

Characteristics of teenagers who use dental floss

Abstract

Objective: The objective was to explore use of dental floss in 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 (D₁₋₂Sa) and dentine caries experience (D₃MFSa) 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 were flossing, 15% reported flossing daily. Dental personnel's recommendation was the most important reason for use of dental floss. A higher proportion of girls and teenagers having parents with high education reported flossing. Teenagers who reported flossing more often had favourable oral health behaviours than other children. Teenagers who used dental floss more often had approximal enamel caries (D₁₋₂Sa) and approximal dentine caries experience (D₃MFSa) than other teenagers (p<0.05). **Conclusion:** Use of dental floss was not a daily behaviour in majority of teenagers. Flossing was associated with having approximal caries lesions, indicating that teenagers having signs of approximal caries had been recommended to use dental floss.

Introduction

Caries prevalence in teenagers has decreased in many countries during the last 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, studies have shown that 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 to approximal surfaces and a lower proportion 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). The majority of lesions were initial lesions, and the 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. When approximal enamel lesions were included in caries registration, only 6% of the teenagers were cariesfree (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). Levi Spear Parmly is considered the inventor of dental floss, and in 1819 he recommended use of waxen silk thread for interproximal cleaning (Parmly, 1881). During World War II, nylon floss was developed, it was found to have better abrasion resistance than silk thread, and could be produced in various lengths (Christen, 1995, Fischman, 1997). Since the 1970-ies, interdental cleaning and dental floss has been accepted as part of oral health care.

Dental personnel recommend interproximal cleaning to avoid caries, with dental floss as the preferred product recommended for children (Sarner *et al.*, 2010). A majority of teenagers report to brush their teeth twice daily (Astrom, 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 reported daily flossing and 25% of Canadian children (Kuusela *et al.*, 1997). In a Swedish study, only 8% of the teenagers reported to use dental floss daily; 30% once a week (Sarner *et al.*, 2010), while 38% of Norwegian girls reported to floss several times a week (Astrom, 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 has been shown to disrupt and remove dental plaque at approximal sites (Waerhaug, 1981). It is reasonable to assume that dental floss can prevent approximal caries, but the evidence for dental floss' ability prevent approximal caries in primary and permanent dentition is still weak (de Oliveira *et al.*, 2017, Hujoel *et al.*, 2006, 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 from birth in the public dental services. The children are called regularly based on individual need. All children are recommended to brush twice daily with fluoridated toothpaste from eruption of the first tooth. Use of dental floss and fluoride supplements are recommended after individual caries risk assessment made by dentists and dental hygienists in the dental services.

The objective of the study was to explore 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.

Material and methods

Material

All 14-year-old teenagers born in 2000 (2950 teenagers) having dental care 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 caries (60%) and dentine caries experience (57%), D₃MFT was 1.8 (SD 2.4). Approximal enamel caries was registered in 44% of the teenagers, and approximal dentine caries experience in 21%. Caries prevalence in children in the studied county was equal to the average in the country (Statistics Norway, 2014).

Methods

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 was cross-sectional, baseline data in a longitudinal study exploring effects of regular instruction and motivation to use dental floss.

Dental examinations

Examinations were performed in fully equipped dental clinics using mirror and probe after the teeth had been dried with air. Caries was registered with tooth surfaces as the unit of measurement. Bite-wing radiographs were taken when approximal surfaces could not be inspected visually. Surfaces were coded as sound, decayed (D), missed (M) and filled because

of caries (F). Five caries grades (D₁-D₅) were registered (Amarante *et al.*, 1998). Both enamel caries (D₁ and D₂), and caries lesions extending to dentine (D₃, D₄ and D₅) were included. Number of surfaces (S) with approximal enamel caries and approximal dentin caries experience was extracted from dental records and reported as approximal enamel caries (D₁₋₂Sa) and approximal dentin caries experience (D₃FSa).

