

Self-reported Oral Health, Dental Care Habits and Cardiovascular Disease in an Adult Swedish Population

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Purpose: The primary aim was to investigate the oral health; oral care habits and the ability of the participants to afford dental care in an adult Swedish population. A secondary aim was to study whether there is a relationship between dental care habits, self-reported oral health status and cardiovascular disease (CVD).

Materials and Methods: The participants answered a questionnaire about the frequencies of diseases, the need for treatment and the effects of socio-economic factors on oral care habits. A questionnaire was mailed to 893 persons in 3 age groups (20–29, 50–59, and 75–84 years of age) of whom 723 replied (81.0%).

Results: The answers indicated that 16% had experienced dental problems without seeking help and more than 10% reported problems with chewing. In the group as a whole, 31.5% had sought no dental treatment, partly for financial reasons.

When using a logistic regression model, as regards bleeding gums as a risk indicator of CVD, correcting for diabetes, education, gender, age and tobacco use, the estimated odds ratio (OR) was 1.70 ($p = 0.05$). The OR for those 50 years old or more was 1.79 ($p = 0.05$). For the oldest group alone, the OR was 2.69 ($p = 0.05$). The model showed an increased risk of CVD among those who had problems with their teeth without seeking help, OR 2.45 ($p = 0.05$).

Conclusion: The study indicates that a large proportion of those answering the questionnaire had experienced dental problems without seeking help, partly for financial reasons. This group is more likely to have CVD and bleeding gums. It shows a relationship between the presence of bleeding gums and CVD, especially amongst the oldest participants.

Key words: cardiovascular disease, epidemiology, oral health, periodontitis, questionnaire

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In 1974, a National Dental Insurance system was introduced in Sweden, which enabled every citizen to obtain subsidized dental care; the insurance system also included prophylactic care, which was

unique for Sweden. The insurance system made dental care cheaper and thus affordable to most of the adult population. Oral health has improved in Sweden, as shown by an increasing number of remaining teeth, fewer cavities and less gingivitis (Håkansson, 1978; Hugoson et al, 1986; Österberg et al, 1995). However, during the last decade, this dental insurance system has been gradually reduced and dental treatment has once again become costly. This may affect the quality of dental care and some groups may refrain from necessary dental treatment and even avoid it, despite experiencing pain or other problems.

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Several studies in the 1990s have shown an association between oral health, especially periodontitis, and CVD. DeStefano et al (1993) reported that men with periodontitis, or who were edentulous, ran higher risks of developing coronary heart disease (CHD) than those with no periodontitis. Joshipura et al (1996) found an increased risk of CHD among men with a history of periodontal disease and ten or fewer teeth than those with 25 or more. Another population-based study (Beck et al, 1996) showed that men with severe periodontitis ran a threefold higher risk of CHD than those without periodontal disease. The same group also reported that the risk of CHD increased with more alveolar bone loss. A Canadian study showed a significant association between both gingivitis and edentulousness, and fatal coronary heart disease (Morrison et al, 1999). One recently published study has noted a strong relationship between periodontitis and edentulousness, and non-hemorrhagic stroke (odds ratio 2.11 and 1.23, respectively) (Wu et al, 2000). A relationship was also found between fatal stroke and periodontitis. In an American review article (Armitage, 2000), the author concluded that epidemiological studies indicate a relationship between periodontitis and CHD, but that there may be considerable residual confounding factors in the studies. In particular, smoking was discussed as being of significance (Hujoel et al, 2002). Therefore one focus of this study was to investigate the possible relationship between self-reported oral health and CVD and the elimination of as many confounding factors as possible.

The primary aim was to investigate the oral health; oral care habits and the ability of the participants to afford dental care in an adult Swedish population. A secondary aim was to study whether there is a relationship between dental care habits, self-reported oral health status and CVD.

MATERIALS AND METHODS

During the spring of 2000, 900 adult persons (300 aged 20–29 years, 300 aged 50–59, and 300 aged 75–84 years) were randomly selected from the population in the municipality of Huddinge, a suburban area 20 kilometers south of Stockholm. The persons selected represented 3.7% of the total number of inhabitants, in corresponding age groups, living in Huddinge on 1 January 2000. Seven persons moved out of Huddinge between the selection and

the investigation and were therefore excluded from the study. The questionnaire was mailed and a first reminder was sent one-week later. A second reminder, including a new questionnaire, was sent after a further 2 weeks and a third reminder after 2 months.

