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Toothbrushing and smoking among adolescents – aggregation of health damaging behaviours

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Abstract

Aim: The aim of this study was to determine whether an association exists between daily smoking and infrequent toothbrushing habits among adolescents.

Materials and Methods: Nationally representative samples of 14-, 16- and 18-year-old Finns ($N = 5643$) took part in the survey. A 12-page structured questionnaire was posted to the adolescents, asking them to complete it and return it in an enclosed prepaid envelope. The χ^2-test and a logistic regression model were used for analyses.

Results: At the age of 14 years, 8.5% reported smoking daily, at 16 years 25.0% and at 18 years 33.2%. Only 28.3–54.7% of the adolescents reported brushing their teeth more than once a day. Among 14-year-olds, 6.5% of the adolescents reported both smoking daily and brushing less than twice a day. The respective figures were 17.7% for the 16-year-olds and 21.6% for the 18-year-olds. Among the14-year-olds, the strongest association with smoking daily and brushing less than twice a day was found with low school performance (OR = 8.2), and among 16- and 18-year-olds school career (studying at a vocational school, OR = 3.4).

Conclusion: Daily smoking and infrequent toothbrushing are strongly associated in adolescence.

Key words: adolescents; Finland; school performance; smoking; socioeconomic status; toothbrushing; youth

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Smoking, in addition to being the fourth most common risk factor for chronic diseases (World Health Organization 2006), has a considerable influence on oral health. It is associated with oral cancer and precancerous lesions (Reibel 2003) and has been identified as a major risk factor for poor periodontal health (Stoltenberg et al. 1993). The relative risk of periodontal disease among smokers has been reported to be 2.5–6 times higher than that of non-smokers (Bergstrom & Preber 1994, Page & Beck 1997). Further, smokers tend to have more severe periodontal disease, e.g. greater probing depth and greater loss of attachment, than non-smokers (Sheiham 1970a, Stoltenberg et al. 1993, Rivera-Hidalgo 2003). About half of the periodontitis observed in individuals under 30 years of age is thought to be associated with smoking (Page & Beck 1997). Smoking has been shown to be one of the important aetiological factors of periodontal disease among children and adolescents (Albandar & Rams 2002, Heikkinen et al. 2008). The onset of smoking during adolescence has been shown to be a strong predictor of continued smoking behaviour in adulthood (Paavola et al. 2004a). Adolescents who smoke at a young age are unlikely to quit when they get older (Kelder et al. 1994).

Poor oral hygiene has been shown to increase the occurrence and progression of periodontal disease among children and adolescents (Albandar & Rams 2002). The simultaneous presence of plaque and poor oral hygiene practices can cause the initiation of periodontal inflammation/gingivitis (Löe 1996). Furthermore, gingivitis can be seen as an initial clinical stage in the development of periodontal lesions. However,

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not all gingivitis proceeds to periodontitis. Such progress also depends on the host response and pathogenesis of the plaque bacteria (Löe 1996), but the proper control of plaque can prevent or slow down the progression of periodontal disease (Axelsson & Lindhe 1981, Corbet & Davis 1993). Toothbrushing and inter-dental cleaning are simple and effective ways to reduce plaque and gingivitis, and thus maintain periodontal health (Sheiham 1970b, Löe 2000). Kornman and Löe (1993) stated in their review that ''Good oral hygiene, in particular good toothbrushing, has long been associated with better periodontal health than poor oral hygiene''. However, the evidence for the role of oral hygiene in chronic periodontitis is inconsistent (Hujoel et al. 2005). In order to maintain good oral health, prevent periodontal diseases and decrease levels of dental caries, twice-a-day toothbrushing frequency with fluoride toothpaste is recommended internationally (Sheiham 1970b, Löe 2000). It has been shown that relatively stable patterns of toothbrushing are established during childhood; individuals who brush their teeth more than once a day seem to have a more stable habit than those who brush less often (Kuusela et al. 1996).

During adolescence, many young people experiment with behaviours that, if continued long term, are likely to be detrimental to their health (Pavis et al. 1998). A number of studies have reported that health behaviours tend to cluster together (Rajala et al. 1980, Fisher et al. 1991, Sanders et al. 2005, Savolainen et al. 2009). Smokers tend to brush their teeth less frequently than non-smokers, both as adolescents and as adults (Rajala et al. 1980, Macgregor & Balding 1987, Savolainen et al. 2009). Recently, boys in Finland who smoked also reported very low brushing frequencies (Heikkinen et al. 2008). In general, smokers might have a greater risk of developing periodontal disease as a result of their smoking and poor oral hygiene habits (Reibel 2003).

