International Journal of Paediatric Dentistry 2005; **15:** 190–196

Eating habits, smoking and toothbrushing in relation to dental caries: a 3-year study in Swedish female teenagers

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Summary. *Objectives.* The aims of the present study were to describe eating, toothbrushing and smoking habits in a cohort of Swedish female adolescents, and to relate the findings to dental caries increment.
Design. The research took the form of a longitudinal study.
Subjects and methods. The study sample consisted of a cohort of 162 girls under regular dental care, aged 12 years at baseline, who were followed for 3 years, from the sixth to the ninth grade. Eating, oral cleaning and smoking habits were self-reported three times per year through a questionnaire, and caries data at baseline and after 3 years were collected from dental records.
Results. The results showed significantly ($P < 0{\cdot}05$) impaired eating habits during the study period and that adherence to regular main meals diminished. In the eighth grade, one-third of the girls skipped breakfast before school and only 50% had their free school lunch daily. The omission of breakfast and irregular main meals, as well as smoking were significantly associated with caries (decayed, missed and filled surfaces) increment in the eighth grade (odds ratio = 4·1–4·9, $P < 0{\cdot}05$). Snacks, light meals, soft drinks and sweets were already frequently consumed at baseline and continued to be so over the years. Although > 95% of subjects reported that they brushed their teeth at least once a day, approximately 20% did not do it every evening, and this figure remained stable over the study period. However, snacks, soft drinks and sweets, and toothbrushing habits had no significant influence on caries development.
Conclusion. Dietary advice for caries prevention in adolescent girls should focus on the importance of retaining regular main meals, and especially, not skipping breakfast.

Introduction

The 'classic' relationship between diet and dental caries has been reviewed in recent years, and the relative importance of sugar consumption in caries aetiology is now seen as a modifying risk factor rather than a primary causative factor [1,2]. This has also been confirmed by recent reports from cross-sectional and longitudinal studies in different countries [3–5]. Furthermore, it has been suggested that the role of diet in caries development is not so much related to the diet itself, but rather, to individual eating behaviour [6]. It has been clearly shown that food habits can change significantly during adolescence, along with other lifestyle changes [7]. Girls in particular may exhibit an irregular eating pattern, as well as smoking and frequent snack consumption, all of which may jeopardize their dental health [8,9], and it has been proposed that caries preventive efforts could benefit from being gender-specific [10]. Therefore, it was considered important to obtain current and longitudinal information on eating habits in adolescent girls in order to be able to target and improve future

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dental health promotion activities. The aim of the present study was to describe eating, toothbrushing and smoking habits in a cohort of Swedish female adolescents, and to relate the findings to dental caries increment.

Subjects and methods

The sample consisted of girls, 12 years of age at baseline, who were listed as recall patients at one of the two public dental clinics in Falkenberg, a small town located on the west coast of Sweden. The selected cohort represented approximately 60% of all females of their age in the 36 000-inhabitant community. All participants signed a consent form together with their parents, and the study protocol was approved by the ethics committee of Lund University, Lund, Sweden. The project was launched in 1999, when the girls were attending the sixth grade of school, and 185 subjects were included at baseline. Twenty-three girls (12%) dropped out because of relocation, and therefore, 162 subjects were followed for 3 years, through the seventh, eighth and ninth grades, as described below.

Eating habits and oral hygiene routines

Data on eating, toothbrushing and smoking habits were collected with the aid of a self-reported 15-item questionnaire that was repeated every fourth month over the 3 years. The questions were primarily focused on the regularity of prepared meals rather than on the sugar content of the diet. The intakes of light meals, snacks, sweets and soft drinks were queried in separate items, and scored according to frequency as 'never or very seldom', 'several times a week, 'daily' and 'several times a day'. The questions regarding oral hygiene dealt with toothbrushing routines, as well as the use of fluoride toothpaste and fluoride supplements. In addition, smoking habits, menarche and the presence of menses were noted. The questionnaire was completed in small groups in a quiet setting at school, and in connection to this, stimulated whole saliva samples were collected for biochemical and microbial analysis. These findings will be presented elsewhere.

