

Dental caries prevalence among adults in Denmark – the impact of socio-demographic factors and use of oral health services

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Objectives To measure the prevalence of dental caries in the Danish adult population and to analyse how the risk of dental caries is affected by age, gender, region, area, and socio-economic factors. Furthermore to assess the impact on dental caries experience of use of oral health services during childhood and adult life. **Basic research design and participants** A cross-sectional study of a random sample of 1,115 Danish adults in ages 35-44 years and 65-74 years. Data were collected by means of personal interviews and by clinical examinations according to criteria of the World Health Organization. Dental caries was recorded at tooth and tooth surface levels. **Results** At age 35-44 years the mean caries experience was 46.6 DMF-S against a mean of 104.1 DMF-S in the total sample of 65-74-year-olds. The D-component was low (35-44 years D-S = 0.9; 65-74 years D-S = 1.5). The M-component was three times higher in the elderly than in the younger age group. The multivariate analysis showed that significantly more untreated decay was found among men, in rural areas and in low income groups. A significantly higher score of filled surfaces were found among older adults and in the group with more education (12-13 years) whereas the F-component was low in the low income group. The total DMF-S was significantly higher among the elderly, persons living in Jutland and in groups with less education, while men had low DMF-S compared to women. **Conclusion** Reducing social inequality in dental caries experience remains a challenge to oral health services in Denmark; strengthening community-oriented oral disease prevention and health promotion is needed to improve the oral health in the Danish adult population.

Key words: Clinical-epidemiological assessment, dental caries, dental visiting habits, socio-economic status.

Introduction

During the past two decades evidence has accumulated in several industrialised countries of changing oral disease patterns. In relation to the adult population, reductions in the prevalence rates of edentulousness are observed and more individuals preserve their natural teeth and maintain functional dentitions (Chen *et al.* 1997; Kelly *et al.*, 2000; Petersen *et al.*, 2004). In children, this improvement in oral health is apparent from a reduction in the mean dental caries experience and growing proportions of caries free individuals over time. In Denmark, over the past three decades systematic information for surveillance of the oral health status of children and adolescents has been collected through the Recording System for the Municipal Dental Services (SCOR) (Poulsen and Malling, 2002). Clinical examinations of every child or adolescent are performed at regular intervals and at least on an annual basis for certain standard age groups. Meanwhile, a population-based oral health information system has not been established in relation to the adults.

Oral health care for Danish adults is delivered by private dental practitioners and services to patients are offered on a fee-per-item basis. The National Health Insurance covers part of the expenses for curative dental care whereas rehabilitative services (e.g. prosthetic treatment) are paid entirely by the patients themselves. As for other Scandinavian countries, Denmark established

public third-party payment systems in the 1970s in order to prevent social inequalities in oral health status and in use of oral health services (Petersen, 1992). From a European perspective, the use of oral health services by Danish adults is high (Petersen *et al.*, 2004). Since 1988, the Danish oral health system for adults has been reoriented towards prevention of oral disease and health promotion and the National Health Insurance provides diagnostic and preventive services for patients at high risk of oral disease.

The Municipal Dental Services in Denmark offers comprehensive oral health care free of charge for children and adolescents. The system is a school-based programme, first established in 1910 in urban centres while rural areas were covered somewhat later. According to recent information, significant proportions of adults have participated in regular child dental care (Petersen *et al.*, 2004). Regular dental care during childhood has shown positive effect on dentate status in adult life, particularly for the younger- and middle-aged adults as more adults retain a functional dentition in adulthood and the risks of edentulousness and removable dentures are markedly reduced (Petersen *et al.*, 2004).

The most recent national clinical-epidemiological survey of oral health of the adult population in Denmark was carried out in the beginning of the 1980s (Kirkegaard *et al.*, 1982). Similar to local studies (Christensen, 1977; Petersen, 1983), this national survey outlined disparities in

the oral health status of adults according to demographic and socio-economic factors. Throughout the 1980s and 1990s, surveillance of oral health in adults has been undertaken from national questionnaire surveys (Petersen, 1983; Petersen, 1990; Petersen, 1992; Petersen *et al.*, 2004). Population data were recently collected on self-reported dental health status, use of dental health services and self-care practices of adults (Christensen *et al.*, 2003; Petersen *et al.*, 2004). However, planning and evaluation of oral health services for the adult population should also be based on systematic data on oral health status as assessed by clinical examination, particularly in order to evaluate the impact of the more prevention-oriented oral health services for adults in the country. The objectives of the present study were to measure the dental caries prevalence of the adult Danish population in two standard age groups (i.e. 35-44-year-olds and 65-74-year-olds); to analyse whether dental caries experience was affected by gender, urbanization, geographical region and socio-economic factors, and finally to analyse the impact of the use of oral health care services in adult life and during childhood on the level of dental caries.

