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Periodontal conditions in 35–44 and 65–74-year-old adults in Denmark

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Abstract

Objectives. To assess the periodontal health status in the Danish adult population and to analyze how the level of periodontal health is associated with age, gender, urbanization, socio-economic factors, and dental visiting habits; furthermore, to compare the periodontal health status of Danish adults with that of adults in other industrialized countries. ***Material and Methods***. A cross-sectional study of a random sample of 1,115 Danish adults aged 35–44 years and 65–74 years. Data were collected by means of personal interviews and by clinical examinations in accordance with the World Health Organization Basic Methods Criteria. ***Results***. The clinical examination revealed a low prevalence of healthy periodontal conditions in both age groups: at age 35–44 years 7.7% and at age 65–74 years 2.4% had healthy periodontal conditions. A high proportion of the elderly had scores of severe periodontal health; more than 82% of older participants had pockets of 4–5 mm or deeper against 42% in younger adults. In both age groups, the mean number of teeth with periodontal pockets deeper than 4–5 mm was high in individuals with low education. Only a weak association between periodontal health and income was found. High Community Periodontal Index scores were seen for irregular dental visitors, but in the 35–44-year-olds deep periodontal pockets were more often seen among young regular dental visitors. The multivariate analysis showed that participants with low or medium levels of education had significantly more teeth with shallow and deep pockets than those with high education. Persons with regular dental visiting habits had fewer teeth with gingival bleeding, shallow and deep pockets than individuals with irregular dental visiting habits. ***Conclusion***. Reorientation of the Danish dental health-care services is needed with further emphasis on preventive care, and public health programs should focus on risk factors shared by chronic diseases in order to improve the periodontal health of Danish adults.

Key Words: *Clinical-epidemiological assessment, dental visiting habits, periodontal health status, socio-economic status, urbanization*

Introduction

Periodontal disease affects most people worldwide and adds significantly to the burden of oral disease. The risk factors for periodontal disease have been studied in various epidemiological studies. Poor oral hygiene [1,2], smoking [3–8] and extensive alcohol drinking [9,10], and irregular or no use of dental health services [11,12] are important factors associated with a high prevalence of periodontal disease. The prevalence rates of periodontal disease vary considerably between countries [13]; in Europe, deep periodontal pockets are seen in 1.6% of French people aged 35–44 years [14] against 14.1% of Germans [15].

Update information about the periodontal health status of adults in Denmark is limited. A national clinical-epidemiological survey of the oral health of the adult population was carried out at the beginning of the 1980s [11], and since then the occurrence of periodontal disease in the adult Danish population has been analyzed in local studies, too [12,16,17]. These studies indicate that the periodontal health of adults is poor, particularly in the elderly, and disparities in the prevalence of periodontal disease are revealed according to demographic and socio-economic status [12,16,17].

In Denmark, oral health care for adults is provided by private dental practitioners, and services to

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patients are offered on a fee-per-item basis. The National Health Insurance covers a proportion of the expenses for curative dental care (approx. 30%), whereas rehabilitative services (e.g. prosthetic treatment) are paid entirely by the patients themselves. The National Health Insurance scheme covers costs up to 40% in the case of scaling of teeth and simple periodontal disease treatment; however, the reimbursement for complex periodontal treatment (i.e. periodontal surgery) is relatively low. Over the past 15 years or so, the Danish oral health services for adults have been reoriented towards the prevention of oral disease and health promotion. Since 1988, the National Health Insurance scheme has also included preventive services. Accordingly, patients at high risk of oral disease are entitled to specific diagnostic and preventive services for individual intervention against dental caries and periodontal disease. The implication of this new scheme was a general decrease in reimbursement for curative services [18].

The World Health Organization (WHO) has established a database for monitoring population-based changes in oral health. The available data on periodontal conditions are insufficient despite one of the goals for oral health in the year 2000 (goal 6) emphasizing the importance of obtaining data on periodontal health [19]. There is no oral epidemiological information system for the Danish adult population [18], so surveillance of oral health status is dependent on regular population surveys. Planning and evaluation of oral health services for the adult population should also be based on clinical-epidemiological data on oral health, including periodontal health status, particularly in order to evaluate the impact of the more prevention-oriented scheme within oral health services for adults in the country.

