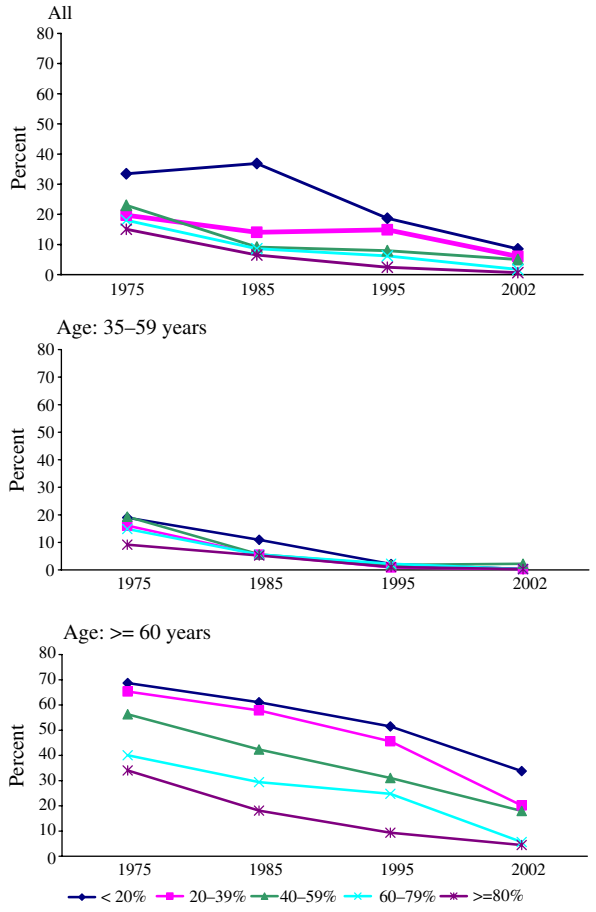

Fig. 1. Percent being edentulous according to age group, income quintile and year.

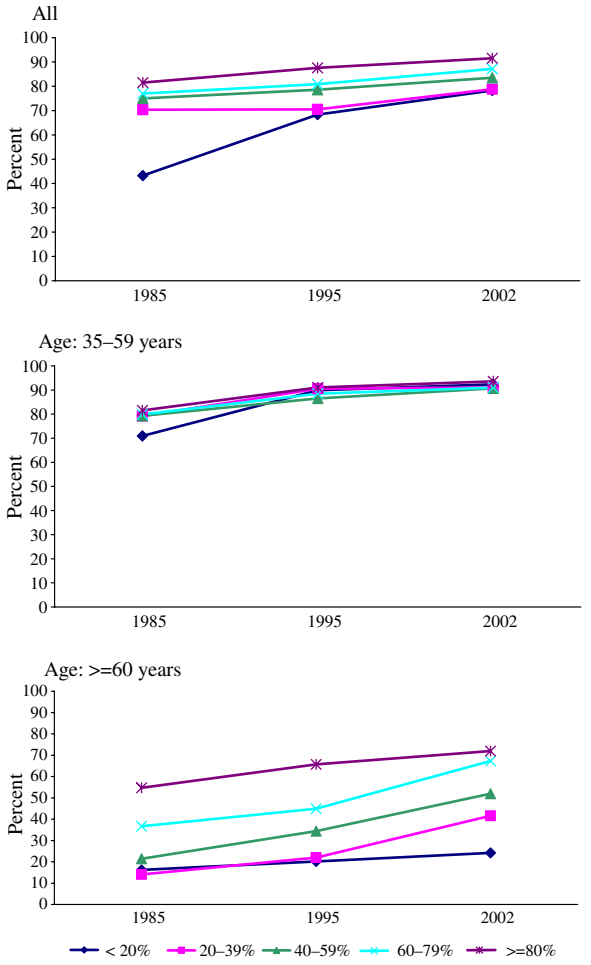

Fig. 2. Percent with a functional dentition according to age, quintile and year.

them dentally. Only later birth cohorts confronting changing disease risks and treatment conditions have a potential to benefit and remain dentate. In the most recent birth cohort, in this material, the youngest of the ≥60 year olds were born in 1942. Assuming the oldest to become 100 years they were born back to approximately 1902. Members ≥60-years old of the historically first cohort in this material were born between approximately 1875 and 1915. Even in the most recent cohort the chance of becoming edentulous before the age of 60 was relatively high (12, 13, 24). Consequently, many cohort members have not had the chance to benefit from the improved living conditions after 1975 that have given the younger age groups in cohorts the chance to stay dentate. The irreversibility of dental diseases and their treatment reduces the potential for oral health improvement in age groups already affected by edentulousness. This is probably the most likely explanation of the historically backlog manifested in the nearly parallel slopes of edentulousness and having a functional dentition in Figs 1 and 2. It may also be worthwhile to make a distinction between the societal conditions that lead to edentulousness and those that lead to maintenance of a functional dentition. Edentulousness is now an unusual outcome, but the conditions promoting and maintaining a healthy oral dentition may not be equally distributed yet.