In Finland, smoking and toothbrushing behaviours of adolescents have been monitored regularly since 1977 (Rimpelä et al. 2005). Unfortunately, 15-year-old Finns are among the most frequent tobacco smokers in Europe; 19% of the boys and 15% of the girls smoke every day (Currie et al. 2008). Adolescents in Finland are also among the most infrequent brushers in Europe; only 39% of the boys and 69% of the girls are brushing more than once a day (Currie et al. 2008). At the end of the 1970s, smoking was found to be weakly associated with sporadic toothbrushing among Finnish adolescents (Rajala et al. 1980). However, it is not known whether and how these unfavourable habits are associated with each other in adolescence.

The aim of this study was to determine whether an association exists between daily smoking and infrequent toothbrushing habits among 14-, 16- and 18-year-old adolescents in Finland, and which factors might be associated with concurrent daily smoking and infrequent toothbrushing.

Methods

Implementation of the study

This study is part of the Adolescent Health and Lifestyle (AHL) Survey, which has been conducted in Finland every second year (February–April) since 1977. The data included in the present study were collected in 2005. In addition to smoking, several other habits related to health (alcohol consumption, physical activity, hygiene, food habits, etc.) were assessed. Ethical approval for the project was obtained from the Ministry of Social Affairs and Health, which has also been the main funding agency for these surveys. Nationally representative samples of 12-, 14-, 16- and 18-year-old Finns were drawn from the Central Population Registry. Altogether 9853 adolescents were selected for this survey in 2005. The AHL Survey uses a cross-sectional quantitative research design. A 12-page structured questionnaire with 85 questions was posted to the adolescents, asking them to complete it anonymously and then return it in an enclosed pre-paid envelope to the researcher. If the questionnaire was not returned in 2 weeks, a reminder was posted (twice, if needed). For this purpose, the forms were numbered. The youngest age group reported smoking tobacco very seldom and was omitted from the analysis here. Altogether 65% ($n = 5643$) of the selected adolescents participated in the survey. The numbers of respondents and the response rates according to sex and age are shown in Table 1.

Variables

Smoking was determined by the following questions: ''Have you ever smoked?'' (no/yes). If the answer was yes, the further question was ''Which of the following options best describes your current smoking habit?'' The alternatives were: I smoke once a day or more often; I smoke once a week or more often, but not daily; I smoke less than once a week; I don't smoke currently/have quit smoking. Because the proportions of respondents in the middle groups were very small, for bivariate analysis and for the logistic regression model, the answers were re-coded into two categories (smoking daily, not smoking daily). *Toothbrushing* frequency was asked by a question: ''How often do you brush your teeth?'' Six options were given: never, once a week or more seldom, about once a week, a couple of times per week, once a day, more than once a day. While in some categories there were only a few responses, for bivariate analysis the answers were re-coded into three categories (more than once a day, once a day, less than once a day), and for logistic regression model into two categories (once a day or less often, more than once a day). *Demographic factors* included age and sex. *Socio-economic factors* were described by the following variables:

- self-assessed school performance (much better compared with the class average, slightly better, about average, slightly lower, much lower) for 14-year-olds;
- school career (primary school, upper secondary school, university/polytechnics, vocational school, vocational school+upper secondary school, other school) for 16- and 18-year-olds;
- education of father/mother (primary school or equivalent, primary school

Table 1. Numbers of respondents (n) and response rates (%) in the Adolescent Health and Lifestyle Survey 2005, by sex and age

Age	Boys		Girls		Total	
	n	%	*n*	%	*n*	%
14	1092	64	1189	75	2281	70
16	806	57	958	76	1764	67
18	661	49	937	68	1598	58
Total	2559	57	3084	73	5643	65

and vocational education, secondary school, upper secondary school, university);
- urbanization of the place of residence (city centre, suburban area, rural centre, rural area).

The validity of the different questions has been studied since the beginning of the survey and has been found to be acceptable (Ahlström et al. 1979). The validity of self-reported school performance has been tested separately by collecting the actual school performance grades from the school records (Honkala 1984). The repeatability of the answers concerning toothbrushing frequency (all six categories) was 81% (κ statistics = 0.68) for boys and 88% (0.87) for girls in a previous study (Kuusela et al. 1997b), which indicates good repeatability (Landis & Koch 1977). The behaviour of non-respondents has not been significantly different from that of the respondents (Rimpelä et al. 2005).