A total of 893 questionnaires were mailed and 437 (48.9%) were returned immediately with answers; 175 (19.6%) were returned after the first reminder, 54 (6.0%) after the second, and 26 (2.9%) after the third. Those with a telephone number who did not reply after the second reminder were contacted by telephone; 32 (3.6%) of the total that declined to fill in the mailed questionnaire agreed to answer questions by telephone. A total of 22 (2.5%) declined to participate in the study at all. The total response rate was 723 of 893 questionnaires or 81.0%. Of the participants, 148 (20.4%) were randomly selected for a clinical dental examination to evaluate and validate their oral status compared to the completed questionnaires. This was previously described in Buhlin et al (2002a). The participants were asked questions about their oral health without any instructions or information on how to perform the self-examination. Each questionnaire contained 25 questions concerning knowledge about the ability to pay for dental care, dental care habits, oral health, general health, CVD and the socio-economic variables of education and place of birth. Most questions were of the multiple-choice type but three were open. The question concerning bleeding gums had the alternatives: 'Yes', 'Yes, but only when I brush my teeth', and 'No'. The question regarding dentures had the alternatives: 'Only natural teeth', 'Only removable dentures', 'Both removable dentures and natural teeth', and 'Neither removable dentures nor natural teeth'.

In answer to the question: 'Has somebody told you that you have deep gingival pockets around your teeth?' three answers were given: 'Yes', 'No', and 'I don't know'. Since both public and private dental care is provided in Sweden, the questionnaire contained a question as to where the respondent sought dental care. Five possible answers were given: 'Public dental care', 'Private dental care', 'Both', 'Dental school', and 'Other'. The questionnaire also included an open question that asked: 'At your last dental visit, how many cavities did you have that needed attention?'.

Concerning CVD, the participants were asked if they had experienced any type of CVD during the last 9 years. If they answered 'Yes', they were asked

Table 1 Frequencies (%) of oral health variables obtained from the questionnaire in all participants and in the various subgroups. The column 'Bleeding gums' includes the answers 'Yes, I have bleeding gums', and 'Yes, my gums bleed when I brush my teeth'. Dentures refer to presence of all removable dentures and complete implant therapy. Participants who attended compulsory school up to 16 years of age were compared to those with a university degree. Significant differences ** = p 0.01, * = p 0.05

Oral variable		Age (yrs)	Bleeding gums	Deep pockets	Dentures	Mean number of teeth
Categories	n (%)	No.(SD)	%	%	%	No.(SD)
All participants	723	54.2 (21.9)	37.6	26.7	15.2	25.2 (7.6)
Women	416 (57.5)	53.2 (22.0)	37.5	23.2	16.3	25.0 (7.6)
Men	307 (42.5)	55.5 (21.7)	37.7	31.2*	13.6	25.5 (7.6)
Age groups (yrs)						
20–29	215 (29.7)	24.5 (2.9)	39.2	9.1	1.4	29.6 (2.5)
50–59	245 (33.9)	54.5 (2.5)	46.2	38.1	7.9	25.7 (6.1)
75–84	263 (36.4)	78.1 (2.7)	28.0	30.6	33.7	20.4 (9.5)
Smoking						
Non-smoker	394 (56.1)	51.4 (23.7)	36.5	22.8	11.2	26.1 (7.1)
Former smoker/ Current	308 (43.9)	56.7 (18.9)	38.4	32.3**	19.2**	24.6 (7.6)
Education						
University	176 (25.1)	44.1 (20.8)	35.1	22.7	5.7	27.5 (5.6)
Upper secondary school	260 (37.1)	47.3 (21.4)	40.0	23.5	5.8	26.8 (6.0)
Compulsory	264 (37.7)	66.4 (16.5)	36.4	32.4*	30.7**	21.5 (9.2)
Origin						
Sweden	576 (84.0)	54.2 (22.1)	35.1	25.3	12.8	26.0 (6.6)
Nordic countries	41 (6.0)	61.7 (15.8)	46.2	31.6	28.2	19.6 (10.8)
Other	69 (10.1)	48.6 (20.9)	49.3*	27.0	22.4**	24.5 (8.8)

to specify the type (myocardial infarction, stroke, thrombosis, angina pectoris, atherosclerosis, and severe hypertension). Those who answered 'Other' were excluded from the analysis due to the uncertainties about the nature of their CVD.