Caries experience and increment

All subjects were thoroughly examined by their regular dentist at baseline and after 3 years, and assessed with validated criteria according to the Public Dental Service guidelines based on the World Health Organization recommendations [11]. Prior to the baseline and final examinations, calibration exercises were performed with the six dentists involved. The examinations included between two and four bitewing radiographs covering the distal surface of the canine to the mesial surface of the second permanent molar. Proximal lesions within the enamel were scored from the radiographs according to Gröndahl *et al*. [12]. Caries experience was expressed as decayed, missed and filled teeth (DMFT) or surfaces (DMFS), as well as decayed and filled proximal surfaces (DFSa), and proximal enamel lesions (ECa). Caries increment was calculated as the difference in caries prevalence between the examinations. The regular dentist carried out any required preventive and restorative dental treatment during the study period, based on the need of the individual.

Statistical methods

Eating, toothbrushing and smoking habits were evaluated by descriptive statistics and two-tailed chi-square (χ^2) tests with Yates' correction for continuity. For further statistical calculations, the data were dichotomized according to predetermined values. A favourable habit was scored as '0', while an unfavourable habit (e.g. not having breakfast before school) was scored '1', as indicated in Table 1. Regarding the odds ratio calculations, the DMFS increment was scored as 'yes' (ΔDMFS = 1) or 'no' (ΔDMFS = 0). Differences in caries increment between groups with favourable and unfavourable habits were analysed with the aid of two-tailed *t*-tests. A P-value $< 0{\cdot}05$ was considered statistically significant.

Table 1. Dichotomised values for eating, toothbrushing and smoking habits.

Variable	Cut-off point for an unfavourable habit
Eating habits	Omitting breakfast before school ≥ 1 day week^{-1}
	Omitting school lunch ≥ 1 day week^{-1}
	Omitting dinner at home ≥ 2 days week^{-1}
	Snacks and sweets several times per day
	Soft drinks or juice several times per day
	Irregular main meals: omitting breakfast, lunch or dinner ≥ 2 days week^{-1}
Toothbrushing habits	Nondaily toothbrushing, morning or evening
Smoking habit	Cigarette smoking > 2 days week^{-1}

Caries index*	Baseline		After 3 years		Increment
	Mean ± SD	Range	Mean ± SD	Range	(mean ± SD)
DMFT	1·47 ± 2·27	0–10	2·56 ± 2·95	0–15	1·09 ± 1·61
DMFS	1·68 ± 2·85	0–16	3·79 ± 5·13	0–24	2·10 ± 3·02
DFSa	0·30 ± 1·00	0–9	0·94 ± 2·01	0–13	0·64 ± 1·49
ECa	2·33 ± 3·50	0–15	3·90 ± 4·29	0–22	1·57 ± 2·89

*Abbreviations: (DMFT) decayed, missed and filled teeth; (DMFS) decayed, missed and filled surfaces; (DFSa) decayed and filled approximal surfaces; and (ECa) enamel caries on approximal surfaces.

Table 2. Mean caries experience (± SD) at baseline (aged 12 years) and after 3 years (aged 15 years) in a cohort of 162 Swedish females.

Table 3. Percentage distribution of selected eating habits among 162 females at baseline and during the following junior high school years.

