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The Cardiff Dental Survey: oral hygiene, gingival and periodontal health in relation to smoking in young adults

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Abstract: *Objective:* To examine the relationship between tobacco smoking, oral hygiene, gingival and periodontal health in young adults. *Study design:* Cross-sectional (conducted in the course of a cohort study). *Setting:* Cardiff, UK, 1989 and 2000. *Methods:* Plaque was recorded, as was presence or absence of bleeding on probing and loss of attachment (LA). Information concerning tobacco smoking was obtained from questionnaire data. *Results:* At age 19–20 years, smokers had statistically significantly ($P < 0.01$) higher whole mouth mean plaque scores than non-smokers. Whole mouth mean bleeding scores, however, were similar in smokers and non-smokers. The relationship of plaque to smoking was very similar at age 30–31, yet bleeding scores were approximately 25% lower in smokers than in non-smokers ($P < 0.01$). Whole mouth LA scores showed small, statistically non-significant differences between smokers and non-smokers. At the age of 30–31 years, gender and social class had a negligible confounding effect on oral hygiene, gingival and periodontal health in smokers and non-smokers. *Conclusions:* Smokers consistently demonstrated poorer oral hygiene than non-smokers. The effect of smoking in reducing gingival bleeding was already apparent at age 19–20 years despite the fact that, at this time, subjects might be assumed to have been exposed to a relatively small dose of tobacco over a short period of time. In the follow-up study conducted at the age of 30–31 years, the impact of smoking on the periodontal tissues was, as expected, more pronounced.

Key words: gingivitis; oral hygiene; periodontitis

Introduction

A recent 'state of the art' review (1) refers the reader to a number of cross sectional studies that support the relationship between smoking and periodontitis (2–15). The strength of these data varies according to the criteria used to identify periodontitis and whether the effects of plaque and confounding variables are considered. A meta-analysis of six studies (16) has concluded that smokers are almost three times more likely than non-smokers to have severe periodontitis. In general, in studies where plaque accumulation is similar in smokers and non-smokers, or where this is adjusted, current smokers have deeper probing depths (2, 13, 15, 17–19), greater attachment loss (5, 8, 13, 18, 19), more bone loss (6, 20–22) and fewer teeth (8, 18). Smokers also exhibit more supragingival calculus deposits (23) and the majority of studies show a trend towards increased clinical signs of inflammation.

Relatively few studies, however, have focussed specifically on the inter-relationship between tobacco smoking, oral hygiene and gingival/periodontal health in adolescents and young adults. Preber and Kant (24), in a study of 15-year-old school children, observed that smokers exhibited poorer oral hygiene than non-smokers, but no differences were seen between the two groups with regard to gingival health and interdental bone level. By way of explanation, the authors contended that the smokers in this group, commensurate with the age of the study population, had been exposed to a relatively small dose of tobacco over a short period of time. In a subsequent study of young adults (healthy male army conscripts) aged 19–27 years (25), Preber and co-workers observed significantly more severe gingivitis in smokers than non-smokers. Regression analysis of the data, however, revealed that this finding was due to the poorer standard of oral hygiene exhibited by the former group. The authors considered it justifiable to conclude that, in young people, smoking is accompanied by an increased plaque accumulation which in turn promotes the progression of chronic gingivitis.

In 1981, a cohort study commenced in Wales with the aim of evaluating the long-term interrelationships between malocclusion, caries and periodontal disease (26). The cohort was followed up in 1984, 1989 and 2000. A recently published paper has examined how oral hygiene and gingival health changed between the ages of 11–12 and 30–31 years (27). The aim of this second paper is to examine, on a cross-sectional basis, the inter-relationship between tobacco smoking, oral hygiene and gingival/periodontal health in early adulthood.

Study population and methodology

In 1981, at the commencement of the parent study (the main aim of which was the evaluation of the long-term interrelationships between malocclusion, caries and periodontal disease) extensive baseline data were recorded for 1016 subjects aged 11–12 years (28). The strategy for investigation, including details of the selection criteria and clinical assessments carried out, has been published previously (26). In brief:

Access was granted to 23 of 29 South Glamorgan Education Authority Secondary Schools in Cardiff, Barry and Penarth, Wales. Combined information/consent letters were issued to the parents of all 4810 first form pupils listed. Consent to participate was denied for 390 children (8.1%) and 651 (13.6%) were absent from school at the time of screening. Non-Caucasian children (163, 3.4%) and those already wearing orthodontic appliances (186, 3.9%) were excluded. This yielded 3420 potential subjects for the study.

Criteria developed to identify various occlusal conditions of specific interest to the study were applied to the available population of 3420 children. Details of these screening criteria are discussed fully in the strategy for investigation (26). About 1016 children were finally recruited to the study by disproportionate stratified sampling (29). This methodology ensured that occlusal conditions of low prevalence but high orthodontic interest would be adequately represented.