The objectives of the present study were to describe the periodontal health conditions of two standard age groups (i.e. 35–44 years and 65–74 years) and to analyze whether the prevalence of periodontal disease is associated with gender and urbanization as well as socio-economic factors such as income and education. Furthermore, the intention was to analyze how the level of periodontal health is related to dental visiting habits in adult years.

Study population and methods

In the present clinical-epidemiological study, participants were chosen from a large sample of adult Danes who were involved in a nation-wide household-based survey of health and illness conducted by the National Institute of Public Health [20,21]. The national survey was based on a random sample of 22,500 citizens aged 16 years or more, and the selection of individuals was made using personal identification numbers. Data on self-reported general health status and illness were collected through personal interviews in the respondent's home. The response rate was 74% ($n = 16{,}690$). The interview included questions about socio-economic status in terms of education, income, and occupation and use of dental health services [21]. Subsamples were identified for the actual clinical investigation of 35–44-year-olds and 65–74-year-olds who participated in the personal interview The sampling procedure was designed in collaboration with the Danish National Institute of Social Research, and stratified cluster sampling was applied in order to ensure that the sample would be representative of the adult Danish population with respect to socio-demographic characteristics. Criteria for inclusion were gender, urbanization, and socio-economic background. A total of 1,242 individuals were eligible for the survey and the regions covered were Copenhagen, Zealand and islands, Jutland, and Funen. The final study population comprised 762 individuals aged 35–44 years and 353 individuals aged 65–74 years; 1,115 persons (89.8% of individuals sampled) therefore took part in the clinical study.

Non-response (127 individuals) was higher among men than among women, especially in 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 WHO [22]. The examination was carried out in the respondent's home using mobile equipment, including fibre optic light with a dental mirror attached to the light source and the standardized Community Periodontal Index (CPI) probe (Ash UK CPITN C-99) for detection of signs of periodontal disease. The principles of the CPI were applied; however, the system was modified by recording the periodontal health status of all teeth present rather than indicator teeth only. Moreover, the clinical signs of periodontal disease were recorded separately and for each individual tooth, i.e. presence or absence of gingival bleeding (CPI 1), periodontal pockets 4–5 mm (shallow) (CPI 3) or periodontal pockets 6 mm+ (deep) (CPI 4). Probing was performed on three different sites of both the buccal surface and the oral surface. At least one site with a sign of gingival bleeding or pocketing was sufficient for a positive score. In addition, loss of attachment (LA) was recorded for all teeth present

according to the following criteria: LA 0–3 mm; LA 4–5 mm; LA 6–8 mm; LA 9–11 mm; LA not measured.

Prior to the clinical examinations, and halfway through the clinical data collection procedure, the two examining dentists were calibrated by an experienced international epidemiologist (P.E.P.). The calibration procedure was carried out to control reliability of data as well as to ensure the level of registration. Procedures and criteria of periodontal conditions were carefully discussed in the examination of adult patients not covered by the survey. The Kappa statistic was not calculated owing to the nature of periodontal disease.

Data analysis

The proportion of edentulous persons in the total study population was 5.7% and edentulous persons were excluded from the analysis.

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. The International Standard Classification of Education (ISCED) was used and the final four categories were as follows: less than 10 years of education (low), 11–12 years (medium), 13–14 years (high), and more than 15 years (very high).

Income categories defined in this study were four categories for the 65–74-year-olds; less than 100,000 DKK, 100,000–199,999 DKK, 200,000–299,999 DKK, and more than 300,000 DKK. For the 35–44-year-olds, four income categories were also generated as follows: less than 200,000 DKK, 200,000–299,999 DKK, 300,000–399,999 DKK, and more than 400,000 DKK. The location was classified into areas of urbanization based on number of inhabitants; rural areas (<10,000 inhabitants), periurban areas (10,000–30,000 inhabitants), and urban areas (>30,000 inhabitants).

Persons who reported having visited the dentist at least once a year during the previous 5 years were considered regular users of dental health services; individuals who visited the dentist less often or never during the previous 5 years were classified as irregular dental visitors.