Time point	Late evening meal (never)	Snacks during recesses (never)	After-school light meal (never)	Daily sweets/candies	Daily soft drinks/juice
Baseline	26%	19%	17%	17%	26%
Seventh grade	14%	14%	17%	14%	20%
Eighth grade	6%	6%	15%	14%	20%
Ninth grade	9%	5%	11%	12%	21%

Results

Dental caries

The caries scores at baseline and after 3 years, as well as the 3-year increment, are presented in Table 2. At baseline, 44% of the girls were caries-free, displaying no lesions or fillings in either their enamel or dentine. After 3 years, at the age of 15 years, the corresponding value had decreased to 27%. Proximal enamel lesions were more commonly diagnosed than cavitated or filled lesions at both baseline and the follow-up. The majority of subjects experienced new DMFS (62%) and/or proximal enamel lesions (57%) during the study period, while 19% were totally caries-inactive.

Eating habits

The main meal eating habits are summarized in Fig. 1. At baseline in sixth grade, 81% of the participants always had breakfast at home before school, but this value decreased significantly ($P < 0{\cdot}05$, χ^2 test) to 62% in the eighth and ninth grades. Similarly, an increasing proportion up to 50% of the girls skipped the free school lunch or ate it only occasionally. Most of the girls had a regular dinner or evening meal at baseline, but this habit also tended to decrease by age. Snacking habits and the consumption of sweets and soft drinks are shown in Table 3. Approximately 20% of subjects

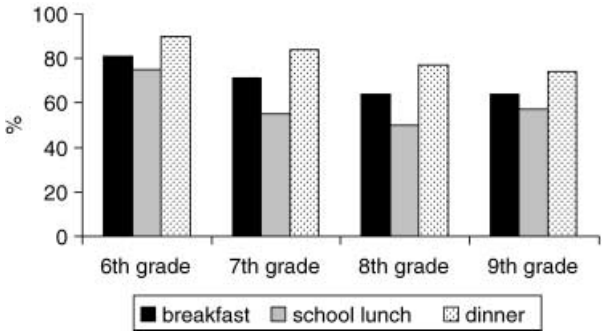

Fig. 1. Percentage distribution of female adolescents who took regular main meals (i.e. always breakfast at home before school, always school lunch, and always dinner or an evening meal at home) during grades 6–9.

recorded daily or several daily intakes of sweets and/or soft drinks and juices, and this figure was fairly stable over the 3-year period. The frequency of snacking at school recesses and late-night light meals increased slightly during the study period since the number of girls who totally rejected these habits dropped from 20–25% at baseline to 5–10% in the ninth grade.

The relationship between eating habits in the eighth grade and 3-year caries (DMFS) increment (grades 6–9) is shown in Table 4. Omitting breakfast and dinner, as well as irregular main meals, were significantly associated with caries increment, while frequent daily snacking and intake of sweets and sugar-containing beverages failed to reach significance. The mean 3-year caries increment (DMFS)

Table 4. Odds ratio for caries increment (ΔDMFS ≥ 1) during the study period with unfavourable eating, toothbrushing and smoking habits in 14-year-old girls attending the eighth grade ($n = 162$): (NS) not significant.

Variable	Number (%)	Odds ratio	Ninety-five per cent confidence interval	*P*-value
Omitting breakfast	23 (14)	4·9	1·4–17·3	< 0·05
Omitting school lunch	14 (9)	1·6	0·5–5·4	NS
Omitting dinner	41 (25)	2·8	1·3–6·4	< 0·05
Irregular main meals	61 (38)	3·1	1·5–6·3	< 0·05
Snacks and sweets (several times a day)	8 (5)	5·5	0·7–46·1	NS
Soft drinks/juice (several times a day)	26 (16)	1·2	0·5–2·9	NS
Omitting toothbrushing				
Morning	28 (17)	1·1	0·5–2·7	NS
Evening	36 (22)	1·3	0·6–3·0	NS
Smoking	14 (9)	4·1	1·0–18·9	0·05

in girls with irregular main meals in the eighth grade was $5{\cdot}0 \pm 5{\cdot}0$ compared with $1{\cdot}6 \pm 2{\cdot}2$ in those with regular meals ($P < 0{\cdot}001$, two-tailed *t*-test).

