

# Characteristics of teenagers who use dental floss

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**Objective:** To describe the use of dental floss by teenagers and study associations between flossing and approximal caries experience, oral health behaviours, gender, parental education and national background. **Methods:** The study included 2156 14-year-old teenagers. Data were collected in conjunction with routine dental examinations. Teenagers answered a questionnaire about frequency of and reasons for flossing, oral health behaviours and family characteristics. Information about approximal enamel ( $D_{1,2}Sa$ ) and dentine caries experience ( $D_3MFSa$ ) was collected from dental records. Data were cross-tabulated and tested with Chi-Square statistics and ANOVA, and analysed using multivariable logistic regression. The data was baseline data in a longitudinal study exploring effects of dental floss. The study was performed as part of the quality assurance system required by law in the dental services and did not require ethical approval. **Results:** Half of the teenagers (54%) used dental floss. Among teenagers who flossed, 15% reported doing so daily. Recommendation from dental personnel was the most important reason for using dental floss. Proportionately more girls and teenagers whose parents had high educational achievement reported flossing. Teenagers who flossed more often had more favourable oral health behaviours than other teenagers but more often had approximal enamel caries ( $D_{1,2}Sa$ ) and approximal dentine caries experience ( $D_3MFSa$ ) than other teenagers ( $p < 0.05$ ). **Conclusion:** Use of dental floss was not a daily behaviour in most teenagers. Flossing was associated with having approximal caries lesions, indicating that teenagers having signs of approximal caries had been recommended to use dental floss.

**Keywords:** adolescent, caries, oral health behaviour, dental floss, topical fluoride.

## Introduction

Caries prevalence in teenagers has decreased in many countries during recent decades, but some children still develop caries in the period from childhood to adulthood (Statistics Norway, 2014; Norderyd *et al.*, 2015). If enamel caries lesions are included in caries registration, only a minor proportion of teenagers has no caries experience (Alm *et al.*, 2007; Jacobsen *et al.*, 2019). A high proportion of caries development from 11 to 27 years of age is located on approximal surfaces and less is occlusal caries (Mejare *et al.*, 2004). In Sweden, only 33% of 15-year-old children had no approximal caries lesions (Alm *et al.*, 2007). Most lesions were initial lesions, and teenagers were reported to have on average 2.8 surfaces with initial caries and 0.5 surfaces with manifest caries (Alm *et al.*, 2007). One study from northern Norway reported that 84% of 16-year-olds had approximal enamel lesions with a mean of 5.8 surfaces per child. When approximal enamel lesions were included in caries registration, only 6% of the teenagers were caries free (Jacobsen *et al.*, 2019).

Dental floss has been widely accepted as a tool to clean approximal surfaces to prevent caries and periodontal disease in addition to tooth brushing with fluoridated toothpaste (Fischman, 1997; Marinho *et al.*, 2003). Dental personnel in Scandinavian countries recommend interproximal cleaning to avoid caries, with dental floss as the preferred product recommended for children (Sarner *et al.*, 2010). Most Scandinavian teenagers report brushing their teeth twice daily (Åstrøm, 2004; Norderyd *et al.*, 2015), but few studies report use of dental floss in teenagers (Hujoel *et al.*, 2006; Worthington *et al.*, 2019). One study reported flossing frequency among 11-year-old

children in Europe and Canada; 2 to 17% of European children and 25% of Canadian children reported daily flossing (Kuusela *et al.*, 1997). In a Swedish study, only 8% of the teenagers reported using dental floss daily; 30% once a week (Sarner *et al.*, 2010), while 38% of Norwegian girls reported to floss several times a week (Åstrøm, 2004). Among children and adolescents, low compliance and difficulties in flossing have been related to lack of motivation (Mattos-Silveira *et al.*, 2017).

Dental floss disrupts and removes plaque at approximal sites (Waerhaug, 1981). It is reasonable to assume that floss can prevent approximal caries, but the evidence for its ability to do so in the primary and permanent dentition is weak (de Oliveira *et al.*, 2017; Worthington *et al.*, 2019). A systematic review concluded that there was no evidence that flossing is effective in caries prevention in the presence of topical fluorides (Hujoel *et al.*, 2006).

All children in Norway are entitled to dental care free of charge in the public dental services. The children are recalled regularly, based on individual need. All children are recommended to brush twice daily with fluoridated toothpaste from the eruption of the first tooth. Use of dental floss and fluoride supplements are recommended after individual caries risk assessment by dentists and dental hygienists in the dental services.