Statistical analyses

The data were analysed using SPSS, version 17.0. Toothbrushing and smoking were analysed by cross-tabulation according to demographic and socio-economic factors. The association between smoking and toothbrushing frequency was analysed by the χ^2-test. The level of significance was set at $p < 0.05$. No significant differences in smoking habits were found between sexes; thus, the data were pooled across gender. A logistic regression model was used to estimate the odds ratios (OR) and their confidence intervals (95% CI) for smoking daily and for brushing less than twice a day (a summary variable) according to those demographic and socio-economic factors that were statistically significant in the bivariate analyses. The summary variable was dichotomized by giving a value ''1'' for combined concurrent daily smoking and infrequent toothbrushing and a value ''0'' for all the other combinations. While sex was significantly associated with toothbrushing habits in the bivariate analysis, it was also included into the logistic model to control it as a possible confounding factor.

Results

Less than 10% of the 14-year-olds reported smoking daily (Table 2). At the age of 16 years, every fourth respondent reported smoking daily and at the age of 18 years every third. The proportions were almost equal among boys and girls. Altogether 14.4% of the adolescents reported brushing their teeth less than once a day 45.6% once a day, and 40% more than once a day. Girls brushed significantly more frequently than boys did, and the older girls more often than the younger ones.

Table 2. Proportions (%) of self-reported smoking and toothbrushing habits, according to sex and age

Age	14 years		16 years		18 years	
	boys	girls	boys	girls	boys	girls
Smoking						
Daily	7.3	9.6	23.3	26.6	33.9	32.6
Not daily	92.7	90.4	76.7	73.4	66.1	67.4
Toothbrushing						
Less than once a day	24.5	10.5	19.6	7.0	20.6	4.1
Once a day	47.2	41.1	51.5	43.1	49.5	41.2
More than once a day	28.3	48.3	28.9	49.8	30.0	54.7

Table 3. Proportions (%) of self-reported smoking and toothbrushing frequency, according to sex and age

Age (years)	Daily smoking	Toothbrushing frequency					
		$\leq$ 1/day (%)		$>$ 1/day (%)		Total (*n*)	
		boys	girls	boys	girls	boys	girls
14	Yes	6.6	6.4	0.7	3.2		
	No	65.1	45.3	27.6	45.1	1083	1179
16	Yes	19.1	16.3	4.0	10.2		
	No	52.0	33.9	24.9	39.6	796	979
18	Yes	26.2	17.1	7.6	15.3		
	No	43.8	28.2	22.4	39.4	671	929

Association between smoking and toothbrushing

In all age groups and among both sexes, adolescents who brushed their teeth less than twice a day more frequently reported smoking daily than did those adolescents who brushed according to recommendations (Table 3). The association between these two unhealthy behaviours was particularly obvious among the boys. Among 14-year-olds, 6.5% of the adolescents both smoked daily and did not brush according to the recommendation. The respective figure was 17.7% for the 16-year-olds and 21.6% for the 18-year-olds.

Statistically significant associations were found between unhealthy behaviours (smoking daily and brushing teeth daily or less often) and education level of the mother and the school performance of the child at the age of 14 years, the education of the mother and father, and the school career at the ages 16 and 18 years, and sex among 18-year-olds (Table 4). An especially large difference was found for the 16-/18-year-old students according to their school career. Those who were in a vocational school had higher proportions of both risk behaviours than the students in an upper secondary school (32.3% *versus* 9.5%).

In multivariate analysis, the strongest association of the concurrent daily smoking and infrequent toothbrushing at the age of 14 years was with the child's school performance, where it was below average (OR = 8.2) or average (2.2) (Table 5). Mother's education (primary/secondary school only) had the next strongest association. Among the 16-year-olds, the school career had the strongest association; OR 4.6 for a vocational school and 3.2 for a primary school. There was no significant association between either father's or mother's education and both concurrent health damaging habits among the 16-year-olds. Also, among the 18-year-olds, school career had the strongest association; OR 3.4 for a vocational school. Other strong explaining factors were male gender (1.6) and father's low educational level (1.3). The association

Table 4. Proportions (%, *n*) of the Finnish adolescents who smoked daily and brushed their teeth less than twice a day, according to different background variables