Toothbrushing habits

The majority of subjects reported (> 95%) daily toothbrushing throughout the study period, and all but one used fluoride toothpaste. At baseline, more girls brushed in the morning (88%) compared with the evening (78%), and this 10% difference remained consistent at all follow-ups. Fluoride supplements (e.g. fluoride tablets, rinses or gums) were recommended or prescribed to approximately one-third of the subjects and 12–18% followed the programme on a daily basis. Irregular toothbrushing habits in the morning and evening were not correlated to caries increment during the 3-year follow-up (Table 4).

Smoking habits

At baseline, only one girl smoked occasionally. This figure increased to 3% in the seventh grade, and to 8% and 12% in the eighth and ninth grades, respectively, and half of these subjects smoked daily. Smokers in eighth grade exhibited significantly higher mean DMFS increment than the nonsmokers ($7{\cdot}7 \pm 4{\cdot}7$ versus $1{\cdot}9 \pm 2{\cdot}7$; $P < 0{\cdot}001$, two-tailed *t*-test). The odds ratio for caries development is given in Table 4.

Discussion

The present study was performed as a part of a larger project intended to gain longitudinal information on saliva function and composition with special reference to sex hormones in adolescent girls. Before any generalizations, it should be considered that the selected cohort had free access to regular dental care during the study period, and that the vast majority used fluoridated toothpaste and one-third had further fluoride supplementation. The caries data were collected from the dental records of experienced and calibrated dentists according to well-established criteria. The self-reported questionnaire was validated in a group of teenage girls before the start of the study and remained the same over the 3-year study period. It contained a limited number of straightforward questions with clear-cut categorized answers to facilitate its completion, as suggested by Gatenby [13]. Nevertheless, a certain under-reporting on factors such as snacking frequency, night meals and smoking could be expected [14]. For example, approximately 20% reported that they had a daily consumption of sweets that certainly was lower than expected from other studies [8,15].

The findings clearly show significantly impaired eating habits during the study period, with increasing frequency of irregular meals and snacking from the sixth to the eighth grades. Approximately one-third of the participants did not eat breakfast every day and only about 50% attended the free school lunch daily. Interestingly, a tendency of 'recovery' and better eating was noted in the ninth grade. The present figures are well in agreement with previous reports from other cohorts of teenagers in Sweden [8,9]. The intake of light meals, snacks and candy was already common and frequent at baseline. Because of the type of questions used in the questionnaire, it was not clear whether or not the frequency increased by age *per se*, but the proportion of girls who totally rejected light meal and snacks diminished. It has previously been shown that

snacking and light meals are very common among Nordic adolescents, contributing 25–35% of the daily energy intake [9].

The main finding from the present study was the clear and statistically significant association between skipping breakfast and regular meals and caries development, and a four to five times increased risk for caries was revealed. Similar results have recently been demonstrated in preschool children, although this relationship was hot homogenous across the poverty strata [16]. It could be argued that skipping meals could imply fewer cariogenic meals, such as breakfast cereals, but an irregular meal pattern will probably be substituted by light meals and snacks with a high sugar content during the day [17,18], which may explain the enhanced caries activity. The present authors did not ask the girls about any activities to lose weight, but it is likely that dieting is one factor behind the irregular meal pattern, along with other lifestyle changes. However, the food habits, as well as smoking and caries prevalence, are generally thought to be linked to the socio-economic conditions and lifestyle factors [8,19–21], and therefore, these results must be interpreted with some caution. Although no attempt was made to group the participants in the present cohort, they represented a rather homogenous, small-town, middle-class group, with parents working in community service and agricultural occupations. The proportion of first-generation immigrants or refugees was around 15%. Even considering the covariables above, the present results support the assumption that caries development in today's low-caries communities is more dependant on the eating behaviour of the individual than on the sugar content of the diet [6].