Data, processed and analyzed using the Statistical Package for the Social Sciences (SPSS 10.0), were described in bivariate frequency distributions and two units of analysis were included in the bivariate analysis to describe periodontal health status: persons and teeth. The distribution of persons by maximum CPI scores expresses the prevalence of periodontal conditions, while the number of teeth with CPI scores describes the intensity of periodontal conditions. The chi-squared test was used for statistical evaluation of proportions, while Student's *t*-test and analysis of variance (ANOVA) were used for evaluation of the mean number of teeth with certain periodontal conditions.

The independent variables used in the multivariate regression analysis were gender, age, area of urbanization, education and income, and dental attendance. The dependent variables introduced into the regression models were percentages of teeth present with certain periodontal conditions. Several dummy variables were constructed for the actual multivariate analyses. A dummy variable was created for each category of the various independent variables by recoding into the values 0 or 1. The regression coefficient is interpreted in relation to the excluded category. In the case of a positive regression coefficient, the dummy variable has a positive effect on the dependent variable. Similarly, a negative regression coefficient implies a negative effect of the dependent variable. The regression coefficients were tested using the *t*-test.

Results

The mean number of retained teeth was 28.1 for 35–44-year-olds and 20.0 for 65–74-year-olds. No assessment was made of the reasons for lost teeth, as this would have implied information bias. Healthy periodontal conditions with no signs of gingival bleeding, shallow or deep pockets were found in 7.7% of the 35–44-year-olds and in 2.4% of the dentate persons aged 65–74 years (Table I). Gingival bleeding was found for 85.8% of the younger adults and for 93.1% of the elderly. One or more shallow pocket (4–5 mm) as the most severe sign was recorded in about one-third of the younger and in two-thirds of the older adults, while 6% of younger adults and 20% of the elderly showed deep pockets (6 mm+) (Table I). Younger women had relatively better periodontal conditions than younger men (Table I). A significantly higher proportion of elderly women had gingival bleeding than men had, but there was a tendency for more elderly men to have shallow and deep pockets compared to women.

In the younger age group, about one-fourth of the teeth had gingival bleeding, while this was the case for about 40% of the teeth among the elderly (Tables II and III). In general, women tended to have lower mean percentages of teeth with gingival bleeding and shallow pockets than men had (Tables II and III). In the older age group, a higher proportion of teeth had gingival bleeding and shallow pockets in urban areas, while more teeth with deep pockets were found in rural areas (Tables II and III).

The association between income and the mean percentages of teeth with certain CPI scores showed no significant results for any of the age groups (Tables II and III); however, for younger persons, poor periodontal status tended to be associated with low income (Table II). Education seemed to have a stronger association with the mean percentage of

Table I. Distribution (%) of 35–44-year-olds and 65–74-year-olds with signs of periodontal disease according to age and gender

Variables	(*n*)	Healthy	Bleeding	Pockets 4–5 mm	Pockets 6 mm+
35–44 years					
Gender					
Men	(343)	4.1	***91.3	35.6	6.4
Women	(419)	***10.7	81.4	35.8	6.0
Total	(762)	7.7	85.8	35.7	6.2
65–74 years					
Gender					
Men	(151)	3.3	90.1	63.6	23.8
Women	(139)	1.4	*96.4	60.4	15.8
Total	(290)	2.4	93.1	62.1	20.0

*p <0.05, ***p <0.001.

teeth with CPI scores (Tables II and III). In the age group 35–44 years, the mean percentages of teeth with gingival bleeding, shallow or deep pockets were high among participants in the low education group. For the elderly, similar associations between the mean percentage of teeth with CPI scores and education were seen (Table III).

In both age groups, the mean percentage of teeth with gingival bleeding and shallow pockets was higher for irregular than for regular dental visitors (Tables II and III); the mean number of teeth with deep pockets was higher among regular dental visitors in the young age group than irregulars, while among the elderly the proportion of teeth with deep pockets was higher among irregular dental visitors than among regulars.

The LA scores for both age groups are presented in Tables IV and V. The younger adults had a low LA score compared to the older adults; about 80% of the younger age group had an LA score of 0–3 mm, whereas only one-third of the elderly were found with this score. No differences in LA scores were found by gender for either of the age groups. At old age, LA score 4–5 mm was significantly more common in periurban and urban areas than in rural areas. Income seemed not to influence the LA for any of the age groups. High LA scores were indicated for lower educational groups among the younger adults, but this pattern was not statistically significant. Among the elderly, high LA scores (6–8 mm and 9–11 mm) were often found in the high or very high education groups. LA score 4–5 mm was often observed in the older age group with regular dental visiting habits, while LA ≥6 was seen more often among older persons with irregular dental visiting habits.

