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Root caries, root surface restorations and lifestyle factors in adult Danes

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Abstract

Aim. To investigate selected lifestyle factors in relation to active caries and restored root surface lesions in adults. ***Materials and methods.*** Based on clinical examinations and questionnaires, data on root caries, socioeconomic status, body mass index, dietary habits, alcohol consumption, tobacco use and oral hygiene routines were collected from 4369 adults aged 21–89 who took part in a survey covering 13 municipalities across Denmark. Uni- and multivariate logistic regression analyses were applied to analyse the relationship between the independent lifestyle variables and active caries and restored root surface lesions, respectively. ***Results.*** The prevalence of active root caries was 4%, while 26% displayed restored root surfaces. The sugar intake was not related to root caries. A multivariate logistic regression analysis revealed that, in subjects aged 45 or over, smoking and wearing dentures were significantly associated with presence of active root caries ($p < 0.01$). The intake of 15 drinks or more per week was associated with higher odds of root surface restorations compared with no alcohol intake (OR = 1.7; $p < 0.001$). ***Conclusions.*** Lifestyle factors such as tobacco use and alcohol consumption, as well as wearing dentures, were significantly associated with the occurrence of untreated caries and restored root surface lesions, especially in persons over 45. Thus, such lifestyle factors should be taken into consideration, identifying persons with a need of preventive dental services. In addition, oral health education should focus on the possible risks of smoking and a high alcohol intake.

Key Words: *Alcohol, diet, oral hygiene, root caries, tobacco use*

Introduction

It is well established that dental caries is strongly influenced by physical, biological, environmental, behavioural and lifestyle factors [1,2] and the habits relevant to oral health include physical activities, diet, smoking, drinking and drug consumption. While there are frequent reports linking crown caries to the frequency of sugar intake [3,4], tobacco use [5,6], alcohol use [7,8] and drug abuse [9], the relations between lifestyle factors and root caries in adults have not been investigated as thoroughly. Root caries is evenly distributed within the dentition, but most frequently occurs on labial surfaces in older adults [10]. In a previous survey, it was shown that users of chewing tobacco had 4-times more decayed and restored root surfaces than those who never used tobacco [11]. Furthermore, Steele et al. [12] found that consuming sugar nine or more times per day doubled the odds of root caries in older adults. Other behavioural factors affecting root caries are poor oral hygiene, partial dentures and living in an institution [12,13]. We have recently established a database on the oral health of adult Danes (a sub-database of the Danish Health Examination Survey, DANHES 2007–2008) in order to explore the influence of lifestyle on oral health [14]. The aim of the present report was to investigate the relationship between active caries and restored root surface lesions and selected lifestyle factors such as nutrition, dietary habits, alcohol consumption, tobacco use and oral hygiene routines.

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Materials and methods

Study group, general and oral health questionnaire

DANHES 2007–2008 is a cross-sectional comprehensive study on general health carried out in 13 municipalities in Denmark [15]. The participants of the DANHES study (n = 18,065) who had completed a DANHES questionnaire and a physical health examination were invited to participate in the present oral health study and were consecutively enrolled on a first come, first served basis. In total, 4402 persons, 18–96 years of age, were enrolled in the oral study. Since 33 persons were edentulous, the final study population comprised 4369 dentate persons. A special oral health questionnaire was completed with information on dental visit habits, oral hygiene habits, complaints of oral dryness (xerostomia) and wearing of dentures. Information on education level, marital status, alcohol intake, smoking habits and diet intake derived from the DANHES general questionnaire. The participants were divided into three age categories, <45, 45–64 and ≥65 years. Educational levels were divided into four categories according to the number of years in school, lowest ≤7 years and highest >11 years. Marital status was dichotomized to either married/living with a partner or living alone. Smoking had two categories, smoking or not smoking, and alcohol intake had three categories based on the total number of drinks taken per week: <1 drink per week, 1–14 drinks per week and >14 drinks per week. Xerostomia was registered as no feeling, slight feeling, severe feeling and troublesome feeling of dry mouth [16] and in the analyses further dichotomized to xerostomia or no xerostomia. The UKU rating scale for dry mouth involves one score for no feeling of dry mouth and three scores for dry mouth of increasing intensity [16]. The cut point for dichotomization was set between the score for no dry mouth as one group and another group comprising all participants with any of the three scores for dry mouth, regardless of intensity.