Of relevance to the present report, plaque present at the gingival margin of the buccal and lingual aspects of all the permanent teeth was recorded using the plaque index of Silness & Löe (30). The presence or absence of buccal, lingual and mesial bleeding was noted after gentle probing of the gingival margin for plaque (31); a simple dichotomous scheme was employed whereby 0 = no bleeding and 1 = bleeding. Loss of attachment (LA) was measured using a Williams round No.14 periodontal probe, the following two components (scored in mm) being recorded at each site examined:

- Component A = gingival margin to CEJ (representing pocketing)
- Component B = CEJ to pocket base (representing recession)

Mean plaque, bleeding and LA scores were derived by averaging the values from all scoreable sites.

The cohort was invited to attend for re-examination in 1984, 1989 and 2000 (i.e. when the subjects were aged 15–16, 19–20 and 30–31 years). These three invitations resulted in the re-examination of 792, 456 and 337 subjects respectively. With regard to the evaluation of oral hygiene, gingival and periodontal health, all follow-up examinations employed the methodology described previously. Information concerning tobacco

smoking was obtained from questionnaire data. Approval for all four waves of the study was given by the appropriate Local Research Ethics Committee and participating subjects gave their informed consent in writing.

Collection of periodontal data was, throughout, the responsibility of one individual (MA). On those few occasions during the four survey periods when this principal examiner was unavailable, an individual whose concordance with MA in the use of the relevant indices had been well established in the course of clinical trials was substituted. In order to ensure examiner reliability, 5–10% repeat examinations were undertaken at all stages.

The baseline examination was conducted in mobile dental units with standardized lighting and equipment; subsequent examinations were conducted under similarly standardized conditions at the University Dental Hospital, Cardiff.

Social class was ascribed at baseline and retained throughout the study. This was determined on the occupation of the head of the household (information collected by questionnaire) and in accordance with the Office of Population Censuses and Surveys (1980) classification of social class (32).

Statistical methods

Whole mouth mean plaque, bleeding and LA scores were compared between smoking and non-smoking groups by *t*-tests and confirmatory Mann–Whitney tests. These comparisons were subsequently refined to adjust for differences in gender and social class by multiple regression. The relationship of smoking habit to social class was assessed by a one degree of freedom linear trend chi-square.

Results

Examination of the data recorded in 1981 showed that too few subjects aged 11–12 years smoked (or at least admitted to doing so) to allow meaningful analysis. In addition, disappointingly, 45 subjects re-examined at age 15–16 years in 1984, and for whom smoking data were available, had no recorded periodontal data. The following cross-sectional analyses, therefore, are based on those subjects who were examined in 1989 and 2000 (i.e. when they were aged 19–20 and 30–31 years respectively). Attrition analysis of the data for these two examinations showed there to be very little evidence of differential loss of subjects according to smoking status.

Summary data for plaque, bleeding and LA by tobacco smoking at both time points are presented in Tables 1 and 2. At age 19–20 years, smokers had statistically significantly ($P < 0.01$) higher whole mouth mean plaque scores than non-smokers. Whole mouth mean bleeding scores, however, were similar in the two groups. Whole mouth LA scores, overall and for both components A and B separately, showed very small, statistically non-significant differences (by *t* and Mann–Whitney) between smokers and non-smokers.

Table 1. **Whole mouth mean plaque and bleeding scores by smoking 1989 and 2000. Means, standard deviations and *p*-value from unpaired *t*-tests comparing smokers and non-smokers are shown**

	Smoker 1989 (n = 122)	Non-smoker 1989 (n = 201)	*P*-value
Plaque	0.86 (0.43)	0.71 (0.40)	0.002
Bleeding	0.18 (0.15)	0.18 (0.15)	0.96
	Smoker 2000 (n = 98)	Non-smoker 2000 (n = 233)	*P*-value
Plaque	0.83 (0.43)	0.67 (0.42)	0.003
Bleeding	0.18 (0.15)	0.23 (0.17)	0.009

Table 2. **Whole mouth mean loss of attachment (in mm) by smoking 1989 and 2000. Means, standard deviations and *p*-values from Mann-Whitney tests comparing smokers and non-smokers are shown**

	Smoker 1989 (n = 123)	Non-smoker 1989 (n = 201)	*P*-value
Total loss of attachment	1.31 (0.24)	1.31 (0.22)	0.65
Pocketing	1.29 (0.24)	1.28 (0.21)	0.72
Recession	0.027 (0.058)	0.029 (0.055)	0.12
	Smoker 2000 (n = 94)	Non-smoker 2000 (n = 226)	*P*-value
Total loss of attachment	1.57 (0.52)	1.52 (0.38)	0.81
Pocketing	1.44 (0.48)	1.37 (0.33)	0.79
Recession	0.13 (0.20)	0.14 (0.17)	0.19

The relationship of plaque to smoking was very similar at age 30–31, with whole mouth mean plaque scores being approximately 25% higher in smokers than in non-smokers ($P < 0.01$). Conversely, bleeding scores were approximately 25% lower in smokers than in non-smokers ($P < 0.01$). As at age 19–20 years, with the exception of LA component B (recession), LA was slightly greater in smokers than non-smokers, but none of these differences approached statistical significance.