Table II. Mean percentage of teeth present with signs of periodontal disease among 35–44-year-olds (standard error of mean given in parentheses)

Variables	(*n*)	Bleeding	Pockets 4–5 mm	Pockets 6 mm+
Gender				
Men	(343)	***29.6 (1.3)	6.6 (0.8)	1.3 (0.4)
Women	(419)	22.1 (1.0)	5.3 (0.6)	1.0 (0.3)
Area				
Rural	(245)	28.3 (1.6)	6.4 (0.9)	1.6 (0.5)
Periurban	(179)	25.0 (1.6)	6.0 (1.0)	0.7 (0.3)
Urban	(338)	23.7 (1.2)	5.3 (0.7)	0.1 (0.3)
Income (DKK)				
Less than 200,000	(190)	27.8 (1.9)	6.9 (1.1)	1.8 (0.6)
200,000–299,999	(337)	24.9 (1.2)	5.6 (0.7)	1.0 (0.3)
300,000–399,999	(120)	25.4 (1.7)	5.6 (1.1)	0.9 (0.3)
400,000 or more	(86)	21.5 (1.9)	3.6 (0.8)	3.1 (0.3)
Education				
Low	(62)	*35.5 (4.0)	**10.7 (2.4)	***4.5 (1.8)
Medium	(158)	29.9 (1.9)	9.9 (1.5)	2.0 (0.7)
High	(299)	23.6 (1.2)	4.4 (0.6)	0.6 (0.2)
Very high	(193)	21.2 (1.4)	3.6 (0.5)	0.3 (0.2)
Dental visits in adult years				
Regular	(683)	24.6 (0.8)	5.3 (0.5)	**8.6 (0.2)
Irregular	(79)	*33.5 (3.4)	***10.3 (2.1)	3.5 (1.3)
Total	(762)	25.5 (0.8)	5.9 (0.5)	1.1 (0.3)

*p <0.05, **p <0.01, ***p <0.001.

Table III. Mean percentage of teeth present with signs of periodontal disease among 65–74-year-olds (standard error of mean given in parentheses)

Variables	(*n*)	Bleeding	Pockets 4–5 mm	Pockets 6 mm+
Gender				
Men	(151)	44.4 (2.7)	17.3 (2.0)	5.3 (1.2)
Women	(139)	40.1 (2.6)	13.7 (1.6)	4.9 (1.4)
Area				
Rural	(102)	40.8 (3.3)	13.2 (2.2)	5.8 (1.8)
Periurban	(64)	43.0 (4.1)	13.3 (2.6)	3.8 (1.4)
Urban	(124)	43.2 (2.8)	18.7 (2.0)	5.1 (1.3)
Income (DKK)				
Less than 100,000	(96)	41.0 (3.3)	14.8 (2.3)	4.6 (1.5)
100,000–199,999	(120)	45.0 (3.0)	16.7 (1.9)	6.1 (1.6)
200,000–299,999	(28)	41.3 (6.2)	18.9 (4.2)	1.8 (0.7)
300,000 or more	(25)	39.9 (6.2)	15.4 (5.1)	4.2 (2.6)
Education				
Low	(84)	*50.7 (3.9)	18.2 (2.9)	***11.0 (2.7)
Medium	(85)	41.5 (3.5)	18.0 (2.4)	3.1 (1.1)
High	(46)	42.6 (4.4)	15.4 (3.3)	2.4 (1.1)
Very high	(47)	33.0 (3.9)	9.7 (2.0)	1.6 (0.7)
Dental visits in adult years				
Regular	(256)	39.1 (1.9)	13.4 (1.2)	3.9 (0.8)
Irregular	(34)	***66.6 (6.7)	***31.9 (5.9)	***14.2 (4.6)
Total	(290)	42.3 (1.9)	15.6 (1.3)	5.1 (0.9)

*$p < 0.05$, ***$p < 0.001$.