Study population and methods

Participants were chosen from a large sample of adult Danes who were involved in a nation-wide survey of health and illness conducted by the National Institute of Public Health (Petersen *et al.*, 2004). The survey was based on a random sample of 22,500 citizens aged 16 years or more and data on general health status and illness were collected through personal structured interviews in the respondent's home. The interview included information about socio-economic status in terms of education, income and occupation, and use of dental health services in adult years (Petersen *et al.*, 2004). In all, the response rate was 74 % for the personal interviews (n = 16,690).

A sub-sample was identified for the actual clinical investigation among 35-44-year-olds and 65-74-year-olds who participated in the personal interview. In collaboration with The Danish National Institute of Social Research, a stratified cluster sampling technique was applied in order to ensure that the sample would be representative of the adult Danish population with respect to socio-demographic characteristics. Figure 1 illustrates the regions included to cover typical geographical locations of the country. The total number of 1,242 individuals was eligible for the survey and 1,115 individuals (89.8%) took part in the clinical study. The final study population comprised 762 individuals aged 35-44 years and 353 individuals aged 65-74 years and representative samples were obtained from within the regions that were involved.

Non-response was somewhat higher among men than women, especially for the younger age group. Almost 40% of the non-respondents refused to participate in the clinical examination for the following reasons: they did not have the time, they had just been to the dentist, they did not think the study was of any importance, they suffered from dental phobia or they declined because of edentulousness. The remaining 60% of non-respondents were no longer available at the informed address or telephone number when contacted.

The clinical study was carried out during 2000-2001 and involved two trained dentists. Clinical registrations were based on the methods and diagnostic criteria recommended by the World Health Organization (WHO) (World Health Organization, 1997) and the D₂ level was used to define dental caries. Dental caries of all teeth, including third molars, was recorded at the tooth surface level. The clinical examination was carried out through home visits, using mobile equipment and fibre optic light with a dental mirror attached to the light source. Prior to the clinical examination and halfway through the clinical data collection process the two examining dentists were

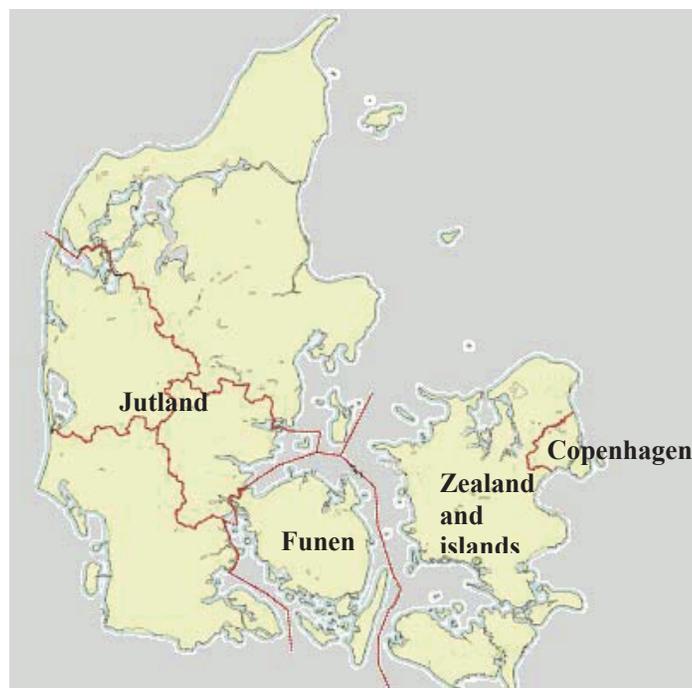


Figure 1. The Danish regions where the clinical examinations were performed

calibrated by an experienced international epidemiologist acting as gold standard (P.E.P.). The Kappa-statistic was 95% for both examining dentists for the first calibration exercise, 88% and 89% respectively, for the second calibration exercise.