Statistical Analyses

The statistical analyses were performed using SPSS 10.0 and Excel software. The statistical significance of the differences between the groups in Tables 1 and 2 was calculated using the chi-square independent test. Odds ratios for all types of CVD were calculated with a logistic regression model adjusted for age, gender, smoking, diabetes mellitus, civil status and education. The statistical significance was also calculated for all types of CVD, bleeding gums, deep

periodontal pockets and the presence of dentures (Table 3). The dichotomization from the answers given in the questionnaires was performed as follows: dentures – Yes ('Only removable dentures', 'Both removable dentures and natural teeth', and 'Neither removable dentures nor natural teeth'), and No ('Only natural teeth'); bleeding gums – Yes ('Yes, I have bleeding gums', and 'Yes, my gums bleed, when I brush my teeth'), and No; and deep pockets (Yes/No). Those who answered 'I don't know' were excluded from the analysis. As regards CVD two groups were also used (Yes/No).

The ratios regarding CVD in Table 4 were calculated for all participants; in the two oldest groups and in the oldest one separately. In the 20–29 year olds, no separate calculation was performed because few people develop CVD before this age (Arbes et al, 1999).

Table 2 Frequencies (%) of oral health and dental care habit variables obtained from the questionnaire in all participants and in the various subgroups. Participants who attended compulsory school up to 16 years of age were compared to those with a university degree. Significant differences ** = p 0.01, * = p 0.05

Oral variable	Do you suffer from dry mouth?	Cannot chew food without problems	Have had dental problems, but did not seek help	Declined dental care in the past few years (completely or partly) for financial reasons	Accepted treatment for everything suggested by the dentist at the last visit
Categories	%	%	%	%	%
All participants	22.8	11.3	15.8	31.5	86.5
Women	26.4	10.9	17.8	32.8	85.1
Men	18.1*	11.7	13.1	29.7	88.4
Age groups (yrs)					
20–29	13.3	4.4	27.5	46.2	83.3
50–59	17.7	9.0	13.3	28.5	87.9
75–84	37.0	19.1	8.4	22.1	88.0
Smoking					
Non-smoker	20.6	8.2	14.3	31.2	85.4
Former smoker/Current	25.3	13.5**	16.7	32.2	87.8
Education					
University	17.4	4.7	14.8	37.0	85.3
Upper secondary school	21.7	7.6	17.8	33.5	87.7
Compulsory	27.5	18.4**	13.4	26.0	85.5
Origin					
Sweden	22.3	8.9	14.5	28.4	88.6
Nordic countries	22.5	22.0	25.0	32.5	80.0
Other	27.9	23.9**	21.2*	47.0**	71.9**

The study was approved by the Ethics Committee of the Huddinge University Hospital and was conducted in accordance with the Helsinki Declaration. All participants gave their informed consent.

RESULTS

Of those answering the questionnaire 57.2% were women, 43.9% current or former smokers and 16.1% were of non-Swedish origin. The frequencies of the oral variables – i.e., bleeding gums, deep pockets, dentures, oral health and dental care habits are shown in Tables 1 and 2. Smokers (current and former) had significantly more deep pockets and dentures ($p < 0.01$) than did non-smokers. Those who had only a compulsory school education

had significantly more deep pockets ($p < 0.05$) and dentures ($p < 0.01$) than those with a university education (Table 1).

Of those who reported that they had complete dentures, 44.1% had problems with chewing, while in the dentate group, 7.2% of the respondents reported that they had problems with chewing. Regarding dental implants, 7.5% of the respondents stated that they had some kind of dental implant therapy. None of those with dental implants alone answered that they had problems with chewing. A bivariate comparison showed that the respondents of non-Swedish origin had bleeding gums ($p < 0.05$) and dentures ($p < 0.01$) more frequently than those of Swedish origin (Table 1). They also had refrained from seeking dental care ($p < 0.01$) more frequently and had more problems with chewing ($p < 0.01$) (Table 2).

