Subsidized dental care associated with lower mutans streptococci count in male industrial workers

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Salivary mutans streptococci count, dental status, and related factors were studied in male industrial workers (age 38–65 years) with or without access to subsidized dental care. Altogether 315 subsidized workers and 168 controls without subsidy were compared. A prior questionnaire survey had shown that the two study groups were similar in age, oral self-care habits, and socio-environmental factors. In the present study, the mean number of carious teeth was significantly lower in the subsidized group (0.4, SD 1.2) than in the control group (1.7, SD 3.2) ($P < 0.001$). Otherwise the study groups had similar dental status. A total of 92% subsidized employees had visited a dentist within the past 2 years, while 82% in the control group had done so ($P < 0.01$). According to the trend test, men in the subsidized group tended to have a lower mutans streptococci count than the control employees ($P < 0.01$). The logistic regression showed that the probability of having one or more carious tooth was significantly negatively associated with subsidized care and positively associated with high mutans streptococci count. It is concluded that subsidized dental care leading to a smaller number of untreated carious teeth might result in decreased levels of mutans streptococci. □ *Dental caries; saliva; subsidization*

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Despite the overall improvement in oral health status in the industrialized countries, oral health is not equally distributed within populations. Several social and environmental factors are known to affect the utilization of dental care services, and the more affluent tend to have better oral health status than those in lower economic categories (1–3). To combat this inequity, dental care has often been subsidized by various methods. Earlier studies in the USA and the Nordic countries reported contradictory outcomes of such programs (4–6), but a recent Finnish study confirmed that comprehensively subsidized dental care can improve dental care services as well as caries status (7).

Dental caries still affects people everywhere. Oral mutans streptococci infection is involved in the initiation of carious lesions, but the multifactorial etiology of dental caries means that the infection itself must be even more prevalent than the disease. Indeed, infections can be transmitted without the adherent disease (8, 9). The impact of subsidized dental care programs on salivary mutans streptococci count in adults is not known.

The aim of the present study was to analyze the effect of subsidized dental care on salivary mutans streptococci count, dental status, and related factors among male industrial workers in southern Finland.

Material and methods

In 1994, all male workers (born before 1956) on the oil production line at an oil refinery in southern Finland (Neste Ltd., Porvoo, Finland) were asked to return a self-administered postal questionnaire and participate in a comprehensive cross-sectional clinical study. A control group was formed on the same basis from other industrial workers at three companies in the same urban region. The refinery workers (referred to as the subsidized group) have access to free dental care at their workplace during working hours. The workers who formed the control group are obliged to finance their dental care out-of-pocket, without reimbursement from any third party, and to arrange their dental visits outside working hours. The questionnaire survey included items on socio-demographic aspects, dental knowledge, dental health care behavior, and smoking. The survey and the similar backgrounds of the two study groups with regard to age, education, dental knowledge, and environmental factors are described in detail elsewhere (10).

The same dental unit, with conventional lighting and compressed air flow, was used for clinical examinations at all workplaces to ensure equivalent conditions. One experienced practitioner examined all the subjects using a mouth mirror and a WHO periodontal probe and explorer, while the clinical data were recorded by a trained dental assistant. Teeth were blown dry but not cleaned, and examined in good illumination. All totally erupted natural teeth (also third molars) were recorded in the dental status and classified as carious whenever one or more tooth surface was clinically assessed as needing restoration due to caries. Teeth with fractures or lost fillings without clinically observable caries were not categorized as carious teeth.

To estimate the salivary mutans streptococci count, a

Table 1. Classifications of the dichotomous background variables entered in the multivariate analysis

Variables	Category	Value	*n*
Group	Self-financed dental care	0	166
	Access to subsidized dental care	1	312
Tooth brushing	Less than once a day	0	85
	At least once a day	1	393
Last dental visit	More than two years ago	0	55
	Within the past two years	1	423
Smoking	No tobacco use or quit more than a year ago	0	298
	Current tobacco use	1	180
Dentocult SM® score	<2	0	150
	≥2	1	328
	<3	0	351
	=3	1	127

plastic strip (Dentocult® SM Strip mutans; Orion Diagnostica, Helsinki, Finland), developed by Jensen & Bratthall (11), was used. The subjects had been asked to avoid eating, smoking, and tooth brushing for 2 h prior to the examination. After 1 min of paraffin chewing, the strip was rotated approximately 10 times in the mouth and withdrawn through closed lips to remove excessive saliva. The strip was placed in tubes following the manufacturer's instructions and incubated for 48 h at 37°C. The mutans streptococci count (colony-forming units (cfu) per ml saliva) was obtained by comparing the test strip with the evaluation chart provided by the manufacturer, and scored from 0 to 3 as follows: scores 0 and 1: $<10^5$ cfu/ml saliva; score 2: $>10^5$ but $<10^6$ cfu/ml saliva; score 3: $>10^6$ cfu/ml saliva.