Diet questionnaire

All participants (n = 18,065) answered an internet-based semi-quantitative food questionnaire including 267 food items (FFQ) that have been used extensively in Danish Studies and in the European EPIC studies (The European Prospective Investigation into Cancer and Nutrition). The participants reported their intake of each item during the recent year with answer options in up to 11 categories, ranging from rarely/never to eight or more portions/day. The dietary questionnaire has previously been validated and used in many Danish population studies [17,18]. The portion sizes of individual food items were estimated with the help of photo series and daily nutrient intakes were quantified on the basis of the Danish food-composition tables [19]. After merging the diet information with oral health data, data from 3366 individuals were available, although not all items in the diet questionnaire were complete. Our analyses on body mass index (BMI) and diet were based on 3212 persons with completed diet questionnaires. In the present study, the following dietary intake variables were considered on daily basis (gram/day): (i) intake of sucrose, (ii) added sugar (sugar added to other food items), (iii) calculated total amount of sugar, (iv) total carbohydrates and (v) total energy (expressed as megajoules (MJ)).

Oral examination

The oral examinations took place in specially equipped dental caravans parked in allocated areas in 13 municipalities. Three dental hygienists, trained by two experienced examiners, were responsible for the oral examinations. Clinical calibration exercises were conducted prior to and halfway through the data collection displaying Kappa values for caries scoring between 0.85–0.93 [14]. In the present study, active root caries was defined as lesions located on root surfaces with a soft or leathery texture based on visual–tactile examination. All types of restorations (fillings or crowns) located on root surfaces were registered.

Ethical considerations

The project was approved by the regional ethical board (Region Hovedstaden, Copenhagen) and the Danish Data Authority. Informed consent was obtained from all participants and after the oral examination all participants were informed about their oral status and individual treatment needed.

Statistical procedures

The primary outcome variables were the presence of active root caries lesions and root surface restorations. The data were analysed by means of the IBM-SPSS software (version 20.0, Chicago, IL). The data were described in bivariate tables. One-way ANOVA was applied to evaluate differences in means, while chi-square tests were used for comparing proportions. Uni- and multivariate logistic regression analyses were applied to assess the relative effect of the independent variables on the dichotomized variables presence or non-presence of active root caries lesions and root surface restorations, respectively. P-values less than 0.05 were considered statistically significant.

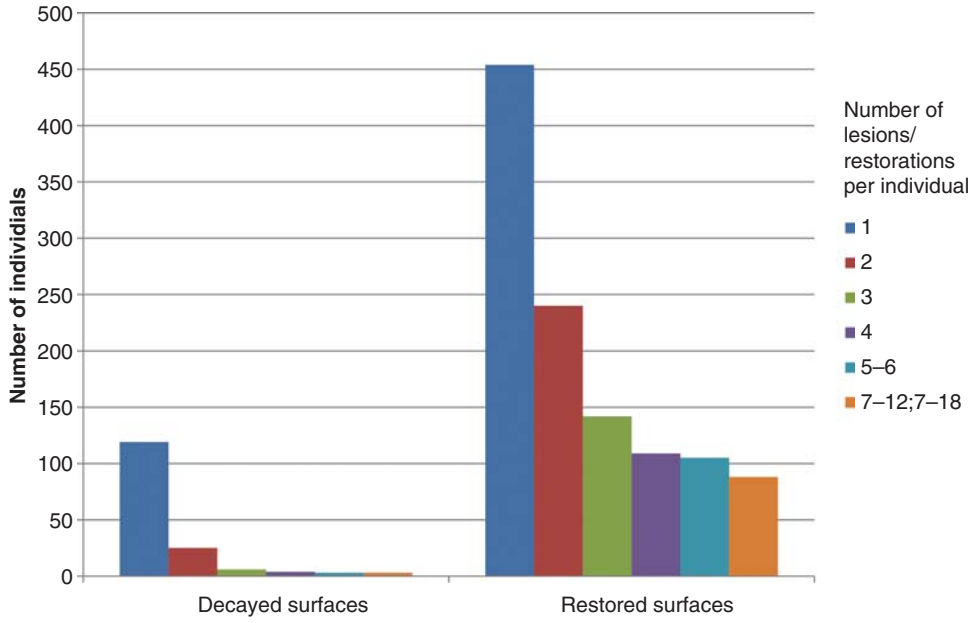

Figure 1. Number of individuals with decayed and restored root surfaces.