Table 3 Odds ratios (95% confidence interval (CI)) for the relationship between oral parameters, all types of cardiovascular disease (CVD), and attitudes and socio-economic factors for all participants. Each category refers to the 'No' alternative in the questionnaire. The question regarding bleeding gums refers to those who answered 'Yes, I have bleeding gums', or 'Yes, my gums bleed when I brush my teeth'. Dentures refer to presence of all removable dentures and complete implant therapy. The category place of birth refers to those with a non-Swedish background as compared to those with a Swedish one. Education compares those who attended compulsory school up to 16 years of age to those with a university degree, and the category that bought private dental care is compared to public dental care. The categories are corrected for gender, age and smoking habits.

Category	Dentures		Bleeding gums		Deep pockets		CVD	
	All age groups, n = 582		All age groups, n = 576		All age groups, n = 576		All age groups, n = 578	
	Ratio	95% CI	Ratio	95% CI	Ratio	95% CI	Ratio	95% CI
Did not treat everything that was suggested by the dentist	1.73	0.488 – 9.106	1.36	0.669 – 2.770	1.14	0.531 – 2.429	0.72	0.274 – 1.911
Sought private dental care	1.21	0.570 – 2.587	1.03	0.673 – 1.579	1.31	0.791 – 2.175	0.83	0.466 – 1.479
Declined dental care past few years (completely or partly) for financial reasons	0.73	0.323 – 1.631	1.62	1.04 – 2.53	1.93	1.151 – 3.231	0.82	0.436 – 1.526
Had dental problems, but did not seek help	0.90	0.312 – 2.573	1.74	1.007 – 3.021	1.56	0.795 – 3.060	2.45	1.066 – 5.652
Place of birth (non-Swedish)	4.83	2.162 – 10.79	1.38	0.836 – 2.292	0.91	0.500 – 1.637	1.11	0.556 – 2.202
Education, Compulsory	3.68	1.489 – 9.106	0.78	0.603 – 1.009	0.96	0.732 – 1.267	0.76	0.555 – 1.043

Another difference was that women often suffered from dry mouth more than did men ($p < 0.05$) and they also tended (non significant) to have dental problems without seeking help more often (17.8% vs. 13.1%, Table 2).

Of the patients in private dental care, 24.5% had rejected dental care in recent years (completely or partly) for financial reasons. In the public sector, more patients had declined dental care (completely or partly) for such reasons (45.3%, $p < 0.001$, Table 5).

Most people of non-Swedish background said they had more than 1 cavity detected at their last dental examination, 65.3% versus 27.0% in the Swedish group. Respondents of non-Swedish origin

also revealed a greater risk of having dentures in the logistic regression model (odds ratio, OR 4.83, $p < 0.05$, Table 3).

A majority (75.5%) of those refusing dental treatment for financial reasons also had experienced problems with their teeth during the last year. Those who had declined dental care for financial reasons were more likely to have bleeding gums and deep pockets. A total of 1.6% answered that they had been absent from work because of dental problems during the last 10 years; a majority of those was in the younger group. Those who stated that they had suffered from dental problems without seeking help were more likely to have CVD and bleeding gums (Table 3).

Table 4 Odds ratios (95% confidence interval (CI)) for the association between all types of cardiovascular disease (CVD) and indicators of oral health, gender, age, diabetes, education and tobacco smoking. The associations are shown for all participants, the two oldest age groups and the oldest group separately. Each category refers to the 'No' alternative in the questionnaire.

The question regarding bleeding gums is divided into 2 categories:

1. The first row¹ deals only with those who answered 'Yes I have bleeding gums';
2. The second row² include the answers, 'Yes, I have bleeding gums', and 'Yes, my gums bleed, when I brush my teeth'.

Dentures refer to presence of all removable dentures and complete implant therapy. Regarding education, participants who have attended compulsory school up to 16 years of age are compared to those with a university degree.