The classification of education was based on the total number of years of education, i.e. number of years of schooling and vocational training combined, and the International Standard Classification of Education (ISCED) was used (Petersen et al., 2004). Persons who reported having visited the dentist at least once a year during the past five years were regular users of dental services, individuals who visited the dentist less often or never during the previous five years were classified into irregular or no use, respectively.

Data were processed and analysed using the Statistical Package for the Social Sciences (SPSS 12.0). Prevalence proportion rates and the DMF index at tooth and tooth surface levels were calculated according to WHO standards (World Health Organization, 1997), i.e. 32 permanent

teeth. Data on dental caries experience were analysed in bivariate tables and Student's t-test and Analysis of Variance (ANOVA) were used for the statistical evaluation of mean values in DMF-S and DMF-T. Linear regression was applied for the multivariate analysis of D-S, F-S and DMF-S for the dentate population and DMF-S for the total study population. The independent variables comprised gender, age, region of residence, area of urbanization, education and income, and dental attendance. For the actual multivariate analyses several dummy variables were constructed and the regression coefficients are to be interpreted in relation to the excluded category. The regression coefficients were tested by the t-test.

Results

Only one of all persons clinically examined had no dental caries experience, yielding a prevalence proportion rate of 99.9%. Tables 1-2 present the mean caries experience according to age group and gender. The M-component was

Table 1. Mean dental caries experience (DMF-S and DMF-T) in 35-44-year-old Danes by gender (standard error of mean given in brackets).

	<i>Men</i>	<i>Women</i>	<i>Total</i>
(n)	(343)	(419)	(762)
D-S	1.2 (0.2)	0.8 (0.1)	0.9 (0.1)
M-S	17.5 (0.7)	20.7 (0.7)***	19.3 (0.5)
F-S	27.0 (0.8)	25.8 (0.7)	26.4 (0.5)
DMF-S	45.7 (1.1)	47.3 (1.0)	46.6 (0.7)
D-T	0.6 (0.1)	0.4 (0.1)	0.5 (0.0)
M-T	3.5 (0.2)	4.1 (0.1)**	3.9 (0.1)
F-T	12.6 (0.3)	12.1 (0.2)	12.3 (0.2)
DMF-T	16.7 (0.3)	16.6 (0.3)	16.7 (0.2)

** p < 0.01, *** p < 0.001

Table 2. Mean dental caries experience (DMF-S and DMF-T) in 65-74-year-old Danes (dentate persons and total sample) by gender (standard error of mean given in brackets).

	<i>Total sample</i>			<i>Dentate</i>		
	<i>Men</i>	<i>Women</i>	<i>Total</i>	<i>Men</i>	<i>Women</i>	<i>Total</i>
(n)	(182)	(171)	(353)	(151)	(139)	(290)
D-S	2.0 (0.5)	1.0 (0.2)	1.5 (0.3)	2.4 (0.6)	1.2 (0.2)	1.8 (0.3)
M-S	72.8 (3.6)	75.5 (3.6)	74.1 (2.6)	57.4 (3.1)	58.8 (2.9)	58.1 (2.2)
F-S	26.2 (1.7)	31.0 (1.8)*	28.5 (1.2)	31.6 (1.7)	38.1 (1.8)**	34.7 (1.2)
DMF-S	101.0 (2.5)	107.5 (2.2)*	104.1 (1.7)	91.4 (2.4)	98.1 (2.0)*	94.6 (1.6)
D-T	0.8 (0.2)	0.5 (0.1)	0.7 (0.1)	1.0 (0.2)	0.6 (0.0)	0.8 (0.1)
M-T	15.4 (0.1)	15.9 (0.8)	15.6 (0.6)	11.9 (0.7)	12.2 (0.6)	12.1 (0.5)
F-T	9.4 (0.6)	10.4 (0.6)	9.9 (0.4)	11.3 (0.5)	12.8 (0.5)*	12.0 (0.4)
DMF-T	25.6 (0.4)	26.8 (0.3)**	26.2 (0.3)	24.2 (0.4)	25.4 (0.3)**	24.8 (0.3)

* p < 0.05, ** p < 0.01

three times higher for the elderly than for the younger age group whereas minor differences were found in the number of decayed and filled surfaces/teeth. The difference in mean caries experience by gender was statistically significant for the elderly. Amongst 65-74 year-olds dentate women had significantly higher F-components than had dentate men while in the younger adults women had significantly more surfaces/teeth missing than men.