Results

Socioeconomic and oral health characteristics

The mean age of the study population was 54 years and the sample comprised more women than men, especially in the younger age groups (<65 years of age). One third of the participants reported an education level of fewer than 9 years and 78% were married. The vast majority (90%) attended a dental clinic on a regular basis or at least once a year in the previous 5 years. Compared with men, women reported more favourable oral hygiene habits, including twice daily tooth brushing (86% vs 72%; $p < 0.001$) and daily use of toothpicks (44% vs 39%; $p < 0.01$). Tobacco was used by 13.6% and the number of smokers decreased with increasing age ($p < 0.001$). Subjectively perceived dry mouth (xerostomia) was twice as frequent in the oldest age group (20%) compared with people under 45 ($p < 0.001$) and was more often reported among women than men (17% vs 11%; $p < 0.001$).

Root caries and root surface restorations

The mean number of natural teeth present was 26.6 and 6% had partial dentures. The prevalence of untreated caries lesions on root surfaces was 3.7%, while 26% displayed root surface restorations. Figure 1 illustrates the distribution of individuals in relation to the number of decayed root surfaces and restored surfaces. The relation between root caries and root surface restorations and age, gender, oral hygiene habits, xerostomia, denture wearing as well as selected lifestyle factors is presented in Table I. No associations were found between active caries or restored root surface lesions and level of education and marital status (not shown in table). Brushing teeth more than once a day was associated with less active caries, while the use of toothpicks and dental floss more than once a day was related to more active caries and restored lesions compared with those who were less frequent users of toothpicks and dental floss (Table I). The relationship to sugar, carbohydrate intake and BMI is displayed in Table II. No statistically significant differences were found between persons with or without root caries and restorations on root surfaces. Having root restorations was, however, associated with a higher total daily energy intake ($p < 0.05$). The results of the logistic regression analyses are shown in Tables III and IV. After control for other factors, the multivariate logistic regression analyses revealed that, at age 45 years or over, smoking and wearing dentures were significantly associated with the presence of active caries ($p < 0.01$; Table III). Likewise, the multivariate model in Table IV suggested that being aged 45 years or over and wearing dentures were associated with the presence of root surface restorations ($p < 0.001$). Furthermore, the intake of 15 drinks or more per week indicated increased odds for root surface restorations compared with those with no alcohol intake ($p < 0.001$). Finally, a high daily energy intake was associated with an odds ratio of 1.2 for having root surface restorations ($p < 0.05$).

Discussion

We found a significant association between smoking and active root caries, while the relation between general caries and tobacco earlier has pointed to varying directions. For instance, a recent systematic review found that tobacco smoking was associated

Table I. Prevalence of untreated root caries (RC) and root surface restorations (RSR) in relation to various independent variables.

Variable (total *n*)	Cut-off	*n*	RC Yes	*p*	RSR Yes	*p*
Gender (4369)	Men	1695	4.4%	< 0.05	28.0%	< 0.05
	Women	2674	3.2%		25.2%	
Age group (4369)	<45 years	1100	0.6%	< 0.001	6.0%	< 0.001
	45–64 years	2206	3.6%		27.5%	
	65+ years	1063	7.0%		44.8%	
Tooth brushing (4303)	> once a day	3477	3.2%		26.0%	
	≤ once a day	826	5.7%	< 0.001	26.6%	NS
Tooth picks (4145)	≥ once a day	1739	4.9%	< 0.001	34.0%	< 0.001
	< once a day	2406	2.5%		20.6%	
Dental floss (3746)	≥ once a day	713	3.8%	NS	29.6%	< 0.001
	< once a day	3033	2.9%		23.5%	
Tobacco use (4108)	Smoking	559	6.3%	< 0.001	26.5%	NS
	Non-smoking	3549	3.2%		26.0%	
Alcohol intake (4114)	No alcohol	526	4.6%	NS	19.6%	< 0.001
	≤14 drinks per week	2948	3.5%		24.8%	
	>14 drinks per week	640	3.6%		37.2%	
Partial dentures (4369)	Yes	260	11.5%	< 0.001	44.6%	< 0.001
	No	4109	3.2%		25.1%	
Xerostomia (4171)	Yes	594	5.4%	< 0.01	34.0%	< 0.001
	No	3577	3.4%		24.7%	

NS, not statistically significant.

Table II. Dietary variables (mean gram per day) and BMI in relation to presence of active root caries (RC) and root surface restorations (RSR).