The objective of this study was to describe the use of dental floss in teenagers and to study associations between flossing and approximal caries experience, oral health behaviours, gender, parental education and national background. The null hypothesis was that use of dental floss was not associated with approximal caries experience, oral health behaviours and background characteristics.

## Methods

All 14-year-olds born in 2000 (2950 teenagers) whose dental care was delivered by the dental services in one Norwegian county (Vestfold) were invited to participate in the study as part of the regular dental examination at 14 years of age. As a result of individualised recall intervals in the dental services, data were collected in 2014 and 2015. The county had 240 860 inhabitants, 5% of the total Norwegian population (Statistics Norway, 2014). In total, 2156 teenagers had complete data from the dental examinations and were included in the study. More than half of the teenagers had enamel (60%) and dentine caries experience (57%),  $D_3MFT$  was 1.8 (SD 2.4). Approximal enamel and dentine caries was registered in 44% and 21% of the teenagers respectively. Caries prevalence in children in Vestfold was equal to the national average (Statistics Norway, 2014).

Data were collected at clinical examinations and extracted from dental records, and included anamnestic information, oral health behaviour and caries experience. The data analysed in this paper were cross-sectional, baseline data in a longitudinal study of the effects of regular instruction and motivation to use dental floss.

### *Dental examinations*

Examinations were conducted in fully equipped dental clinics using mirror and probe after the teeth had been air dried. Caries was registered with the tooth surfaces as the unit of measurement. Bite-wing radiographs were taken when approximal surfaces could not be inspected visually. Both enamel caries ( $D_1$  and  $D_2$ ), and caries lesions extending to dentine ( $D_3$ ,  $D_4$  and  $D_5$ ) were included (Amarante *et al.*, 1998). Numbers of surfaces (S) with approximal enamel and dentine caries experience were extracted from dental records and reported as  $D_{1-2}Sa$  and  $D_3FSa$  respectively.

The examinations were performed by 39 dentists and 23 dental hygienists. Written and oral information about the caries criteria was given to the examiners before data collection. Intra- and inter-examiner agreements were based on eight radiographs of permanent molars, including 12 approximal surfaces were performed twice three months between the registrations. Intra- and inter-examiner agreements were calculated using Cohen's kappa (Landis and Koch, 1977). A gold standard was developed using the authors' diagnoses. The mean intra- and inter-examiner Cohen's kappa values of 0.73 (SD 0.13) and 0.72 (SD 0.12) were categorized as substantial to almost perfect (Landis and Koch, 1977). Calibration of clinical caries examination was not performed for practical reasons.

### *Questionnaire*

Anamnestic information included national background and parental education. Oral health behaviour included use dental floss and reasons for flossing, tooth brushing frequency, use of fluoride supplements and sugar consumption.

National background was recorded as parents' country of birth, and in the analyses categorised as both parents with Western background and one or both parents with non-Western background. Non-western background

included parents born in Asia, Africa, south- and Central America and Eastern Europe. Parental education was measured as highest completed education, and categorized as high (13 years or more at school) and low (12 years or less at school).

Frequency of flossing was reported as daily, several times a week, once a week or seldom. Reasons for flossing were reported as dental personnel's recommendation, to avoid cavities, to get clean teeth, and to avoid gingivitis. Participants were asked about how they considered flossing 2-3 times a week for the next year, with response categories very easy, easy, difficult and very difficult.

Tooth brushing frequency was dichotomized as twice daily and once daily or less. Use of fluoride lozenges or fluoride rinse were combined to one variable, 'fluoride supplements' and categorized as daily, sometimes or never. Sugar consumption was recorded as the frequency of consumption of sugary drinks and food (including sweets), and reported as less often than once a week, once a week, several times a week and daily, and in the analyses dichotomized as once a week or less often and several times a week.

### *Statistical analyses*

Data analyses were conducted in SPSS for Windows (Armonk, NY, USA). Results are presented as frequencies, means and standard deviations (SD). Data were cross-tabulated and tested using Chi-Square statistics, and differences between means were tested with ANOVA. Spearman's Rank correlation was used to explore collinearity between the independent variables before multivariable analysis was conducted. Multivariable logistic regression analysis was conducted to explore the association between use of dental floss and caries experience, oral health behaviour and background characteristics. The level of statistical significance was set at 5%.

### *Ethical approval*

The study was performed as part of the quality assurance system required by law in the public dental services in Norway. Quality assurance and evaluation that are part of the health service do not require approval from ethical committees. Analyses were conducted on anonymised data.

## Results

Of the included teenagers, 51% were boys, 13% had parents with non-Western background and 60% had parents with low educational attainment (Table 1). Proportionately more girls and teenagers whose parents had higher education reported flossing ( $p < 0.05$ ).