As regards 35-44-year-olds, DMF-S and the M- and F-components showed significant variation by region (Table 3). In general, higher means of missing and filled surfaces and higher scores of DMF-S were found for individuals living on Funen and in Jutland as compared to persons living in Copenhagen and on Zealand and the islands. No statistically significant differences in caries experience by area were found for the younger age group but the index components as well as DMF-S tended to be higher among participants in rural areas compared to urban areas (Table 3). Among persons aged 65-74 years the regional and area differences in caries

indices were substantial (Table 3); for the total sample of elderly high scores of M-S and DMF-S were found for individuals living on Funen and in Jutland as compared to the participants living in Copenhagen and on Zealand and the islands. For 65-74-year-olds significantly more decayed surfaces were found in rural than urban areas (Table 3).

Multivariate analysis of dental caries experience

Controlling for other factors, relatively high D-S-scores were observed for men, persons living in rural areas, persons with low income and persons having limited education (Table 4). Significantly low D-S scores were seen for persons living in Jutland and among regular dental visitors. The F-S values were higher for persons aged 65-74 years, persons with high education and regular dental visiting habits while significantly low coefficients of F-S were found for persons having low income and low education. The total caries experience was relatively high for age group 65-74 years, for persons living on

Table 3. Mean dental caries experience (DMF-S) in adult Danes (dentate persons and total sample) by age group in relation to region and area (standard error of mean given in brackets).

<i>Region and area</i>	<i>(n)</i>	<i>D-S</i>	<i>M-S</i>	<i>F-S</i>	<i>DMF-S</i>
<i>35-44 years</i>					
Copenhagen	(223)	1.1 (0.3)	18.2 (0.8)	25.2 (1.1)	44.5 (1.4)
Zealand and islands	(272)	0.9 (0.1)	17.3 (0.7)	24.6 (0.8)	42.8 (1.1)
Funen	(91)	1.3 (0.5)	22.4 (1.8)***	28.6 (1.5)	52.3 (2.4)***
Jutland	(176)	0.7 (0.1)	22.1 (1.3)	29.5 (1.1)**	52.3 (1.5)***
Rural	(245)	1.1 (0.2)	20.1 (0.9)	27.5 (0.9)	48.7 (1.3)
Periurban	(179)	0.8 (0.2)	19.5 (1.0)	26.1 (1.1)	46.4 (1.4)
Urban	(338)	0.9 (0.2)	18.6 (0.7)	25.7 (0.8)	45.2 (1.1)
<i>65-74 years (dentate)</i>					
Copenhagen	(82)	1.1 (0.2)	57.7 (4.2)	36.3 (2.4)	95.1 (2.9)
Zealand and islands	(124)	2.4 (0.7)	55.4 (3.3)	34.3 (1.9)	92.1 (2.5)
Funen	(27)	3.1 (1.3)	60.7 (6.6)	30.6 (4.0)	94.4 (5.4)
Jutland	(57)	0.9 (0.2)	63.2 (4.9)	35.3 (2.5)	99.4 (3.4)
Rural	(102)	3.3 (0.9)**	61.3 (3.8)	31.5 (2.1)	96.1 (2.8)
Periurban	(64)	1.1 (0.4)	54.5 (4.2)	37.7 (2.5)	93.3 (3.4)
Urban	(124)	1.0 (0.2)	57.3 (3.3)	35.7 (1.9)	94.0 (2.3)
<i>65-74 years (total sample)</i>					
Copenhagen	(90)	1.0 (0.2)	65.8 (4.7)	33.0 (2.5)*	99.8 (3.0)
Zealand and islands	(147)	2.1 (0.6)	70.0 (3.9)	28.9 (1.9)	101.0 (2.7)
Funen	(38)	2.2 (1.0)	86.0 (8.0)**	21.8 (3.6)	110.0 (5.5)
Jutland	(78)	0.7 (0.2)	86.0 (5.6)**	25.8 (2.6)	112.5 (3.5)*
Rural	(129)	2.6 (0.7)**	79.4 (4.3)	24.9 (2.0)	106.9 (2.9)
Periurban	(78)	0.9 (0.4)	71.3 (5.3)	30.9 (2.6)	103.1 (3.6)
Urban	(146)	0.9 (0.2)	71.0 (3.9)	30.4 (2.0)	102.3 (2.5)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4. Multivariate dummy regression analysis of dependent variables D-S, F-S, DMF-S among adult Danes aged 35-44 years (n = 762) and 65-74 years (dentate persons) (n = 290).