Multivariate analysis

The multivariate analysis confirmed the findings of the bivariate analysis regarding men having more teeth with gingival bleeding than women (Table VI). The elderly had more teeth with gingival bleeding, shallow and deep pockets compared to the younger age group. Persons with low income had significantly more teeth with gingival bleeding than persons with high income. Participants with low or medium levels of education had significantly more teeth with shallow and deep pockets than highly educated persons. Finally, persons with regular dental visiting habits had significantly fewer teeth with gingival bleeding, shallow and deep pockets compared to participants with irregular dental visiting habits.

Table IV. The distribution (%) of 35–44-year-olds by loss of attachment (LA) in relation to gender, area, income, education, and dental visiting habits

Variables	(*n*)	LA 0–3 mm	LA 4–5 mm	LA 6–8 mm	LA 9–11 mm	LA not measured
Gender						
Men	(343)	78.7	20.7	0.6	0.0	0.0
Women	(419)	81.1	18.1	0.7	0.0	0.0
Area						
Rural	(245)	81.6	17.6	0.8	0.0	
Periurban	(179)	79.3	20.7	0.0	0.0	0.0
Urban	(338)	79.3	19.8	0.9	0.0	0.0
Income (DKK)						
Less than 200,000	(190)	78.4	21.1	0.5	0.0	0.0
200,000–299,999	(337)	80.7	18.4	0.9	0.0	0.0
300,000–399,999	(120)	82.5	16.7	0.8	0.0	0.0
400,000 or more	(86)	79.1	20.9	0.0	0.0	0.0
Education						
Low	(62)	71.0	25.8	3.2	0.0	0.0
Medium	(158)	82.3	17.7	0.0	0.0	0.0
High	(299)	79.6	19.7	0.7	0.0	0.0
Very high	(193)	81.3	18.1	0.5	0.0	0.0
Dental visits in adult years						
Regular	(683)	79.9	19.3	0.7	0.0	0.0
Irregular	(79)	81.0	19.0	0.0	0.0	0.0
Total	(762)	80.1	19.3	0.7	0.0	0.0

Table V. The distribution (%) of 65–74-year-olds by loss of attachment (LA) in relation to gender, area, income, education, and dental visiting habits

Variables	(*n*)	LA 0–3 mm	LA 4–5 mm	LA 6–8 mm	LA 9–11 mm	LA not measured
Gender						
Men	(151)	33.1	46.4	17.2	2.6	0.7
Women	(139)	37.4	51.1	10.8	0.0	0.7
Area						
Rural	(102)	***49.0	37.3	11.8	1.0	1.0
Periurban	(64)	32.8	*56.3	10.9	0.0	0.0
Urban	(124)	25.0	54.0	17.7	2.4	0.8
Income						
Less than 100,000	(96)	32.3	53.1	10.4	2.1	2.1
100,000–199,999	(120)	35.0	47.5	16.7	0.8	0.0
200,000–299,999	(28)	32.1	46.4	21.4	0.0	0.0
300,000 or more	(25)	36.0	48.0	12.0	4.0	0.0
Education						
Low	(84)	36.7	51.2	10.7	0.0	1.2
Medium	(85)	30.6	52.9	12.9	2.4	1.2
High	(46)	34.8	50.0	15.2	0.0	0.0
Very high	(47)	36.2	42.6	17.0	4.3	0.0
Dental visits in adult years						
Regular	(256)	35.5	*50.8	12.5	0.8	0.4
Irregular	(34)	32.4	32.4	*26.5	5.9	2.9
Total	(290)	35.2	48.6	14.1	1.4	0.7

*p <0.05, ***p <0.001.

Discussion

The participants of this national survey were identified through stratified cluster sampling, and random allocation was used to select individuals for the final sample. The response rate was sufficiently high and the study population was considered representative of the general population by civic status, gender, and age distribution [20]. However, as edentulousness and dental phobia were factors involved with non-response, the results may be relatively more positive than expected for the general population. The present clinical study involved a subsample of individuals of the two WHO standard adult age groups. The participation rate in the clinical study was satisfactory and corresponded to similar population studies carried out in Denmark [11,17] and in

Table VI. Multivariate linear regression analysis of dependent variable: percentage of teeth with certain periodontal conditions by socio-demographic factors