Half the teenagers (54%) reported flossing (Table 2). Those who did so most often used dental floss once a week (34%). Fewer (15%) reported flossing daily. More teenagers who flossed felt that it would be very easy to floss 2-3 times a week in the next year than teenagers who did not floss ( $p < 0.05$ ). Teenagers who flossed reported dental personnel recommendations (55%) and avoiding cavities (46%) as the most important reasons for flossing. Other reasons for flossing included to get their teeth clean (44%) and to avoid gingivitis (32%).

**Table 1.** Characteristics of all teenagers and those who reported flossing.

	<i>All</i>	<i>Flossing</i>	p
	( <i>n=2156</i> )	( <i>n=1167</i> )	
	%	%	
Gender			
Girl	49	55	<0.05
Boy	51	45	
Parental background			
Both Western	87	85	ns
One or both non-Western	13	15	
Parental education*			
Both high	40	43	<0.05
One or both low	60	57	

\*Reduced because of internal drop out

**Table 2.** Use of dental floss in all teenagers and those who reported flossing.

	<i>All</i>	<i>Flossing</i>	p
	( <i>n=2156</i> )	( <i>n=1167</i> )	
	%	%	
Use of dental floss			
Yes	54	100	
No	46	0	
Flossing frequency			
Daily	8	15	<0.05
Several times a week	12	23	
Once a week	19	34	
Seldom	61	28	
How easy to floss 2-3 times a week the next year?			
Very easy	54	61	<0.05
Easy	26	25	
Difficult	17	13	
Very difficult	3	1	

Table 3 shows oral health behaviour in all teenagers and in teenagers who reported flossing. Proportionately more teenagers who flossed brushed twice daily, used fluoride supplements daily and consumed sugar-containing food and drinks once a week or less often than teenagers who reported not flossing ( $p < 0.05$ ).

For all teenagers, the mean number of surfaces with approximal enamel and dentine caries were 1.7 (SD 3.0) and 0.5 (SD 1.4) respectively. Teenagers who flossed had more surfaces with approximal enamel and dentine caries (1.8, SD 2.3 and 0.6, SD 1.5) than those who did not floss ( $p < 0.05$ ). Flossing frequency was not associated with approximal caries experience (results not shown).

Table 4 shows results from the multivariable analysis of the association between flossing and approximal caries experience, oral health behaviour and background characteristics. Teenagers who flossed were more likely to have approximal enamel caries (OR 1.0, CI 1.0-1.1), brush twice daily (OR 1.5, CI 1.5-1.9), use fluoride supplements daily (OR 3.7, CI 2.6-4.6), consume sugary drinks seldom (OR 1.3, CI 1.1-1.6), be a girl (OR 1.5, CI 1.2-1.8) and have parents with higher educational attainment (OR 1.3, 1.1-1.6) than other teenagers.

**Table 3.** Oral health behaviour in all teenagers and those who reported flossing

	<i>All</i>	<i>Flossing</i>	p
	( <i>n=2156</i> )	( <i>n=1167</i> )	
	%	%	
Tooth brushing frequency			
Twice daily	78	83	<0.05
Once daily or less often	22	17	
Fluoride supplements			
Daily	21	26	<0.05
Sometimes	54	58	
No	25	16	
Sugar snacking			
Once a week or less often	72	74	<0.05
Several times a week	28	26	
Sugary drinks			
Once a week or less often	56	60	<0.05
Several times a week	44	40	

**Table 4.** Logistic regression analysis of the association between use of dental floss and approximal caries experience, oral health behaviour and background characteristics (n=1946).

	OR	95% CI
Approximal enamel caries (D <sub>1,2</sub> Sa)	<b>1.1</b>	<b>(1.0-1.1)</b>
Approximal dentine caries (D <sub>3</sub> FSA)	1.0	(0.9-1.1)
Tooth brushing frequency		
Twice daily	<b>1.5</b>	<b>(1.5-1.9)</b>
Once daily or less often (ref)	1	
Fluoride supplements		
Daily	<b>3.5</b>	<b>(2.6-4.6)</b>
Sometimes	<b>2.6</b>	<b>(2.1-3.3)</b>
No (ref)	1	
Sugar snacking		
Once a week or less often	1.1	(0.9-1.4)
Several times a week (ref)	1	
Sugary drinks		
Once a week or less often	<b>1.3</b>	<b>(1.1-1.6)</b>
Several times a week (ref)	1	
Gender		
Girl	<b>1.5</b>	<b>(1.2-1.8)</b>
Boy (ref)	1	
Parental background		
Both Western	0.8	(0.6-1.1)
One or both non-Western (ref)	1	
Parental education		
Both high	<b>1.3</b>	<b>(1.1-1.6)</b>
One or both low (ref)	1	

Variables where the 95% CI does not include 1 are marked in bold



## Discussion

This study aimed to describe dental flossing in teenagers and study associations between the use of dental floss and approximal caries experience. Half of the teenagers reported flossing, only a minority did so daily. Use of floss was associated with having approximal caries.