Variable	*n*	RC, Yes/No	*p*	RSR, Yes/No	*p*
Added sugar, g/day	3212	32/31	NS	30/31	NS
Sucrose, g/day	3212	26/27	NS	26/27	NS
Total sugar, g/day	3212	109/107	NS	107/106	NS
Carbohydrates, g/day	3212	287/283	NS	284/282	NS
Total energy, MJ/day	3212	9.8/9.5	NS	9.7/9.4	< 0.05
BMI, kg/m^2	3212	25.2/25.2	NS	25.3/25.2	NS

MJ, Mega Joules; NS, not statistically significant.

with an increased risk of dental caries, but the quality of evidence was poor [5]. However, Swedish epidemiological studies performed in 1993 and 2003 among 20–70-year-olds showed that daily smoking did not increase the risk of caries [20]. On the other hand, the American NHANES III study based on dentate men found an increased level of decayed and restored root surfaces among cigarette smokers [11]. Although the actual role of tobacco smoking in relation to crown and root caries seems to be unclear [5], the association found in the present study between active root caries and smoking may be an indication of an unfavourable lifestyle, which may lead to decay.

We did not find any relation between alcohol intake and active caries, which is in contrast to a Swedish study [8] showing that the number of surfaces with active caries was 2-times higher among those with high alcohol intake (>5 cl of pure alcohol per day) compared with persons with 0–1 cl of pure alcohol per day ($p = 0.01$). In Denmark, a standard drink contains ~12 g of alcohol. The categorization of alcohol consumption was based on the Danish Health and Medicines Authority's recommendations for sensible drinking limits. The association between high alcohol intake and increased prevalence of root surface restorations in the present study was interesting

Table III. Logistic regression analysis for having active root caries lesions.

Variable	Cut-off	Simple odds ratio (CI)	*p*	Multivariate odds ratio (CI)	*p*
Gender	Men	1.4 (1.0–1.9)	< 0.05	1.2 (0.8–1.8)	NS
	Women	—		—	
Age group	65+ year	11.7 (5.3–25.5)	< 0.001	12.7 (4.4–36.3)	< 0.001
	45–64 year	5.8 (2.7–12.6)	< 0.01	7.6 2.7–21.3)	< 0.001
	<45 year	—		—	
Tooth brushing	≤ once a day	1.8 (1.3–2.6)	< 0.001	1.4 (0.9–2.1)	NS
	≥ twice a day	—		—	
Tooth picks	< once a day	0.5 (0.3–0.7)	< 0.001	0.7 (0.5–1.1)	NS
	≥ once a day	—		—	
Partial dentures	Yes	4.0 (2.6–6.1)	< 0.001	2.4 (1.5–4.1)	< 0.01
	No	—		—	
Xerostomia	Yes	1.6 (1.1–2.4)	< 0.001	1.2 (0.7–1.9)	NS
	No	—		—	
Tobacco use	Never smoked	0.5 (0.4–0.7)	< 0.001	0.4 (0.3–0.6)	< 0.001
	Smoking	—		—	

NS, not statistically significant; CI, confidence intervals.

Table IV. Logistic regression analysis for having root surface restorations.

Variable	Cut-off	Simple odds ratio (CI)	*p*	Multivariate odds ratio (CI)	*p*
Gender	Men	1.2 (1.0–1.3)	< 0.05	0.9 (0.8–1.2)	NS
	Women	—		—	
Age group	65+ year	12.7 (9.6–16.8)	< 0.001	9.2 (6.3–13.2)	< 0.001
	45–64 year	6.0 (4.6–7.8)	< 0.001	4.7 (3.3–6.5)	< 0.001
	<45 year	—		—	
Tooth brushing	≤ once a day	1.1 (0.9–1.2)	NS	1.0 (0.8–1.3)	NS
	≥ twice a day	—		—	
Tooth picks	< once a day	0.5 (0.4–0.6)	< 0.001	0.9 (0.7–1.1)	NS
	≥ once a day	—		—	
Dental floss	< once a day	0.7 (0.6–0.9)	< 0.001	0.9 (0.7–1.1)	NS
	≥ once a day	—		—	
Alcohol intake	>14 drinks/week	2.4 (1.9–3.2)	< 0.001	1.7 (1.2–2.5)	< 0.001
	1–14 drinks/week	1.4 (1.1–1.7)	< 0.01	1.2 (0.0–1.6)	NS
	No alcohol	—	—	—	
Partial dentures	Yes	2.3 (1.9–3.1)	< 0.001	1.7 (1.1–2.4)	< 0.001
	No	—		—	
Xerostomia	Yes	1.6 (1.3–1.9)	< 0.001	1.2 (0.9–1.5)	NS
	No	—		—	
Total energy intake*	> mean*	1.2 (1.1–1.4)	< 0.01	1.2 (1.1–2.5)	< 0.05
	≤ mean	—		—	

*mean value = 9.5 (SD = 2.9) Mega Joules/day.
NS, not statistically significant; CI, Confidence interval.

and, again, indicated an adverse effect of lifestyle. However, it should be taken into consideration that not only root caries may be the reason for having root surface restorations. In a British study from 2000, approximately half of all root surface restorations were placed due to cervical wear/sensitivity [21]. No corresponding Danish data are available, but on the basis of the British findings [21], some speculations on

possible acidic effect of alcohol leading to tooth wear or sensitivity might come about. However, the cross-sectional design of our study does not allow for further conclusions. Nonetheless, the findings of relationships between lifestyle habits such as smoking and alcohol habits after adjustment for other variables may indicate that negative lifestyle habits have a negative effect on active root caries and on the number of treated root lesions accumulated through a lifetime.