Variable	Category	Bleeding	Pockets 4–5 mm	Pockets 6 mm+
Gender	Men	***7.2	1.6	0.0
	Women			
Age group	65–74 years	***13.1	*** 8.7	***3.1
	35–44 years			
Area	Rural	0.7	−1.7	−0.1
	Periurban	0.1	−1.5	−0.8
	Urban			
Income (DKK)	Less than 100,000	2.9	0.1	−1.4
	100,000–199,999	**7.3	3.1	1.0
	200,000–299,999	3.2	3.0	0.6
	300,000–399,999	4.1	3.4	1.5
	400,000 or more			
Education	Low (≤10 years)	***12.8	***7.6	***7.0
	Medium (11–12 years)	**6.6	***7.2	*2.0
	High (13–14 years)	3.4	2.3	0.9
	Very high (≤15 years)			
Regular dental visiting habits	Yes	*** −10.7	*** −6.9	*** −3.6
	No			
R^2		0.15	0.12	0.95

*p <0.05, **p <0.01, ***p <0.001.

other European countries [14,15,23,24]. The non-response analysis showed some under-representation of younger men, and thus the results may provide a somewhat optimistic picture of periodontal health status for this age group.

Periodontal health status was recorded by a modified CPI index; the recordings allow standard CPI statistics to be calculated. The CPI data may provide a basis for planning and adjustment of preventive care and periodontal treatment services, which should be offered to improve periodontal health in populations [22]. The CPI recording system has been applied in several studies worldwide [25–30] and the advantages of the CPI index are simplicity, speed, reproducibility, and international uniformity [13,29]. Some authors have considered the CPI system to have certain limitations, because the standard recordings do not include direct measures of periodontal tissue destruction [28,31]. In order to give a full picture of the periodontal disease status and treatment need, the present study therefore included information about LA of all teeth present in addition to the assessment of clinical signs of periodontal disease. LA is an estimate of the lifetime accumulated periodontal destruction [22], and this measure is particularly meaningful in assessment of periodontal disease in the elderly [13].

In the present study, only a few of the dentate participants had healthy periodontal conditions, and severe periodontal conditions (CPI scores 3 and 4) were particularly frequent among the elderly. The finding of a relatively high prevalence of severe periodontal conditions confirms observations in previous Danish studies [11,12], and the periodontal health status of adults in Denmark appears poor compared to that in surveys carried out in other industrialized countries. For example, the proportion of Danish adults affected by deep pockets is approximately twice that of French [14] and American adults of the same age [32]. Studies from Finland [33] of the age group 76–86 years have shown that nearly half of the participants have periodontal pockets against the nearly two-thirds of Danes aged 65–74 years. Further studies are needed in order to examine the factors responsible for the differences across countries as regards the prevalence of periodontal disease, which potentially could be explained by different preventive efforts on the part of oral health care systems as well as different lifestyles.

Older people are at higher risk of severe periodontal disease primarily due to prolonged exposure to etiologic factors [34]. The major risk factors of poor periodontal health status may relate to poor oral hygiene [1,2], systemic disease [35], consumption of tobacco [3–8,36], and excessive consumption of alcohol [9,10]. These factors may help explain the severe periodontal health profile of the elderly.

Studies from industrialized countries indicate that tobacco-use is a risk factor for periodontal disease [3–7,36] and recently it has been reported that more than half the periodontal cases in US adults can be ascribed to tobacco-use [8]. Hence, the poor periodontal status of older adults could be explained partly by the high smoking rate in Denmark; the rate of daily smokers in the year 2000 among the elderly (67–79 years) was 34.6% for men and 28% for women [20].

It has also been found that there is a positive association between excessive alcohol intake and periodontitis [9]. In a prospective cohort study of male health professionals in the USA, it was reported that men with an alcohol intake of 5–14.9 g/day have an 18% higher risk of developing periodontal disease than non-drinkers, and men with an intake of alcohol 30 g/day or more a 27% higher risk [9]. Alcohol consumption in the Danish population is fairly high [20] and might therefore add to the relatively high level of periodontal disease. Furthermore, periodontal disease is also related to systemic diseases such as diabetes, which in Denmark affects some 12.3% of men and 6.8% of women aged 60+ years (1996/1997) [37]. Diabetics are at higher risk of developing periodontal disease, and periodontitis has therefore been considered the sixth complication of diabetes (diabetes mellitus) [35].