<i>Variable</i>	<i>Category</i>	<i>D-S (b)</i>	<i>F-S (b)</i>	<i>DMF-S (b)</i>	<i>DMF-S (Total sample) (b)</i>
<i>Gender</i>	Men	0.71**	-1.06	-3.26*	-3.91**
	Women				
<i>Age group</i>	65-74 years	0.53	12.30***	47.65***	53.85***
	35-44 years				
<i>Region</i>	Zealand and islands	-0.48	-0.39	-3.03	-2.69
	Funen	-0.08	1.87	4.18	5.69*
	Jutland	-0.83*	2.50	4.67*	6.20**
	Copenhagen				
<i>Area</i>	Rural	0.98**	0.28	1.92	1.68
	Periurban	0.11	1.14	1.43	1.44
	Urban				
<i>Income (DKK)</i>	Less than 100,000	0.82	-10.17***	-3.78	-0.99
	100,000-199,999	1.26**	-3.96*	-0.36	0.03
	200,000-299,999	0.67	-3.48*	-0.99	0.81
	300,000-399,999	0.55	-3.18	1.51	3.60
	400,000 or more				
<i>Education</i>	Low (≤ 10 years)	0.70	-2.80	13.71***	17.76***
	Medium (10-12 years)	0.65	1.30	8.33***	11.40***
	High (13-14 years)	0.60	3.36*	6.69***	8.38***
	Very high (≥ 15 years)				
<i>Regular dental visiting habits (in adult years)</i>	Yes	-2.57***	8.58***	-3.60	-12.54***
	No				
<i>R²</i>		0.29	0.12	0.52	0.78

* P < 0.05, ** P < 0.01, *** P < 0.001

Funen and in Jutland as well as for persons with limited education. Finally, men had significantly lower DMF-S compared to women and participants with regular dental attendance had significantly lower DMF-S than that was observed for irregular dental visitors or non-attenders.

Discussion

Health surveillance is important to support public health planning, evaluation of health services and measuring the outcome of health promotion and disease prevention programmes. In Denmark, oral health surveillance systems in relation to the adult population do not exist and surveillance will then have to rely on population surveys conducted on a regular basis. WHO has recommended such surveys be carried out every five years or so (WHO, 1997), however, such surveys were not undertaken in Denmark over the past several years.

The study population is representative of the general population by socio-demographic characteristics (Petersen et al., 2004). The participation rate in the clinical study was high and corresponds to similar population studies carried out in Denmark (Kirkegaard et al., 1982; Petersen,

1983) and in other European countries (Hescot et al., 1996; Kelly et al., 2000; Micheelis and Reich, 1999; Skudutyte et al., 2000). Meanwhile, the non-response analysis showed some under representation of younger men and this may imply that a somewhat optimistic picture of dental caries experience is outlined for this age group.

The data on dental caries experience were collected according to the criteria of WHO (WHO, 1997) and a high level of inter-examiner consistency was obtained (World Health Organization, 1993). According to WHO criteria decayed surfaces are only registered when lesions are at cavity level since diagnosis of decay at earlier stages is not sufficiently reliable under field conditions (WHO, 1997). An underestimation of the F-component may occur if composite fillings are difficult to identify because of natural tooth colour. The M-component includes surfaces or teeth missing due to caries as well as other causes such as periodontal disease, prosthetic treatment, orthodontic treatment or aplasia. The registration of missing teeth may thus imply some overestimation of dental caries experience while such potential bias is probably small in populations with high caries prevalence.

Alternatively, recall bias would have to be considered when relying on individuals' self-reporting of reasons for missing teeth.

Similar to other studies (Kirkegaard *et al.*, 1982; Petersen, 1983) the present study showed that caries experience varied by age. The elderly had a high caries score largely because of the high number of missing teeth. Due to the nature of the cross-sectional study design the difference in disease experience by age relates to the different groups being examined (35-44 years and 65-74 years) and is not a measure of development over time in caries experience. The difference in caries experience between the age groups examined is mainly

to be explained by the fact that caries experience is accumulated throughout life due to the effect of distinct risk factors. A significant reduction in dental caries experience among adults in Denmark has taken place over the past 20 years. The data presented in Fig. 2 originate from the same survey settings and it is shown that the decline in caries experience particularly relates to a reduction in the number of teeth extracted because of caries. Such time trend was also documented in surveys based on self-reported dentate status (Petersen *et al.*, 2004)