The absolute and the relative measures of equality of oral health gave very different results. The ratio between the rates of dental status in two social groups indicates the relative difference in risk. The absolute measure indicates the population impact of socio-economic differences and depends on the prevalence of the differences in the population. When the health outcome changes over time as shown in this work, it is mandatory to calculate both the rate and the rate ratio and to give both an adequate interpretation (1, 23). The choice between a relative and an absolute measure depends upon the purpose of a study and the nature of the data. If only

cross-sectional 2002 data had been used, the conclusion would be made that a clear income inequality in dental status was found in the adult Norwegian population. The marked improvement in absolute equality and during the period for most groups would have been ignored, and the interpretation could have been partly misleading. A single rate ratio interpretation overlooks the possibility that a seemingly increasing inequality may be part of a general improvement that takes longer time in socio-economic low groups than in economically more advanced social groups. The policy consequences of a real increasing social inequality in the population as a whole versus a slower improvement in the low social status groups than in the high would probably be different.

The approach to studies of health equality is important in order to avoid a partial picture of social process related to health. As seen above single cross-sectional studies may have clear limitations in such respect. A better solution is life course designs that examine various potential processes through which exposures located at different stages of life may exert alone or in combination influences on disease risk (23). 'The critical period model' suggests that exposure acting at a specific time has long-lasting effects on different body outcomes (25, 26). A variant of 'the life time course model' suggests that the effects of socio-economic conditions accumulate over the life course (1, 26). Studies have shown that the relative contribution of childhood and adulthood to social conditions and health appears to depend on the specific outcome studied (23). Næss recently found that education, occupational class and housing conditions seemed to discriminate all-cause mortality to a similar degree. Yet, cause-specific analyses revealed a heterogeneous pattern (23). Household income was used in this work, and analyses not presented showed that similar results were obtained when using educational length as a social indicator. Additional socio-economic variables could be included because it is likely that different indicators of oral health tap into different constructs on the causal pathway to various outcomes (4, 23).

Generally, the causal effect of socio-economic status on disease and health is likely to be largely indirect: through a number of more specific determinants like material living conditions, education and life style which are differently distributed across socio-economic groups. The presence of a gradient, however, shows that the social groups may have something in common. According to Marmot and Wilkinson and Marmot all social groups below the top highest have a common risk of socio-psychological stress related to relative rather than absolute deprivation in the social hierarchy that they are part of (4, 6). At any place below the top of a social hierarchy being of subordinate social status causes social stress that has to do with competition, shame, inferiority, fears of incompetence and being put down, regular hassles and the combination of high demands and low control in every day life. Marmot and Wilkinson and Marmot (4, 6) suggest that stressful life perceptions have independent effects on disease and health through psycho-biological pathways. According to their theory, the gradient in dental status, though observed in an income hierarchy, is not only the result of health habits and purchasing power connected to high income but of the relative position in the social hierarchy.

It was not within the scope of the present study to sort out the mechanisms of oral health inequality. Abundant research shows a relationship between socio-economic status and dental status variables, but provides limited understanding on the mechanisms of the association. The condition of edentulousness is a result of accumulated incidences of dental diseases and fragmented access to dental care. Economic barriers and unavailability of dental care postponed necessary restorative dental care and resulted in more drastic treatment solutions previously especially in the rural areas in Norway (12). It is tempting to blame previous poverty for higher incidence of disease, insufficient knowledge, bad diet and oral hygiene, and financial barriers to dental care. This would be a support to materialistic and behavioural explanations (8, 23). However, the seemingly persistence of a gradient shows that poverty alone was not the cause. Neither people in the higher economic strata avoided edentulousness. In the highest income quintile every third person ≥60-year old was edentulous in 1975. More people in the second highest quintile and more people in the third highest quintile compared to the second highest quintile and so on were edentulous. Generalizing from Marmot and Wilkinson and Marmot (4, 6) it is possible that a feeling of a dental destiny and inescapability, of not having control of the disease and its treatment increased down the social ladder and lead more people stepwise down into a dental misery. Recent research has shown evidence of a psycho-biological stress mechanism that destroys

the periodontal tissue that keeps teeth in the bone of the jaws (3, 27). A crude and yet unsubstantiated speculation could imply that improved material conditions, better living conditions and education, more fluoride toothpaste and adequate health behaviours have largely contributed to the improvement of the level of oral health shown by the indicators in this study. The presence of a social gradient may be conditioned by socio-psycho-biological stress mechanisms, though the causal routes are far from clear. Studies of more refined oral health indicators than used in the present study and of people's perception of their oral health may shade off the picture of equality of oral health of populations.