Category	CVD		CVD		CVD	
	All age groups, n = 638		2 oldest groups, n = 432		Age group 75-84, n = 209	
	Ratio	95% CI	Ratio	95% CI	Ratio	95% CI
Bleeding gums ¹	3.07	1.288 – 7.313	3.55	1.339 – 9.428	16.11	1.966 – 132.0
Bleeding gums ²	1.70	1.078 – 2.690	1.79	1.106 – 2.895	2.69	1.387 – 5.523
Deep pockets	1.16	0.690 – 1.934	1.15	0.695 – 1.909	1.55	0.767 – 3.151
Dentures	0.88	0.498 – 1.545	0.92	0.519 – 1.618	1.06	0.556 – 2.037
Gender, male	1.20	0.777 – 1.869	1.36	0.860 – 2.158	1.18	0.640 – 2.172
Diabetes mellitus	5.00	2.274 – 11.00	5.17	2.298 – 11.62	4.58	1.683 – 12.47
Age 50–59 yrs.	4.67	1.966 – 11.10	–	–	–	–
Age 75–84 yrs.	18.0	7.640 – 42.36	3.90	2.368 – 9.428	–	–
Education, Compulsory	1.94	1.036 – 3.615	1.91	0.988 – 3.706	1.36	0.554 – 3.337
Smoker, (former and current)	1.31	0.839 – 2.054	1.26	0.789 – 2.015	1.66	0.899 – 3.056

Table 5 Frequencies (%) of those who declined dental care in the past few years for financial reasons divided into where they received their oral health care. * = $p < 0.001$**

Dental care centre		Declined dental care in the past few years for financial reasons (%)	
Categories	n	Yes	No
Public dental care***	181	45.3	54.7
Private dental care	372	24.5	75.5
Both	29	51.7	48.3
Dental school	18	33.3	66.6
Other	7	57.1	42.9

Regression Analysis

We used a multiple logistic regression analysis to calculate the odds ratios for CVD and found a relationship. Age was also significantly associated with CVD. The relationship between bleeding gums and CVD was most marked in the oldest age group (Table 4). No other dental variables showed a significant relationship. No relationships were detected between all types of CVD and gender or smoking (both current and former smokers). However, if the group of former smokers was evaluated alone, a relationship was found (OR 2.01).

There was also a relationship between education and CVD when calculated for all participants (Table 4), as well as for diabetes mellitus and all types of CVD (OR 5.0, $p < 0.05$). Among all participants, 6.9% had diabetes mellitus, 1.0% in the youngest age group, 5.0% and 14.3% in the two older groups. Considerably more persons among those with diabetes were edentulous (11.6%) than in the non-diabetic group (6.2%).

DISCUSSION

The percentage of both partial and complete dentures was 15.1, which is slightly higher than reported in other recent Swedish studies (Ahacic et al, 1998; Buhlin et al, 2002b). The higher frequency of dentures in this study may reflect the relatively high percentage of participants in this geographic location of non-Swedish origin, having significantly more dentures than those of Swedish origin. This is still an improvement because others have reported that 20.5–30.5% of the population in various parts of Sweden and in different age groups had removable dentures (Håkansson, 1978; Helldén et al, 1989; Palmqvist et al, 1991). A similar decrease in the number of dentures has been reported in some countries in the Western World (Truin et al, 1993; Weintraub and Burt, 1993; Vrbic, 1996).

However, the frequency of various types of dental implant therapy has increased (7.7%), as compared to a nationwide Swedish study from 1999 (Dental health and dental visits 1975–1999 Statistics Sweden, 2001), that found that 2–3% (depending on gender differences) had dental implants. The increase could be due to differences between urban and rural areas or it could result from implants being used more often than before. Another possible explanation could be that the responders confused implants with various other types of fixed bridgework and hence overestimated the presence of implants (Buhlin et al, 2002a).

We found that 11.3% of the respondents (19% in the oldest age group) stated in the questionnaire that they had problems with chewing. These values are higher than in another Swedish study (Dental health and dental visits 1975–1999, Statistics Sweden, 2001) in which 6–7.5% had such problems. The higher prevalence in our study may be explained because we had 3 stratified age groups and that the other study had participants from 25–84 years of age. We found no difference in the oldest group. Our study showed no correlation between socio-economic factors and education. Another Swedish study (Ahlqwist et al, 1991) has reported that improvements in dental status have been occurring in the population, regardless of the levels of education. The present study also suggests that educational level does not affect a person's readiness to visit the dentist.