Figure 3 illustrates the dental caries experience and index components of 35-44-year-olds based on studies carried out in certain industrialised countries having ap-

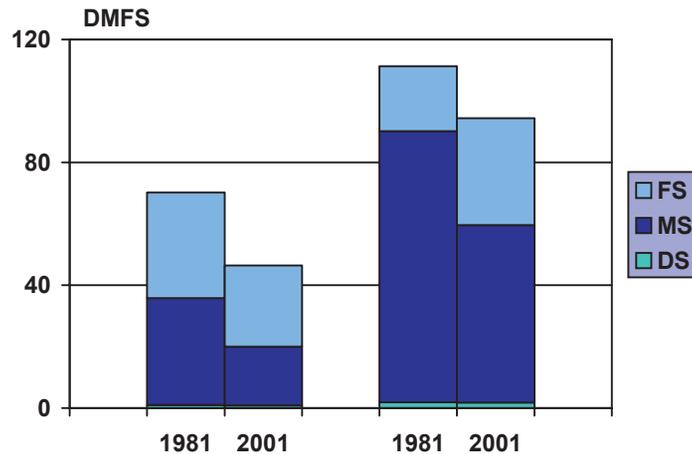


Figure 2. Dental caries experience expressed by average number of tooth surfaces with untreated decay (DS), tooth surfaces missing due to caries (MS) and filled tooth surfaces (FS) for younger and older adults in Denmark in 1981 (Kirkegaard *et al.*, 1982) and 2001

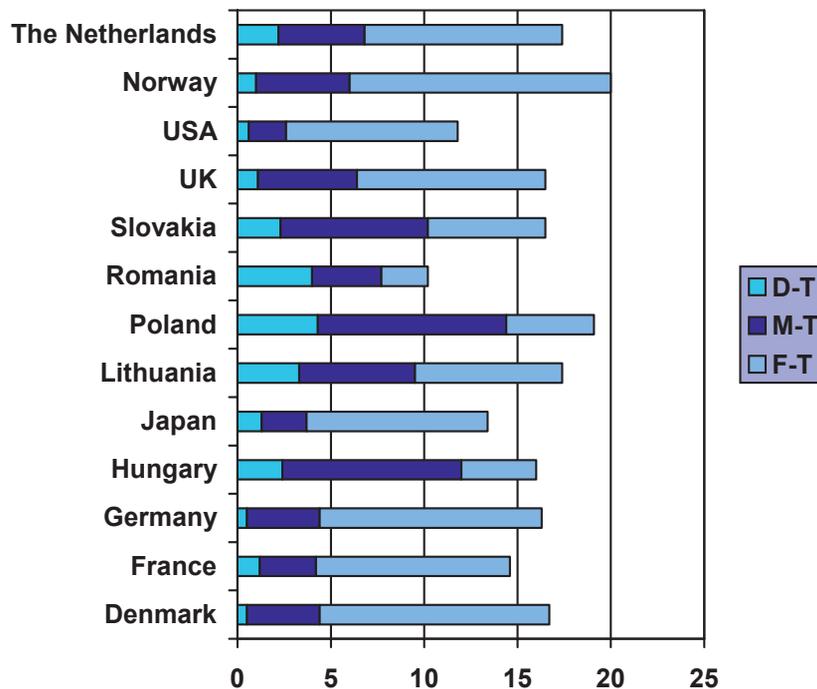


Figure 3. Mean DMF-T index in 35-44-year-olds in selected industrialised countries (Chen *et al.*, 1997; Hescot *et al.*, 1996; Kelly *et al.*, 2000; Micheelis and Reich, 1999; Petersen and Markovska, 2001; Petersen and Szöke, 2002; Petersen and Tanase, 1997; Schuller & Holst, 1998; Skudutyte *et al.*, 2000; Truin *et al.*, 1993).

plied WHO registration criteria. The total caries experience observed in Danish younger adults is similar to data available from other industrialised countries (Chen *et al.*, 1997; Hescot *et al.*, 1996; Kelly *et al.*, 2000; Micheelis and Reich, 1999; Schuller and Holst, 1998; Truin *et al.*, 1993). However, as regards the index components important differences are shown across countries. In a comparative perspective the D- and M-components were low while the F-component was relatively high for the Danish young adults. This pattern may reflect the high level of dental visiting habits and the preventive and the restorative efforts by the oral health care system in Denmark (Petersen *et al.*, 2004). The total caries experience for 65-74-year-old Danes is also similar to reports available from other European countries (Chen *et al.*, 1997; Hescot *et al.*, 1996; Micheelis and Reich, 1999). A low M-component and a high F-component were also found for old age Danes compared to the elderly of those countries.