These findings emphasize the importance of maintaining breakfast and regular main meals, and this should be stressed in the caries-preventive efforts targeted at adolescent girls. A good and balanced diet is probably a key factor in keeping snacking frequency at a moderate level [2]. In addition, tobacco prevention is justified since the present results demonstrate that smoking in junior high school is a lifestyle marker that should be considered as a risk indicator for caries development. Specific aspects of maintaining female oral health have been covered by McCann & Bonci [10].

It is possible that the preventive focus should vary by gender since it has been reported that adolescent boys more frequently retain their main meals, but are less regular with toothbrushing [8,22]. The focus on prepared main meals is definitely in line with general health promotion to secure the nutritional status of the growing adolescent, and to avoid obesity and chronic diseases such as diabetes mellitus. It has been shown that it is not uncommon for adolescents to have a poor knowledge of the cariogenic potential of foods and drinks, and to be unsure of the importance of a regular eating pattern [23]. Therefore, health professionals and health educators could gain from combining their efforts to promote the message of healthy eating. With updated education and training, the dental team, with its regular and periodic recall of teenagers, has a unique opportunity to act on healthy eating, as well as promoting anti-drug and tobacco messages.

In conclusion, the present study demonstrated impaired eating habits with regard to regular main meals in adolescent girls between 12 and 15 years of age. The omission of breakfast and dinner, and irregular main meals were significantly associated with caries development, while the intake of light meals, snacking, candies and sweet beverages, and toothbrushing habits showed no relationship with caries development. These findings suggest that caries preventive efforts in young teenage girls should include information on the importance of retaining breakfast and regular meals.

Acknowledgements

This study was supported by a grant from a health research fund provided by the County Council of Halland, Sweden.

Résumé. *Objectifs.* Décrire les habitudes d'alimentation, de brossage des enfants et de tabagie au sein d'une cohorte d'adolescentes suédoises et relier les données obtenues à l'augmentation des caries dentaires.
Protocole. Etude longitudinale.
Echantillon et méthodes. Le matériel a consisté en une cohorte de 162 filles suivies régulièrement pour soins dentaires, âgées de 12 ans au départ, suivies pendant 3 ans, du 6ème au 9ème grade. Les habitudes d'alimentation, d'hygiène buccale et de tabagie ont été auto-rapportées trois fois par an à travers un questionnaire. La présence de carie, au départ et après 3 ans, a été obtenue à partir des dossiers dentaires.
Résultats. Les résultats ont montré un détérioration significative ($p < 0{,}05$) des habitudes durant la

période d'étude et la diminution des repas principaux réguliers. Au 8ème grade, un tiers des filles faisaient sauter le petit déjeuner avant l'école et seulement 50% avaient leur repas quotidien à la cantine gratuit. Petit-déjeuner non pris et repas principaux irréguliers, de même que fumer au cours du 8ème grade était significativement associé à l'augmentation des caries (CAOs), (odds ratio 4,1–4,9, $p < 0,05$). Les snacks, repas légers, boissons sucrées et sucreries étaient fréquemment consommés dès le début de l'étude et ont continué à l'être après. Bien que plus de 95% aient rapporté qu'elles se brossaient les dents au moins une fois par jour, environ 20% ne le faisaient pas chaque soir, cet état de fait restant stable tout au long de la période d'étude. Les snacks, boissons sucrées et friandises et les habitudes de brossage des dents n'avaient cependant pas d'influence significative sur le développement des caries.
Conclusion. Les conseils diététiques de prévention de la carie chez les adolescents peuvent être focalisés sur l'importance d'avoir des repas principaux réguliers et particulièrement de ne pas faire sauter le petit déjeuner.