Almost one third (31.5%) of the participants said that they had refrained from dental care for financial reasons. This was most noticeable in the

younger age group (46.2%) and among respondents of non-Swedish origin (47%). Respondents in the latter group were significantly more likely to answer that they had bleeding gums and deep pockets. Some had suffered from dental problems, but had not sought help. They were also more likely to answer that they had bleeding gums and CVD was also more frequent in this group. Even if 15.8% claimed that they had dental problems, but had not sought help, only 1.6% had answered that they had been absent from work because of dental problems during the last 10 years. This implies that local problems with oral health are not a reason for sick leave to any great extent.

This study shows a significant relationship between bleeding gums and CVD in an adult Swedish population, particularly among older people, which accords with previous findings from our group (Buhlin et al, 2002b). Those who answered 'Yes' to the question about bleeding gums were more likely to also answer that they had CVD as compared to those who answered 'No' or 'Yes, when brushing'. Our validation of the questionnaire showed that those answering 'Yes' bled significantly more than persons answering 'Yes, when brushing my teeth' (data not shown). The validity of the questionnaire has been investigated in a previous report (Buhlin et al, 2002a) and 63% knew whether they had bleeding gums and the corresponding percentage was 76% for gingival pockets. This demonstrates that, even though a majority knows about gingival health, a large minority did not, and this could influence the results.

The high odds ratio between bleeding gums and CVD, especially in the oldest age group, could also be due to confounding factors, which the regression model did not adjust for – i.e. insufficient oral hygiene.

Our finding of a relationship between gingivitis and CVD is consistent with the idea that chronic inflammations can promote atherogenesis (for review see: Ross, 1999; Beck et al, 1998).

In accordance with some previous studies (Morrison et al, 1999; Buhlin et al, 2002b), we found no significant relationship between deep pockets and CVD. This could be because gingival pockets can only be detected in a professional examination. The answers would therefore be less reliable, since the patient could have periodontitis and deep pockets without knowing it. Unlike another study from our group (Buhlin et al, 2002b), no significant relationship was shown between the use of dentures and

CVD. The reason for this is not clear. A possible explanation could be that socio-economic and cultural factors favor the use of removable rather than fixed prostheses in a suburban population. In the present population, the reason for dentures is unknown and it may not be periodontal disease that caused the loss of teeth. Since the tooth loss may not have been due to a chronic inflammatory disease, the link with CVD is weak.

Tobacco smoking is usually related to CVD. However, when the smokers were divided into current and former smokers, current smokers showed no relationship with CVD, while former smokers did. This suggests that CVD is a strong reason for smoking cessation. Our present study shows an association between oral health, especially gingival bleeding and CVD, which is in agreement with a number of other reports.

The logistic regression model showed a significantly higher risk of CVD among those who answered that they had experienced dental problems, but had not seen a dentist, despite the fact that the model corrects for age, gender, smoking, diabetes mellitus, civil status and education. This could be an effect of impaired oral health or a consequence of lifestyle factors not corrected for in the statistical model.

Recent research (Wolf-Maier et al, 2003) has indicated that hypertension is underdiagnosed in a European population. This could imply that atherosclerosis is more common than previously thought. Also, self-assessment of periodontal disease may be underestimated. This study being a self-reported questionnaire study should be viewed in this context. The results may be less reliable compared to some of the previous studies (DeStefano et al, 1993; Beck et al, 1996). Despite these possible shortcomings, the result points in the same direction regarding oral health and cardiovascular health. However, the association between systemic diseases and oral health is debatable and some recent studies have failed to show an association between the two conditions (Hujoel et al, 2001; Howell et al, 2001). This shows the complexity of the issue and the need for intervention and case-control studies, focusing on causality and biological reasons for such a connection.

CONCLUSIONS

The present study indicates that a large proportion of those answering the questionnaire had experi-

enced dental problems without seeking help, partly for financial reasons. This group is also more likely to have CVD and bleeding gingiva. Another finding is a self-reported relationship between the presence of bleeding gingiva and CVD, especially among the oldest participants.

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