The examinations were performed by 39 dentist and 23 dental hygienists. Written and oral information about the caries criteria was given to the examiners before data collection started. Intra- and interexaminer agreements were based on eight radiographs of permanent molars including 12 approximal surfaces. The registrations were performed twice with a period of 3 months between the registrations. Calibration of clinical caries examination was not performed because of practical reasons. Intra- and interexaminer agreements were calculated using Cohen's kappa (Landis and Koch, 1977). A gold standard was developed based on the authors' registrations and compared with the examiners registrations. The mean intra- and interexaminer kappa values were 0.73 (SD 0.13) and 0.72 (SD 0.12). Cohen's kappa for the intra- and interexaminer agreements were categorized as substantial to almost perfect (Landis and Koch, 1977).

Questionnaire

Anamnestic information included information about 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).

The teenagers reported if they used dental floss or not. Frequency of flossing was reported as daily, several times a week, once a week and seldom. Reasons for flossing were reported as dental personnel's recommendation, avoid cavities, get clean teeth, and avoid gingivitis. The teenagers were asked about how they considered to floss 2-3 times a week 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 more seldom. Use of fluoride lozenges or fluoride rinse were combined to one variable, fluoride supplements and categorized as daily, sometimes or no. Sugar consumption was recorded as frequency of consumption of sugary drinks and food (including sweets), and reported as more seldom than once a week, once a week, several times a week and daily, and in the analyses dichotomized as once a week or more seldom and several times a week.

Statistical analyses

Data analyses were conducted by use of SPSS for Windows (SPSS version 25, Inc Chicago, IL, USA). Results are presented as frequencies, mean and standard deviation (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. Data 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 education (Table 1). A higher proportion of girls and teenagers having parents with high education reported flossing ($p<0.05$).

Half of the teenagers (54%) reported to use dental floss (Table 2). Teenagers who reported flossing most often used dental floss once a week (34%). A minor proportion (15%) reported flossing daily. A higher proportion of teenagers who were flossing reported that they considered it would be very easy to floss 2-3 times a week the next year than teenagers who were not flossing ($p<0.05$). Teenagers who were flossing reported dental personnel's recommendation (55%) and avoid cavities (46%) as the most important reasons for flossing (Figure 1).

Table 3 shows oral health behaviour in all teenagers and in teenagers who reported flossing. A higher proportion of teenagers who reported flossing were brushing twice daily, used fluoride supplements daily and were consuming sugar-containing food and drinks once a week or more seldom than teenagers who reported not to floss ($p<0.05$).

Table 4 shows number of surfaces with approximal caries experience in all teenagers and in teenagers who reported flossing. Mean number of surfaces with approximal enamel caries was 1.7 and approximal dentine caries 0.5. Teenagers who reported flossing had higher number of surfaces with approximal enamel caries and approximal dentine caries than teenagers who were not flossing ($p<0.05$). Frequency of flossing was not associated with approximal caries experience (results not shown).

Table 5 shows results from the multivariable analysis exploring the association between use of dental floss and approximal caries experience, oral health behaviour and

background characteristics. The results showed that teenagers who reported to floss had higher probability of having approximal enamel caries (OR 1.0, CI 1.0-1.1), brushing twice daily (OR 1.5, CI 1.5-1.9), using fluoride supplement daily (OR 3.7, CI 2.6-4.6), consuming sugary drinks seldom (OR 1.3, CI 1.1-1.6), being girl (OR 1.5, CI (1.2-1.8) and having parents with high education (OR 1.3, 1.1-1.6) than other teenagers.

Discussion

This study aimed to explore dental flossing in teenagers and to study associations between use of dental floss and approximal caries experience. The results showed that half of the teenagers reported to use dental floss, only a minor proportion were flossing daily. Use of dental floss was associated with having approximal caries.

The results showed that about one third of the teenagers (38%) reported to use dental floss more than once a week. Few studies have reported use of dental floss in teenagers and the frequency of use varies (Astrom, 2004, Hujoel *et al.*, 2006, Kuusela *et al.*, 1997, Norderyd *et al.*, 2015). The study that reported daily use of dental floss in 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 among 15-year-olds where 38% of the girls and 22% of boys reported flossing several times a week (Astrom, 2004).