Zusammenfassung. *Ziele*. Beschreibung der Ernährungs-, Mundhygiene- und Rauchgewohnheiten in einer Gruppe schwedischer weiblicher Jugendlicher mit dem Ziel, die Variablen mit dem Karieszuwachs zu korrelieren.
Design. Longitudinalstudie.
Stichprobe und Methode. Es wurden 162 Mädchen im Alter von 12 Jahren (zum Zeitpunkt der Eingangsuntersuchung), die in regelmäßiger zahnärztlicher Kontrolle waren, für drei Jahre (von der 6. Bis zur 9. Klasse) verfolgt. Ernährung, Zahnreinigung und Rauchgewohnheiten wurden drei mal jährlich mit einem selbstausgefüllten Fragebogen erhoben. Daten zur Karies wurden durch eine Eingangsuntersuchung und durch Heranziehung von Befunddokumentationen ausgewertet.
Ergebnisse. Die Ergebnisse zeigen eine statistisch signifikante Verschlechterung von Ernährungsgewohnheiten und Teilnahme an Hauptmahlzeiten während der Studiendauer. In der 8. Klasse vernachlässigte ein Drittel der Mädchen das Frühstück, nur 50% nahmen am Mittagessen teil. Das Weglassen des Frühstücks, unregelmäßige Hauptmahlzeiten und rauchen in der 8. Klasse waren statistisch signifikant mit einem erhöhten Karieszuwachs (DMFS) assoziiert (OR 4.1–4.9) $p < 0.05$). Snacks, Zwischenmahlzeiten, Softdrinks und Süßigkeiten wurden bereits zu Studienbeginn häufig konsumiert mit weiterer Steigerung über die Jahre. Obwohl > 95% angaben, regelmäßig mindestens 1 mal täglich die Zähne zu putzen, putzten 20% nicht jeden Abend, diese Zahl blieb stabil über den Untersuchungszeitraum. Snacks, Softdrinks, Süßigkeiten und Putzgewohnheiten zeigten keine signifikante Korrelation zum Karieszuwachs.
Schlussfolgerung. Ernährungsempfehlungen bei jugendlichen Mädchen sollten möglicherweise einen Schwerpunkt setzen auf die Bedeutung regelmäßiger Hauptmahlzeiten und vor allem nicht das Frühstück wegzulassen.

Resumen. *Objetivos*. Describir los hábitos alimentarios, cepillado dentario y tabaquismo en una cohorte de mujeres suecas adolescentes y relacionarlos los hallazgos al incremento de caries.
Diseño. Estudio longitudinal.
Muestra y métodos. El material consistió en una cohorte de 162 niñas con una higiene dental regular, a la edad basal de 12 años, que fue seguida durante 3 años, desde el 6° al 9° grado. La alimentación, la higiene oral y el hábito de fumar fueron autorreferidos tres veces al año a través de un cuestionario y los datos de caries, tanto basales como a los tres años, se recogieron a partir de registros dentales.
Resultados. Los resultados mostraron de forma significativa ($p < 0,05$) hábitos alimentarios alterados durante el período de estudio y disminución de la observancia de la regularidad de las principales comidas. En el 8° gardo, un tercio de las niñas se saltaban el desayuno antes de la escuela y sólo el 50% tomaba su comida libre escolar diariamente. La omisión del desayuno y la irregularidad de las principales comidas así como el hábito de fumar en el 8° grado se asoció significativamente con incremento de caries (CAOS), (odds ratio 4,1–4,9, $p < 0,05$). Las pequeñas comidas entre horas, refrescos y dulces eran consumidos frecuentemente ya en la edad basal y continuaron así con los años. Aunque > 95% indicaron que se cepillaban sus dientes al menos una vez al día, aproximadamente el 20% no lo hacía cada noche y esta situación permaneció estable durante el período de estudio. Las comidas entre horas, los refrescos, los dulces y los hábitos de cepillado dentario no tuvieron, sin embargo, una influencia significativa en el desarrollo de caries.
Conclusión. Los consejos dietéticos para la prevención de caries en niñas adolescentes pueden

enfocarse hacia la importancia de mantener las principales comidas regularmente y en especial en no saltarse el desayuno.

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