Clinical examinations were completed at workplaces in 325 of the subsidized group (81%) and in 174 of the controls (69%). In both groups, 97% ($n = 483$) of the subjects had at least one natural tooth and were enrolled for the salivary mutans streptococci test. Five cultures out of 483 were damaged, and further analyses were applied to the 478 remaining subjects.

Student's *t* test was used for comparison of the group means. The trend test and the chi-square test were used to study the significance of the associations between categorial variables. Differences were considered statistically significant at the 5% level. The effects of the studied background variables on the probability of having any carious teeth were studied using logistic regression (12). Variables from the questionnaire data were categorized for the multivariate analyses as shown in Table 1. Age in years and number of teeth were included in the multivariate models as continuous variables. The forced entry method was used, i.e. all selected independent variables were entered in a single step in the regression models.

Odds ratios (OR) were calculated as: e^{β}, where β is the logistic regression coefficient. The corresponding 95% confidence intervals (CI) were calculated as: $e^{\beta} \pm 1.96$ (SE).

Table 2. Dental status of the subsidized and control groups, Student's *t* test. Group mean (SD)

$n = 483$	Subsidized, $n = 315$	Control, $n = 168$	$P<$
No. of teeth	20.5 (7.6)	21.9 (7.5)	NS
No. of filled teeth	12.1 (6.2)	12.3 (6.7)	NS
No. of carious teeth	0.4 (1.2)	1.7 (3.2)	0.001
No. of sound teeth	7.3 (5.9)	7.3 (6.3)	NS

Results

Eighty-one percent of the subsidized workers and 50% of the controls had no clinically observable carious teeth ($P < 0.001$). Despite caries, the dental status was not significantly different between the groups (Table 2). In the subsidized group, 92%, and in the control group 82%, had had a dental visit within the past 2 years ($P < 0.01$). More men in the subsidized group (41%) than in the control group (30%) were smokers ($P < 0.05$). The mean age was 46 (SD6) years in the subsidized group and 47 (SD 6) years in the control group (NS).

According to the Dentocult® SM Strip mutans test, a score of 3 ($>10^6$ cfu/ml saliva) was significantly less often detected in the subsidized group (21%) than in the control group (36%) ($P < 0.001$). The trend test also showed an overall lower mutans streptococci count in the subsidized group ($P < 0.01$) (Fig. 1).

The logistic regression analyses revealed that the probability of having one or more carious tooth was significantly negatively associated with access to subsidized dental care and a dental visit within the previous 2 years, and significantly positively associated with high mutans streptococci count and smoking (Table 3).

Discussion

As previously described in detail (10), the study groups had

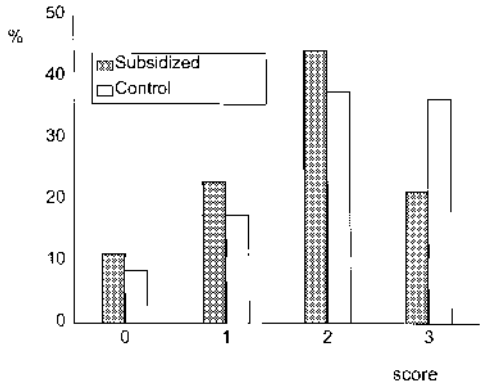

Fig. 1. Salivary mutans streptococci counts in the subsidized and control groups, obtained by using the Dentocult® SM Strip mutans methods.