About one third of the teenagers (38%) reported flossing more than once a week. Few studies have reported on the use of dental floss in teenagers and the frequency of use varies (Åstrøm, 2004; Hujuel *et al.*, 2006; Kuusela *et al.*, 1997; Norderyd *et al.*, 2015). The study of European teenagers was in line with results from the present study where 15% reported daily use of dental floss (Kuusela *et al.*, 1997). The results are also in line with data from an older Norwegian study of 15-year-olds in which 38% of the girls and 22% of the boys reported flossing several times a week (Åstrøm, 2004).

Use of dental floss was associated with approximal caries. Teenagers with enamel or dentine caries experience in approximal surfaces more often used floss than other teenagers. This result is counter-intuitive if the use of dental floss prevents approximal caries. One explanation may be that teenagers with approximal caries have been strongly recommended to floss by dental professionals to prevent further caries development, and have adopted flossing as part of oral health care. This is in accordance with dental personnel recommendations reported as the main reason for using dental floss. Individual oral health promotion is given based on the dental professionals' judgement of each teenager's need in the dental services recall examinations. The health authorities' recommendations at the time of data collection were to brush twice daily with fluoridated toothpaste and to use dental floss or toothpicks as recommended on individual basis (The Norwegian Directorate of Health, 1999). The Norwegian Dental Association recommends the use of dental floss as a daily routine in addition to tooth brushing with fluoridated toothpaste to maintain good oral health.

Use of dental floss was associated with background characteristics and frequency of other oral health care routines. Girls and teenagers whose parents had higher education more often reported flossing than other teenagers. These results are in line with previous research where girls and those with higher education more often demonstrate favourable health behaviours than others (Sanders *et al.*, 2005). Individuals who establish and maintain one favourable health habit often manage to establish others (Sarner *et al.*, 2010).

More teenagers who flossed reported that it would be very easy to floss 2-3 times a week during the next year than teenagers who did not floss. Proper use of dental floss requires technical skills and motivation. Low adherence to flossing has been associated with pain, discomfort and difficulties using the floss (Mattos-Silveira *et al.*; 2017; Smith *et al.*, 2019). Instruction and motivation by dental professionals seems to be important to increase teenagers' use of floss in addition to tooth brushing, to maintain lifelong good oral health.

One quarter (27%) of the eligible teenagers did not participate, which may have caused selection bias. In some cases non-participation arose from lack of an invitation and some teenagers refused to participate. In the

studied children, caries prevalence was equal to national average, and the results are considered representative for the country in general.

This study was based partly on questionnaires, and limitations such as non-response, misconceptions and social desirability bias are present in all questionnaire studies (Sjostrom *et al.*, 1999). Dental personnel did not monitor participants when completing the questionnaire. The questions used were considered uncomplicated, related to daily oral health behaviour and family characteristics, and thus reporting errors are considered to be limited. Caries data were recorded during dental examinations by experienced dental professionals, and intra- and inter-examiner agreement showed substantial to almost perfect agreement.

Maintaining lifelong good oral health is considered a main health goal. Early establishment of favourable oral health behaviour is necessary to be able to fulfil this goal. Initiation of tooth brushing with fluoridated toothpaste from eruption of the first tooth is adopted as a daily routine by most children and adolescents, but these results demonstrate that most teenagers have not included dental floss as a daily oral health behaviour. Dental professionals recommend tooth brushing for everybody, but recommendation on use of floss varies. Use of dental floss or interdental brushes in addition to tooth brushing may reduce gingivitis or plaque more than tooth brushing alone (Worthington *et al.*, 2019). Establishment of dental floss as part of daily oral health routine is often recommended to prevent gingivitis and later periodontal disease. The evidence for dental floss to prevent caries development is scarce, and this may be one reason for the variation in recommendations. More research is needed to increase knowledge on the use of dental floss, to explore barriers for its use and to study the association between use of dental floss and caries development.

## Conclusion

Half of the teenagers reported the use of dental floss, and most flossed once a week. Teenagers who flossed more often were most likely to be girls, to have approximal caries, to report several favourable oral health behaviours and to have parents with higher educational attainment.

## Conflict of interest

The authors have no conflicts of interest with respect to the authorship and the publication of this article.

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