Based on the multivariate analysis men were found to have more teeth with untreated decay than women which also was shown in earlier studies (Christensen J, 1977; Kirkegaard *et al.*, 1982); this may be explained by the higher use of dental services among women (Petersen *et al.*, 2004). Some difference between younger men and women was noted as regards the number of tooth surfaces/teeth missing and the findings suggest that younger women had third molars removed relatively more often than men. Further analysis showed that such difference in number of teeth disappeared when third molars were excluded from the analysis.

For both age groups tooth loss and total dental caries experience was higher for participants living in Jutland and on Funen as compared to persons living in Copenhagen and on Zealand and islands. These differences by region remained after confounder control in the multivariate analyses. The observations of more missing tooth surfaces on Funen and in Jutland may reflect a higher demand for radical treatment services in those regions, as some regional differences in health culture and in oral health attitudes are found in the country (Petersen *et al.*, 2004). In general, higher DMF-S and D-S values were found in rural than in urban areas, particularly among the elderly. Historically, the population to dentist ratio has been higher in rural areas than in urban centres; hence this pattern could be related to the higher availability of restorative and preventive dental services in the capital and in urban centres.

Consistent with previous Danish reports (Antoft *et al.*, 1999; Christensen, 1977; Kirkegaard *et al.*, 1982; Petersen, 1983; Petersen, 1990) the present study observed substantial differences by socio-economic status in dental caries experience. The multivariate analyses revealed that high D-S and low F-S components were associated with low income while high DMF-S was strongly associated with low education. This social inequality in oral health is in agreement with surveys conducted in several industrialised countries showing high caries experience in low socio-economic groups and more untreated decay among individuals in low social classes (Chen *et al.*, 1997; Hescot *et al.*, 1996; Kelly *et al.*, 2000; Micheelis and Reich, 1999; Petersen and Tanase, 1997). It might be anticipated that lower income groups are more reluctant

to receive restorative dental care due to the cost of treatment and alternatively tend to prefer more radical dental treatment in terms of tooth extractions or no treatment whatsoever.

High proportions of adults attending the dentist regularly were found in the high income and high education groups (Petersen *et al.*, 2004) and this observation may explain the better control of dental caries experience found among persons of these socio-economic groups. The high level of dental caries in Danish adults of low socio-economic status may be ascribed to unhealthy lifestyles and less effective utilization of oral health services (Petersen *et al.*, 2004). The multivariate analyses undertaken in the present study clearly demonstrated a pattern of more untreated decay among the persons who irregularly or never paid visits to the dentist as compared to the regular dental visitors; in addition, more filled tooth surfaces were observed among regular attenders. This indicates that use of oral health services particularly had a curative effect. The analysis also showed significantly lower DMF-S for regular dental visitors compared to irregular visitors or persons never attending a dentist but this effect first of all relates to the lower tooth loss in regular dental attenders. Meanwhile, despite the limitations of the study design in making conclusions on cause-effect relationships the present study also suggests that regular dental visiting habits has had some positive effect in terms of disease prevention.

As part of the Health for All Policy, WHO formulated goals and targets for health to be achieved by year 2000 (WHO, 1992), and one of the essential targets were to attain equity in health. However, the present study shows that this target of eliminating social inequity in dental caries experience level has not yet been achieved in Denmark, in particular among the elderly. Over the past decade the use of oral health services by the elderly has increased considerably (Petersen *et al.*, 2004). Compared to previous surveys of oral health status at old age (Christensen, 1977; Kirkegaard *et al.*, 1982), this study indicates lower D- and M-components. Meanwhile, it must be underlined that the oral health care service has not sufficiently met the dental care needs, particularly among the disadvantaged groups..

In general, efficient control of dental caries in the adult population remains a challenge in Denmark. Therefore, continuous strengthening of oral health services towards prevention and health promotion seems necessary to further improve oral health. Social inequality in dental caries seems to prevail for both young and older adults, despite the high use of oral health services in Denmark. Meanwhile, social inequality applies particularly to the elderly who during their lifetime have benefited little from the systematic oral health care. It is therefore highly recommended that community programmes based on outreach services be established in order to meet the needs of the underprivileged. Efforts at reducing social inequality in oral health of the adult population should also consider reforms in financing oral health care, lowering the economic burden among the disadvantaged groups.