Variable	14 years			16 years			18 years		
	%	*n*	*p*-value	%	*n*	*p*-value	%	*n*	*p*-value
Sex									
Boy	6.6	71		19.1	152		26.2	176	
Girl	6.4	75	0.850	16.3	159	0.131	17.1	159	<0.001
Place of residence									
City centre	5.7	58		18.7	172		19.9	182	
Suburban area	9.0	36		18.5	48		21.9	46	
Rural centre/rural area	5.8	47	0.105	15.1	91	0.330	21.4	104	0.708
Education of father									
Upper secondary school/University	4.4	29		9.4	44		13.7	59	
Primary/secondary school	6.9	45		19.2	103		24.9	113	
Vocational school	7.0	56	0.080	20.4	131	<0.001	20.7	131	<0.001
Education of mother									
Upper secondary school/University	3.7	36		11.5	83		15.0	93	
Primary/secondary school	9.3	52		19.5	92		23.0	97	
Vocational school	7.6	48	<0.001	22.3	120	<0.001	24.9	129	<0.001
School performance (14 years)									
Better than average	2.7	28							
Average	6.2	58							
Below average	20.1	59	<0.001						
School career (16–18 years)									
Upper secondary school				8.4	90		10.7	99	
Vocational school				30.4	166		34.2	117	
Other schools				23.3	31	<0.001	31.4	11	<0.001

between mother's education and these both unhealthy habits was not significant among the eldest age group.

Discussion

In Finland, smoking is a common habit among the adolescent population; one-third of the 18-year-olds reported smoking every day and one quarter of the 16-year-olds. At the ages of 14 and 16 years, daily smoking was slightly more common among girls than among boys, which is a finding in accordance with another Finnish study (Heikkinen et al. 2008) and with an international survey (Currie et al. 2008). The proportion of adolescents who reported brushing according to the recommendation of twice per day was quite low. Adolescents in Finland have for decades been among the most infrequent brushers in Europe (Honkala et al. 1990, Kuusela et al. 1997a, Maes et al. 2006). Daily use of dental floss has also been very low (3%) (Kuusela et al. 1997a). In this study, the toothbrushing habits of boys were less favourable than that of girls, which confirms previous findings (Honkala et al. 1981, 1990, Kuusela et al. 1997a, b).

Adolescents who smoked daily also brushed their teeth less frequently than the adolescents who did not smoke, confirming the finding of Rajala et al. (1980). However, while 30 years ago the association was only weak, these two health damaging habits were strongly associated with each other in the present survey. Poor school performance among the youngest age group and school career among the older adolescents were the strongest factors associated with these concurrent unhealthy habits. The child's own perception of the school performance, and school career seemed to have a stronger association in all age groups than parent's education. An earlier study that followed up a group of Finnish children from the age of 13 to the age of 28, found that parental socio-economic status was not significantly associated with smoking in adolescence or in adulthood. Retrospectively, those who were best educated in adulthood were least likely to have smoked at the age of 13 (Paavola et al. 2004b). Among adults, educational status has been found to be more strongly associated with smoking than parental socio-economic status (father's education) in childhood (Lynch et al. 1994, Karvonen et al. 1999). In many developed countries, adult smoking has been found to be more prevalent among the lower socio-economic groups, and socio-economic differences in smoking seem to be widening (Cavelaars et al. 2000). Finnish adults (20–34 years) with the lowest education are more likely to engage in three or four unhealthy behaviours than older respondents (Laaksonen et al. 2003), and females have more positive health behaviour than males (Savolainen et al. 2009). Among the adult population in Australia, males who live in small cities and have a low level of education and low household income tend to engage in multiple unhealthy behaviours (Sanders et al. 2005). Most common diseases are related to high-risk health-related behaviours, which are correlated with the socio-economic status, being more common in people at the lower end of the social gradient (Mackenbach et al. 1997, Sheiham & Nicolau 2005). Oral health has improved markedly during recent decades; however, inequalities in oral health have widened (Watt & Sheiham 1999). In periodontal diseases, the social gradient has also been found to be established among adolescents (López et al. 2006).

In Finland, most adolescents go to a dentist regularly (Honkala et al. 1997) – currently with an individual re-call scheme – because dental treatment is free of charge up to the age of 19 (Honkala et al. 1997). The individually determined re-call intervals might have

Table 5. Odds ratios (OR) and their 95% confidence intervals (95% CI) for Finnish adolescents who smoked daily and brushed their teeth less than twice a day