Generally, women exhibited better periodontal health conditions than did men. An earlier Danish report [11] and results from other countries [14,15,23,32,33] also demonstrate relatively better periodontal health status among women. The differences that appeared between men and women regarding periodontal conditions may be ascribed different levels of oral hygiene [38]. In addition, the smoking rate is high among men [20], and more men than women suffer from diabetes [37].

The present study confirms investigations in other countries showing that periodontal health status is related to socio-economic status regardless of age [14,23,32,39,40]. Various factors could explain the social gradient in periodontal status. First, disadvantaged socio-economic groups are shown to have poor oral hygiene habits [38], which may initiate periodontal disease [38]. Second, tobacco-use is most prevalent in low socio-economic groups [41]. Third, removable partial dentures are more frequently found in low socio-economic groups [12] and oral hygiene may be impaired when such dentures compensate tooth loss. Finally, regular dental visits are more infrequent among the lower socio-economic groups [21], who may experience economic barriers to periodontal treatment.

The structured questionnaire designed for collection of information about dental care habits was developed on the basis of previous experiences and the questions were pre-tested for control of reliability

and validity [21]. Periodontal status was related to dental visiting habits in adult years. The bivariate and multivariate analyses revealed that visiting the dentist regularly in adult life had a positive effect on periodontal health for both age groups, and this could be explained either by the use of preventive services or oral hygiene instructions received at dental visits. The findings of the present study confirm previous Danish studies, which reported more healthy periodontal conditions among regular dental visitors than irregulars [11,12,42].

In conclusion, severe periodontal conditions, including LA, were frequent among older adults compared to younger adults, and the periodontal status of old-age Danes was generally worse than that of similar age groups studied in other industrialized countries. Periodontal health of the Danish adult population could be greatly improved by preventive efforts; however, prevention and treatment of periodontal conditions might be economically prohibitive for some socio-economic groups. Furthermore, there might be reluctance among dentists to recommend periodontal treatment, as it is time-consuming to build patient interest in effective oral hygiene procedures. However, preventive oral health services should be directed towards adults at high-risk of periodontal disease; in addition, public health strategies should target the risk factors linked to the development of periodontal disease as well as chronic systemic disease by application of the common risk factor approach.