Table 3. The regression coefficients of the studied background variables. The probability of having one or more carious tooth, logistic regression. (Figures with covariant' Dentocult® SM Strip mutans score = 3′ in parentheses)

	Regression coefficient ($n = 478$)	S.E.	OR	95% CI for odds ratio
Constant	−1.36	1.12		
	(−1.52)	(1.18)		
Continuous variables:				
Age	0.03	0.02	$p = 0.2$	
	(0.03)	(0.02)	($p = 0.1$)	
No. of teeth	0.17	0.02	$p = 0.3$	
	(0.02)	(0.02)	($p = 0.2$)	
Dichotomous variables:				
Dentocult® SM Strip mutans score ≥2 (score = 3)	0.45	0.25	1.6	1.0–2.6
	(0.64)	(0.25)	(1.9)	(1.2–3.1)
Tooth brushing at least once a day	−0.30	0.28	0.7	0.4–1.3
	(−0.25)	(0.28)	(0.8)	(0.5–1.4)
Last dental visit in past two years	−0.80	0.23	0.5	0.3–0.7
	(−0.78)	(0.23)	(0.5)	(0.3–0.7)
Smoking	0.63	0.23	1.9	1.2–2.9
	(0.63)	(0.23)	(1.9)	(1.2–3.0)
Access to subsidized dental care	−1.55	0.23	0.2	0.1–0.3
	(−1.48)	(0.23)	(0.2)	(0.2–0.4)

similar backgrounds with regard to age, education, dental knowledge, and environmental factors. However, only the refinery workers had access to subsidized dental care as adults, which is unusual; most Finns born before 1956, like all the control group subjects, are in the fee-for-service system, and receive no reimbursement. It can be assumed that the 2 groups were comparable and thus valid for studying the impact of subsidized dental care in this cross-sectional study (6).

The refinery employees work in 3 shifts, and if a subject was off duty for some unexpected reason during the examination period it was sometimes difficult to rearrange their appointment. Nevertheless, their rate of participation was good. Some controls had to attend the examination outside working hours, which may explain their lower rate of participation.

The low variability in reading Streptococcus mutans strips with or without a microscope has been established (13). In addition, all the subjects were examined, salivary samples collected, and cultures analyzed by a single dentist in the present study. The absence of radiographical examinations probably caused underestimation of the occurrence of carious lesions (14), but this would affect both study groups equally. Neither were tooth brushing, eating, or smoking prior to the test likely to have biased the mutans streptococci scores between the groups, as all subjects were equally informed of the examination protocol with a personal invitation letter.

Logistic regression enabled us to investigate the independent effects of the studied background variables on the probability of having one or more carious tooth, while the effects of other variables were simultaneously controlled for. The positive association between higher mutans streptococci count and untreated caries, as well as the negative effects of subsidized dental care and a recent dental visit on the probability of caries, is in line with earlier results (4, 7, 15, 16). On the other hand, accumulation of unhealthy behavior has been suggested to be more pronounced among smokers than non-smokers (17), which may partly explain the significantly positive effect of regular tobacco use in the logistic regression models.

The presence of carious teeth is clinically proven as a valid measure for predicting an individual's future caries experience in children (18). The information obtained by the Dentocult® SM Strip mutans, namely the presence and extent of *S. mutans* infection, does not necessarily implicate mutans streptococci as a risk factor for caries (19). It seems quite plausible to suggest, notwithstanding the role of *S. mutans* in caries initiation, that high mutans streptococci count occurs as a consequence of cavitated (untreated) carious lesions. As only 5 cultures could not be read, the Dentocult® SM Strip mutans can be considered a reliable method. It can be used outside dental clinics (e.g. at workplaces) and could thus cost-effectively assist in caries pre-examinations of large populations and in monitoring caries treatment (20).

Mutans streptococci, unlike Lactobacilli, for example, have evolved the ability to store energy against periods when fermentable carbohydrates are sparse in the mouth (21). This may cause the salivary mutans streptococci count to remain constant even when drastic dietary changes take place. However, Rajasuo et al. (22) showed that, in Finnish conscripts, decreasing local foci of infection by extracting partly erupted third molars had positive effects on oral bacterial flora. Similarly, in the present study, access to subsidized dental care was not only associated with better caries status but also with a concomitant decrement in the overall mutans streptococci count. In fact, the degree of *S. mutans* infection was lower in the subsidized group.

The role of iatrogenic bacteremia of oral origin in problems of malformed or artificial heart valves is

generally agreed, as is its role in destabilizing diabetes and rheumatoid arthritis. However, the relationships between chronic oral infections and general health problems are not well understood (23). Recently discussed is whether the associations between oral conditions and cardiovascular disease, for example, can be explained by antecedent oral infection rather than by confounding or bias from other sources (24). These studies indicate that more research in this area is needed. In the meantime, dental care systems provide oral health education and preventive procedures to children and adolescents in many countries with the expectation of improving oral and general health in the long term. In adults, the fact that subsidized dental care programs may result in more immediate positive outcomes should not be ignored.

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