Use of dental floss was associated with approximal caries. Teenagers having enamel caries or dentin caries experience in approximal surfaces more often used dental floss than other teenagers. This result is contrary to what could be expected as dental personnel consider use of dental floss will prevent approximal caries development. One explanation may be that teenagers with approximal caries have been strongly recommended to use dental floss by the dental professionals to prevent further caries development, and have adopted dental floss as

part of oral health care. This is in accordance with dental personnel's recommendations reported as the main reason for using dental floss. As part of the recall examinations in the dental services, individual oral health promotion is given based on the dental professionals judgement of each teenagers need. The information includes recommendation on dental floss, if considered necessary. The health authorities' recommendations at the time of data collection was to brush twice daily with fluoridated toothpaste, use of dental floss or toothpicks was recommended on individual basis (The Norwegian Directorate of Health, 1999). The Norwegian Dental Association recommend 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 having parents with high education more often reported flossing than other teenagers. These results are in line with previous research where girls and those with high education more often demonstrate favourable health behaviour than others (Sanders *et al.*, 2005). Individuals who is able to establish and maintain one favourable health habit often manage to establish other favourable habits (Sarner *et al.*, 2010).

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

In the present study, 27% of the eligible teenagers did not participate, which may cause selection bias. Non-participation included lack of invitation and some teenagers refused

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

This study was based partly on questionnaires, and limitations such as nonresponses, misconceptions and errors like answering in a socially desirable way are present in all questionnaire studies (Sjostrom *et al.*, 1999). Dental personnel did not monitor the teenagers when completing the questionnaire. The questions used was considered uncomplicated, related to daily oral health behaviour and family characteristics, and report errors considered limited. Caries data was registered as part of dental examination by experienced dental professionals, and intra- and interexaminer 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 the majority of children and adolescents, but the results from this study 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 dental 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 use of dental floss, explore barriers for use of dental floss and study association between use of dental floss and caries development.

In conclusion, half of the teenagers reported use of dental floss, and the majority were flossing once a week. Teenagers who used dental floss more often were girls, had approximal caries, reported several favourable oral health behaviours, and had parents with high education.

Conflict of interest

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

References

- Alm, A., Wendt, L.K., Koch, G. and Birkhed, D. (2007). Prevalence of approximal caries in posterior teeth in 15-year-old Swedish teenagers in relation to their caries experience at 3 years of age. *Caries Res.* **41**, 392-398.
- Amarante, E., Raadal, M. and Espelid, I. (1998). Impact of diagnostic criteria on the prevalence of dental caries in Norwegian children aged 5, 12 and 18 years. *Community Dent Oral Epidemiol* **26**, 87-94.
- Astrom, A.N. (2004). Stability of oral health-related behaviour in a Norwegian cohort between the ages of 15 and 23 years. *Community Dent Oral Epidemiol* **32**, 354-362.
- Christen, A.G. (1995). Sumter Smith Arnim, DDS, PhD (1904-1990): A pioneer in preventive dentistry. *J Dent Res* **74**, 1630-1635.
- de Oliveira, K.M.H., Nemezio, M.A., Romualdo, P.C., da Silva, R.A.B., de Paula, E.S.F.W.G. and Kuchler, E.C. (2017). Dental flossing and proximal caries in the primary dentition: A systematic review. *Oral Health Prev Dent* **15**, 427-434.
- Fischman, S.L. (1997). The history of oral hygiene products: How far have we come in 6000 years? *Periodontol 2000* **15**, 7-14.
- Hujoel, P.P., Cunha-Cruz, J., Banting, D.W. and Loesche, W.J. (2006). Dental flossing and interproximal caries: A systematic review. *J Dent Res* **85**, 298-305.
- Jacobsen, I.D., Crossner, C.G., Eriksen, H.M., Espelid, I. and Ullbro, C. (2019). Need of non-operative caries treatment in 16-year-olds from Northern Norway. *Eur Arch Paediatr Dent* **20**, 73-78.
- Kuusela, S., Honkala, E., Kannas, L., Tynjala, J. and Wold, B. (1997). Oral hygiene habits of 11-year-old schoolchildren in 22 European countries and Canada in 1993/1994. *J Dent Res* **76**, 1602-1609.