Variable	OR	95% CI	*p*-value
Age of 14			
Education of mother			
Upper secondary school/University	1.0		
Primary/ secondary school	2.1	1.32 – 3.27	0.002
Vocational school	1.6	1.02 – 2.56	0.041
School performance			
Much or slightly better	1.0		
Average	2.2	1.34 – 3.51	0.002
Below average	8.2	4.97 – 13.42	<0.001
Age of 16			
Education of mother			
Upper secondary school/University	1.0		
Primary/secondary school	1.1	0.74 – 1.61	0.648
Vocational education	1.2	0.85 – 1.79	0.266
Education of father			
Upper secondary school/University	1.0		
Primary/secondary school	1.3	0.82 – 1.98	0.209
Vocational education	1.3	0.86 – 2.02	0.278
School career			
Upper secondary school	1.0		
Primary school	3.2	1.91 – 5.27	<0.001
Vocational education	4.6	3.31 – 6.34	<0.001
Age of 18			
Sex			
Girl	1.0		
Boy	1.6	1.16 – 2.08	0.003
Education of mother			
Upper secondary school/University	1.0		
Primary/secondary school	1.0	0.70 – 1.54	0.834
Vocational education	1.3	0.87 – 1.85	0.216
Education of father			
Upper secondary school/University	1.0		
Primary/secondary school	1.1	1.03 – 2.41	0.037
Vocational education	1.5	0.71 – 1.66	0.696
School career			
Upper secondary school	1.0		
Vocational education	3.4	2.52 – 4.67	<0.001

had some effect, when those subjects with healthy dentition see the dentist less often compared with those with oral health problems. Both of these groups may smoke equally much and often, but the latter group have an opportunity to receive health education more often. Dentists have an advantage in being able to point to signs of periodontal diseases in the patient's own mouth, so that its potential consequences may have a greater and more immediate impact than a broader warning about the harmful effects of smoking on health (Macgregor 1996). A Swedish study supports the hypothesis that information about the detrimental effects of tobacco given by dental staff can influence the smoking habits of children and adolescents (Skjoldebrand & Gahnberg 1997). Smoking cessation can lead to improved periodontal health (Tonetti 1998). Thus, counselling about smoking cessation should be a part of a dentists' role, in the same way as plaque control and dietary advice (Reibel 2003).

The current study was based on a cross-sectional study design and only allows analysis of associations. A prospective study would have given much stronger evidence of the predictive factors for these concurrent health damaging habits. However, prospective studies with nationally representative samples would be difficult to implement and would be weaker in detecting the trends in the population because of possible Hawthorne effects. One limitation of this study was that the data did not include any information on oral health. Therefore, it was not possible to evaluate the association between health-related habits, in combination or separately, and oral health.

Over the successive Adolescent Health and Life-style Survey, the response rate has decreased considerably. In 1977, it was 91% among girls and 86% among boys, but this fell to 73% and 58% in 2005, respectively. In 2005, only 49% of the sample of 18-year-old boys replied. Accordingly, it is possible that the difference between the true prevalence figures and the prevalence figures gained from surveys has increased (Rimpelä et al. 2005). Non-respondents are more likely to belong to the groups of smokers and infrequent brushers, and therefore the real situation might be even worse than that described in this study. Non-response bias has become increasingly important, because the response rates for all surveys have, in general, fallen sharply over the last two decades (Locker 2000). The mean response rate among postal surveys published in medical journals has been about 60% (Asch et al. 1997). In this study, the percentages of 16- and 18-year-old boys replying were lower than this. The effect of non-response in the survey programme has been tested in 1995, 1997 and 2005 (Rimpelä et al. 2005) showing that the behaviour of the non-respondents did not differ significantly from that of the respondents. A high response rate increases the precision of survey estimates and therefore decreases uncertainty about population parameters (Locker 2000). However, if the response rate is less than ideal, confidence in the survey can be promoted by careful reporting of the response rate and documentation of differences between responders and non-responders (Locker 2000). In addition, adolescents may purposely over-report or under-report some health-risk behaviours, because they might think that engaging in these behaviours is socially desirable or undesirable, respectively (Brener et al. 2003). This also needs to be considered when the results are interpreted.

Conclusions

In adolescence, daily smoking and infrequent toothbrushing are strongly associated in this study. Poor school performance and low socio-economic background are associated with both of these health-damaging habits. Recommendations concerning toothbrushing and smoking cessation and prevention advice should be an integrated agenda for prevention of periodontal diseases and oral health promotion in general.

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Clinical Relevance

Scientific rationale for the study: Smoking has been identified as a major risk factor for poor periodontal health. Another important aetiological factor of periodontal diseases is poor oral hygiene. The smoking and toothbrushing behaviour of adolescents has been studied decades. However, it is not known how strongly these unfavourable habits are associated with each other.

Principal findings: Daily smoking was common habit among 16- and 18-year-olds. At the same time, the low compliance for frequent toothbrushing was found. These risk behaviours seemed to be strongly associated.

Practical implications: Health education on toothbrushing and smoking targeted to adolescents should be combined for fighting more effectively on preventing periodontal disease and promoting general health.