The 2000 data were further examined in relation to the potential confounding effects of gender and social class. Since smoking data were unavailable for 6 of the 337 subjects examined in 2000, these analyses were based on 331 subjects.

Among those presenting for re-examination at age 30–31 years nearly 30% were current smokers, for males and females alike. Table 3 presents data relating social class to smoking status. A one degree of freedom chi-square test shows a statistically significant trend to increased prevalence of smoking in lower social classes ($P = 0.025$), though this is somewhat weaker than one might have expected.

Multiple regression analysis of the data collected at age 30–31 years shows both gender and social class to have a negligible confounding effect on oral hygiene, gingival health and attachment loss in smokers and non-smokers. Parametric analyses for the effect of smoking, both unadjusted and adjusted for gender and social class, are summarized in Table 4.

Longitudinal smoking data were available for 202 subjects. Of these, 43 were smokers and 103 non-smokers in both 1989 and 2000. Eighteen subjects who were non-smokers in 1989 took up the habit between 1989 and 2000, while 38 subjects who were smokers in 1989 had ceased smoking by 2000. Unfortunately, these numbers were insufficient to assess the effects of changing smoking habit on periodontal health.

Table 3. **Proportion of participants who smoked in 2000 by social class (National Statistics Socio-economic Classification 2001)**

All participants	98/331 (30%)
Large employers & higher managerial occupations	8/22 (36%)
Higher professional occupations	14/41 (34%)
Lower managerial and professional occupations	11/74 (15%)
Intermediate occupations	18/70 (26%)
Small employers and own account workers	2/10 (20%)
Lower supervisory and technical occupations	7/19 (37%)
Semi-routine occupations	14/34 (41%)
Routine occupations	10/20 (50%)
Never worked & long-term unemployed	14/41 (34%)

Discussion

A small number of previous studies have shown that, compared to non-smokers, young adult smokers aged 19–30 years have a higher prevalence and severity of periodontitis, despite similar or lower plaque levels (12, 19, 33). Haber and co-workers (12) reported that the prevalence of periodontitis, defined as having a site with attachment loss of ≥2 mm and probing depths ≥ 4 mm, was three to four times higher in young smokers 19–30 years of age compared to non-smokers. This high 'periodontal cost' of smoking has been calculated as 27 years of disease progression; in other words, a 32-year-old smoker has similar attachment loss to a 59-year-old non-smoker (18).

In the present study, smokers aged 19–20 and 30–31 years were noted to display statistically significantly ($P < 0.01$) higher whole mouth mean plaque scores than non-smokers. Interestingly a recent study of smoking prevalence and its effect on dental health attitudes and behaviour among dental students (34) has shown that, even among a highly motivated group, non-smokers tend to brush their teeth more often than smokers (OR 8.67, 95% CI 1.66–45.25).

The seemingly contradictory observation that, at age 19–20 years, the whole mouth mean bleeding scores were similar in the two groups might indicate that there had already been a degree of tobacco-mediated suppression of the gingival response in smokers. At age 30–31, this effect was more pronounced. It is, therefore, logical to speculate that, in this study group, smoking habits were rather better established at the end of the second decade than those of the 'incipient' smokers described by Preber & Kant (24).

The observation that whole mouth LA scores showed small, statistically non-significant differences between smokers and non-smokers may be explained in one of two ways:

Table 4. **Parametric analyses for the effect of smoking on whole mouth mean plaque, bleeding and loss of attachment scores in 2000**

	Estimated difference (smokers minus non-smokers)	95% confidence interval	*P*-value
Whole mouth mean plaque score			
Unadjusted	+0.159	+0.058 to +0.260	0.002
Adjusted for gender and social class	+0.149	+0.049 to +0.250	0.004
Whole mouth mean bleeding score			
Unadjusted	−0.050	−0.088 to −0.011	0.013
Adjusted for gender and social class	−0.054	−0.093 to −0.015	0.007
Whole mouth mean pocketing score (in mm)			
Unadjusted	+0.064	−0.026 to +0.155	0.16
Adjusted for gender and social class	+0.064	−0.027 to +0.155	0.17
Whole mouth mean recession score (in mm)			
Unadjusted	−0.012	−0.054 to +0.031	0.59
Adjusted for gender and social class	−0.011	−0.054 to +0.032	0.62

Firstly, the age of 30 years may have been too early to observe either statistically or clinically significant differences between the two groups. Alternatively, the sample size may have been too small to detect any important difference. Finally, the absence of a clear social class gradient for smoking was somewhat surprising. This may have arisen as a result of young professionals continuing to smoke into their thirties; alternatively, once again, the sample may have been too small to detect a difference.

The authors wish to emphasize the role of the whole dental team in delivering smoking cessation counselling to adolescents. There are many possible approaches to tobacco use intervention which can be used in the dental setting. These range from brief interventions to comprehensive cessation programmes that involve the entire dental team and include: determining tobacco use status; supporting abstinence; advising users to stop; preparing users to stop and to remain tobacco free and offering cessation treatment (35). A systematic approach that combines behavioural counselling with pharmacotherapy has been shown to achieve the highest rates of cessation, though each is also effective alone (1).

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