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References

[1] Albandar JM. Global risk factors and risk indicators for periodontal diseases. Periodontol 2000;29:177–206.
[2] Axelsson P, Albandar JM, Rams TE. Prevention and control of periodontal diseases in developing and industrialized nations. Periodontol 2000;29:235–46.
[3] Bergström J. Cigarette smoking as a risk factor in chronic periodontal disease. Community Dent Oral Epidemiol 1989; 17:245–7.
[4] Bergström J, Eliasson S, Preber H. Cigarette smoking and periodontal bone loss. J Periodontol 1991;62:242–6.
[5] Bergström J, Eliasson S, Dock J. A 10-year prospective study of tobacco smoking and periodontal health. J Periodontol 2000;71:1338–47.
[6] Haber J, Wattles J, Crowley M, Mandell R, Joshipura K, Kent LR. Evidence for cigarette smoking as a major risk factor for periodontitis. J Periodontol 1993;64:16–23.
[7] Haber J. Smoking is a major risk factor for periodontitis. Curr Opin Periodontol 1994;12–18.
[8] Tomar SL, Asma S. Smoking-attributable periodontitis in the United States: findings from NHANES III. National Health and Nutrition Examination Survey. J Periodontol 2000;71:743–51.
[9] Pitiphat W, Merchant AT, Rimm EB, Joshipura KJ. Alcohol consumption increases periodontitis risk. J Dent Res 2003; 82:509–13.
[10] Tezal M, Grossi SG, Ho AW, Genco RJ. Alcohol consumption and periodontal disease. The Third National Health and Nutrition Examination Survey. J Clin Periodontol 2004; 31:484–8.
[11] Kirkegaard E, Borgnakke WS, Grønbæk L. 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, 1982.
[12] Petersen PE. Dental visits, dental health status and dental treatment needs among workers and staff members of a Danish shipyard. Odense: Odense University Press; 1981.
[13] Petersen PE, Ogawa H. Strengthening the prevention of periodontal disease – the WHO approach. J Periodontol 2005. In press.
[14] Hescot P, Bourgeois D, Berger P. 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. Londres: FDI World Dental Press; 1996.
[15] Micheelis W, Reich E. Dritte Deutsche Mundgesundheitsstudie (DMS III). Köln: Deutscher Ärzte-Verlag; 1999.
[16] Petersen PE. Dental health among workers at a Danish chocolate factory. Community Dent Oral Epidemiol 1983; 11:337–41.
[17] Petersen PE, Nørtov B. Evaluation of a dental public health program for old-age pensioners in Denmark. J Public Health Dent 1994;54:73–9.
[18] National Board of Health. Prognosis for dental care. Production and demand for dental staff in Denmark 2000–2020. Copenhagen: National Board of Health; 2001.
[19] World Health Organization, Federation Dentaire Internationale. Global goals for oral health in the year 2000. Int Dent J 1982;32:74–7.
[20] Davidsen M, Kjøller M. The Danish Health and Morbidity Survey 2000 – design and analysis. Statistics in Transition 2000;5:927–42.
[21] 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.
[22] World Health Organization. Oral health surveys – basic methods, 4th edn. Geneva: World Health Organization; 1997.
[23] Kelly M, Steele J, Nuttall N, Bradnock G, Morris J, Nunn J, et al. Adult dental health survey. London: The Stationary Office; 2000.
[24] Skudutyte R, Aleksejuniene J, Eriksen HM. Dental caries in adult Lithuanians. Acta Odontol Scand 2000;58:143–7.
[25] Ainamo J, Ainamo A. Validity and relevance of the criteria of the CPITN. Int Dent J 1994;44:527–32.
[26] Bourgeois D, Hescot P, Doury J. Periodontal conditions in 35–44-yr-old adults in France, 1993. J Periodontal Res 1997;32:570–4.
[27] Österberg T, Carlsson GE, Sundh W, Fyhrlund A. Prognosis of and factors associated with dental status in the adult Swedish population, 1975–1989. Community Dent Oral Epidemiol 1995;23:232–6.
[28] Pilot T, Barmes DE. An update on periodontal conditions in adults, measured by CPITN. Int Dent J 1987;37:169–72.
[29] Pilot T, Miyazaki H. Global results: 15 years of CPITN epidemiology. Int Dent J 1994;44:553–60.
[30] Schürch E Jr, Minder CE, Lang NP, Geering AH. Periodontal conditions in a randomly selected population in Switzerland. Community Dent Oral Epidemiol 1988;16: 181–6.

[31] Baelum V, Papapanou PN. CPITN and the epidemiology of periodontal disease. Community Dent Oral Epidemiol 1996; 24:367–8.
[32] Chen M, Andersen RM, Barmes DE, Leclercq MH, Lyttle CS. Comparing oral health care systems – a second international collaborative study. Geneva: World Health Organization; 1997.
[33] Ajwani S, Tervonen T, Narhi TO, Ainamo A. Periodontal health status and treatment needs among the elderly. Spec Care Dentist 2001;21:98–103.
[34] Papapanou PN, Lindhe J. Epidemiology of periodontal diseases. In: Lindhe J, Karring T, Lang PN, editors. Clinical periodontology and implant dentistry. Copenhagen: Munksgaard; 1997.
[35] Loe H. Periodontal disease. The sixth complication of diabetes mellitus. Diabetes Care 1993;16:329–34.
[36] Bergström J, Preber H. Tobacco use as a risk factor. J Periodontol 1994;65:545–50.
[37] Drivsholm T, Ibsen H, Schroll M. Increasing prevalence of diabetes mellitus and impaired glucose tolerance among 60-year-old Danes. Diabet Med 2001;18:126–32.
[38] Christensen LB, Petersen PE, Krustrup U, Kjøller M. Self-reported oral hygiene practices among adults in Denmark. Community Dent Health 2003;20:229–35.
[39] Hobdell MH, Oliveira ER, Bautista R, Myburgh NG, Lalloo R, Na S, et al. Oral diseases and socio-economic status. Br Dent J 2003;194:91–6.
[40] Norderyd O, Hugoson A. Risk of severe periodontal disease in a Swedish adult population. A cross-sectional study. J Clin Periodontol 1998;28:1022–8.
[41] Petersen PE. Smoking, alcohol consumption and dental health behavior among 25–44-year-old Danes. Scand J Dent Res 1989;97:422–31.
[42] Petersen PE. Effectiveness of oral health care – some Danish experiences. Proc Finn Dent Soc 1992;88:13–23.