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References

- Antoft, P., Rambusch, E., Antoft, B. and Christensen, H.W. (1999): Caries experience, dental health behaviour and social status - three comparative surveys among Danish military recruits in 1972, 1982 and 1993. *Community Dental Health* **16**, 80-84.
- Chen, M., Andersen, R.M., Barmes, D.E., Leclercq, M.H. and Lyttle C.S. (1997): *Comparing oral health care systems - a second international collaborative study*. World Health Organization, Geneva.
- Christensen, J. (1977): Oral health status of 65- to 74-year-old Danes: A preliminary report of the replication of W.H.O.'s international collaborative study in Denmark. *Journal of Dental Research* **56**, 149-153.
- Christensen, L.B., Petersen, P.E., Krustup, U. and Kjølner, M. (2003): Self-reported oral hygiene practices among adults in Denmark. *Community Dental Health* **20**, 229-235.
- Hescot, P., Bourgeois, D. and Berger, P. (1996): *Le programme international de recherche de l'Organisation Mondiale de la Santé sur les déterminants et la santé bucco-dentaire. La situation en France pour la période 1993-1995* FDI World Dental Press Ltd, Londres.
- Kelly, M., Steele, J., Nuttall, N., Bradnock, G., Morris, J., Nunn, J., Pine, C., Pitts, N.B., Treasure, E. and White, D. (2000): *Adult dental health survey*. The Stationary Office, London.
- Kirkegaard, E., Borgnakke, W.S. and Grønbaek, L. (1982): *Oral health status, dental treatment need, and dental care habits in a representative sample of the adult Danish population. Survey of oral health of Danish adults*. Dental Colleges of Copenhagen and Aarhus.
- Micheelis, W. and Reich, E. (1999): *Dritte Deutsche mundgesundheitsstudie (DMS III)*. Deutscher Ärzte-Verlag, Köln.
- Petersen, P.E. (1983): Dental visits, dental health status and need for dental treatment in a Danish industrial population. *Scandinavian Journal of Social Medicine* **11**, 59-64.
- Petersen, P.E. (1990): Social inequalities in dental health - Towards a theoretical explanation. *Community Dentistry and Oral Epidemiology* **18**, 153-158.
- Petersen, P.E. (1992): Effectiveness of oral health care - some Danish experiences. *Proc Finnish Dental Society* **88**, 13-23.
- Petersen, P.E. and Tanase, M. (1997): Oral health status of an industrial population in Romania. *International Dental Journal* **47**, 194-198.
- Petersen, P.E. and Markovska, N. (2001): *Oral health status of children and adults in Republic of Slovakia, 2000*. Copenhagen: WHO Regional Office for Europe, 2001.
- Petersen, P.E. and Szöke, J. (2002): *Oral health status of adults in Hungary - National oral health survey 2000*. Copenhagen: WHO Regional office for Europe, 2002.
- Petersen, P.E., Kjølner, M., Christensen, L.B. and Krustup, U. (2004): Changing Dentate Status of Adults, Use of Dental Health Services, and Achievement of National Dental Health Goals in Denmark by the Year 2000. *Journal of Public Health Dentistry* **64**, 127-135.
- Poulsen S. and Malling Pedersen M. (2002): Dental caries in Danish children 1988-2001. *European Journal of Paediatric Dentistry* **3(4)**, 195-198.
- Schuller, A.A. and Holst, D. (1998): Changes in the oral health of adults from Trondelag, Norway, 1973-1983-1994. *Community Dentistry and Oral Epidemiology* **26**, 201-208.
- Skudutyte, R., Aleksejuniene, J. and Eriksen, H.M. (2000): Dental caries in adult Lithuanians. *Acta Odontologica Scandinavica* **58**, 143-147.
- Truin, G.J., Konig, K.G. and Kalsbeek, H. (1993): Trends in dental caries in The Netherlands. *Advanced Dental Research* **7**, 15-18.
- World Health Organization (1992): *Targets for health for all. The health policy for Europe*. Summary of the updated edition, September 1991. Copenhagen: WHO Regional Office for Europe.
- World Health Organization (1993): *Calibration of examiners for oral health epidemiological surveys*. World Health Organization, Geneva.
- World Health Organization (1997): *Oral Health Surveys - Basic Methods (4th Edition)*. World Health Organization, Geneva.