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References

1. Machenbach JP. Health inequalities: Europe in profile. Expert report commissioned by, and published under the auspices of, the UK Presidency of the EU the Netherlands: The Hague; 2005.
2. Watt R, Sheiham A. Inequalities in oral health: a review of the evidence and recommendations for action. Br Dent J 1999;187:6–12.
3. Sheiham A, Nicolau B. Evaluation of social and psychological factors on periodontal disease. Periodontol 2000 2005;39:1–14.
4. Marmot M, Wilkinson RG. Social determinants of health. Oxford: Oxford University Press; 1999.
5. Machenbach JP, Gunning-Schepers LJ. How should interventions to reduce inequalities in health be evaluated? J Epidemiol Community Health 1997;51:359–64.
6. Marmot M. Status Syndrome. London: Bloomsbury; 2005.
7. Directorate for Health and Social Affairs. The challenge of the gradient. The Norwegian Directorate for Health and Social Affairs' Plan of Action to Reduce Social Inequalities in Health. IS-1245 Oslo: Directorate for Health and Social Affairs; 2005.
8. Krokstad S. Socio-economic inequalities in health and disability. Thesis. Trondheim: Norwegian University of Science and Technology; 2004.
9. Kelly M, Steele J, Nuttall N, Bradnock G, Morris J, Nunn J et al. Adult Dental Health Survey. Oral health of the United Kingdom 1998. London: The Stationery Office; 2000.
10. Chen M, Andersen RM, Baremes DE, Leclercq M-H, Lyttle CS. Comparing oral health systems. Geneva: WHO; 1997.
11. Petersen PE, Kjøller M, Christensen LB, Krustrup U. Changing dentate status of adults, use of dental health services, and achievement of national dental health goals in Denmark by the year 2000. J Public Health Dent 2004;64:127–35.
12. Holst D, Schuller AA. Oral health changes in an adult Norwegian population: a cohort analytical approach. Community Dent Oral Epidemiol 2000;28:102–11.
13. Suominen-Taipale A-L, Alanen P, Helenius H, Nordblad A, Uutela A. Edentulism among Finnish adults of working age, 1978–1997. Community Dent Oral Epidemiol 1999;27:353–65.
14. Petersen PE. Sociobehavioural risk factors in dental caries – international perspectives. Community Dent Oral Epidemiol 2005;33:274–9.
15. Schuller AA, Holst D. Changes in the oral health of adults from Trøndelag, Norway, 1973–1983–1994. Community Dent Oral Epidemiol 1998;26:201–8.
16. Statistics Norway. Health Survey 1975. Oslo: Statistics Norway; 1977.
17. Statistics Norway. Health Survey 1985. Oslo: Statistics Norway; 1987.
18. Statistics Norway. Health Survey 1995. Oslo: Statistics Norway; 1999.
19. Statistics Norway. Survey of living conditions 2002. NOT 2004/22. Oslo: Statistics Norway; 2004.
20. Schuller AA. Changes in oral health in adults, Trøndelag, Norway, 1973–1983–1994. Thesis. Oslo: University of Oslo; 1999.
21. Norheim PW, Heløe LA. Reliability and constancy of information obtained in dental health interviews. Community Dent Oral Epidemiol 1976;4:98–101.
22. Norheim PW. Oral health in a population in Northern Norway. A methodologic and epidemiologic study. Thesis. Oslo: University of Oslo; 1980.
23. Næss Ø. Life course approaches to socio-economic inequalities in cause specific mortality. A registry based epidemiological study of the population in Oslo. Oslo: University of Oslo; 2005.
24. Burt B, Eklund SA. Dentistry, dental practice and the community. 6th edn. St. Louis: Elsewire Saunders; 2005. p. 223–32.
25. Thomson VM, Poulton R, Milne BJ, Caspi A, Broughton JR, Ayers KMS. Socio-economic inequalities in oral health in childhood and adulthood in a birth cohort. Community Dent Oral Epidemiol 2004;32:345–53.
26. Kuh D, Ben-Shlomo Y. A life course approach to chronic disease epidemiology. Oxford; New York: Oxford University Press; 1997.
27. Brevik J. Brain-neuro-endocrine-immune interactions in periodontal disease. Thesis. Oslo: University of Oslo; 2002.