According to the bivariate analyses, it seemed that frequent users of toothpicks and dental floss had more caries and restored lesions. This might indicate a certain awareness of the oral health conditions in these participants. However, after controlling for other factors no significant associations were found between oral hygiene habits and caries and lesions on root surfaces.

Interestingly, we found no association between sugar intake and caries or restorations on root surfaces. Habitual diet intake can only be assessed by asking subjects to report intake. Hence, all dietary methods, including the FFQ, rely on memory, willingness to report actual intake and ability to generalize the intake. Such biased reporting seems particularly related to under-reporting of food items rich in fat and/or simple carbohydrates, including simple sugars. In the present study it cannot be eliminated that reporting bias underlies the fact that we found no association between sugar intake and caries or restorations on root. On the other hand, a systematic review [22] concluded that the relationship between sugar consumption and crown caries is weak today, presumably due to the widespread use of fluorides in recent decades. This was supported by a systematic review by Ritter et al. [23], who found dietary habits of no value in root caries prediction models. On the other hand, Steele et al. [12] found that the root caries was clearly related to a high frequency of sugar intake, suggesting that frequent oral exposure to sugar may indeed be a risk factor for root caries that is not captured by assessment of total daily sugar intake. Another study among children and adolescents also showed evidence for a relationship between frequency of sugar consumption and dental caries [3], meanwhile there was no clear relationship of quantity of sugar used to dental caries [3]. However, a recent review (from 2014) concludes that there is consistent evidence of moderate quality supporting the relationship between the amount of sugars consumed and development of caries [24], although it is underlined that there are few data on the relationship between sugars and dental caries in adults and older people [24].

A Finnish study among 55-year-olds used a special lifestyle index constructed on the basis of four factors, i.e. dietary habits, smoking, alcohol and physical activity, and it was shown that dental caries increased with more unhealthy lifestyles and most significantly in the lowest social class [1]. Wearing dentures and xerostomia have earlier been considered as risk indicators for root caries [6,12], but we were not able to link the latter factor to root caries and root surface restorations.

The main DANHES 2007–2008 study was characterized by a low final response rate (14%), which means that the results cannot be considered fully representative of the municipalities involved [15]. Comparisons with the Danish general population by register-based information from Statistics Denmark showed that women, especially those aged 45–64, were over-represented, while younger men and the eldest women were under-represented [15]. Furthermore, unmarried participants and those with the lowest level of education and the lowest income level were also under-represented. Further details on the main study and the validity and reliability of the findings can be found in a previous publication [15]. In the oral health study, the participants were included on a first come first served basis and, therefore, the distribution of this sub-group mirrored the main cohort to a large extent. In spite of the lack of generalizability, the oral data are still considered of value as they include a large amount of detailed information on oral health conditions, lifestyle in terms of diet, smoking, alcohol, and other information of relevance for oral health [14]. Furthermore, there is no reason to believe that the lack of generalizability would influence the validity of biological or social associations between lifestyle and oral health. The oral health questionnaire comprised previously validated questions [16,25] and the oral examinations were performed in an optimal clinical environment. All clinical findings were registered in accordance with detailed guidelines and a high level of inter-examiner consistency was obtained [26]. Hence, the validity and reliability of the obtained data were satisfactory. Furthermore, the fact that our findings on, for instance, oral health behaviour and xerostomia were in full accordance with findings from previous population studies [27–29] was comforting and indicated that the present data-sets were usable and trustworthy for their purpose.

Conclusion

In a population characterized by a higher socio-economic status than that of the normal population, and, hence, a high level of good oral health behaviour in terms of dental visit habits and oral health hygiene habits, lifestyle factors such as tobacco use and alcohol intake still seem to be associated with the occurrence of active caries and restored root surface lesions in persons over 45 years of age. Such lifestyle factors should be taken into consideration identifying persons with a need of preventive dental care. In addition, oral health education should focus on the possible risks of smoking and a high alcohol intake.

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