- Landis, J.R. and Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics* **33**, 159-174.
- Marinho, V.C., Higgins, J.P., Sheiham, A. and Logan, S. (2003). Fluoride toothpastes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev.* **1**, CD002278.
- Mattos-Silveira, J., Matos-Lima, B.B., Oliveira, T.A., Jarroug, K., Rego, R.V., Reyes, A., Ferreira, F.R., Imparato, J.C. and Braga, M.M. (2017). Why do children and adolescents neglect dental flossing? *Eur Arch Paediatr Dent* **18**, 45-50.
- Mejare, I., Stenlund, H. and Zelezny-Holmlund, C. (2004). Caries incidence and lesion progression from adolescence to young adulthood: A prospective 15-year cohort study in Sweden. *Caries Res.* **38**, 130-141.
- Norderyd, O., Koch, G., Papias, A., Kohler, A.A., Helkimo, A.N., Brahm, C.O., Lindmark, U., Lindfors, N., Mattsson, A., Rolander, B., Ullbro, C., Gerdin, E.W. and Frisk, F. (2015). Oral health of individuals aged 3-80 years in Jonkoping, Sweden during 40 years (1973-2013). II. Review of clinical and radiographic findings. *Swed Dent J* **39**, 69-86.
- Parmly, L. (1881). *A Practical Guide to the Management of the Teeth; Comprising a Discovery of the Origin of Caries, or Decay of the Teeth, with its Prevention and Cure*. Philadelphia: Collins & Croft.
- Sanders, A.E., Spencer, A.J. and Stewart, J.F. (2005). Clustering of risk behaviours for oral and general health. *Community Dent Health* **22**, 133-140.
- Sarner, B., Birkhed, D., Andersson, P. and Lingstrom, P. (2010). Recommendations by dental staff and use of toothpicks, dental floss and interdental brushes for approximal cleaning in an adult Swedish population. *Oral Health Prev Dent* **8**, 185-194.

- Sjostrom, O., Holst, D. and Lind, S.O. (1999). Validity of a questionnaire survey: the role of non-response and incorrect answers. *Acta Odontol Scand* **57**, 242-246.
- Smith, A.J., Moretti, A.J., Brame, J. and Wilder, R.S. (2019). Knowledge, attitudes and behaviours of patients regarding interdental deplaquing devices: A mixed-methods study. *Int J Dent Hyg*, DOI: 10.1111/idh.12410.
- Statistics Norway. (2014). Dental status by age. <https://www.ssb.no/en/statbank/table/04163/>. Accessed 10.08.2019.
- Statistics Norway. (2014). Population and population changes. <https://www.ssb.no/en/statbank/table/07459/>. Accessed 10.08.2019.
- The Norwegian Directorate of Health. (1999). Tenner for livet. Helsefremmende og forebyggende arbeid. [Teeth for life. Health promotion and health prevention] (IS-2659) Oslo
http://www.helsetilsynet.no/upload/Publikasjoner/veiledningsserien/tenner_livet_ik-2659.pdf
- Waerhaug, J. (1981). Healing of the dento-epithelial junction following the use of dental floss. *J Clin Periodontol* **8**, 144-150.
- Worthington, H.V., MacDonald, L., Poklepovic Pericic, T., Sambunjak, D., Johnson, T.M., Imai, P. and Clarkson, J.E. (2019). Home use of interdental cleaning devices, in addition to toothbrushing, for preventing and controlling periodontal diseases and dental caries. *Cochrane Database Syst Rev* **4**, CD012018.

Table 1. Characteristics of the teenagers. All teenagers and teenagers who reported flossing.

	All (n=2156)		Flossing (n=1167)		p
	%	(n)	%	(n)	
Gender					<0.05
Girl	49	(1052)	55	(639)	
Boy	51	(1104)	45	(528)	
Parental background					ns
Both Western	87	(1868)	85	(998)	
One or both non-Western	13	(288)	15	(169)	
Parental education*					<0.05
Both high	40	(768)	43	(455)	
One or both low	60	(1178)	57	(613)	

*Reduced because of internal drop out

Table 2. Use of dental floss in teenagers. All teenagers and teenagers who reported flossing.

	All (n=2156)		Flossing (n=1167)		p
	%	(n)	%	(n)	
Use of dental floss					
Yes	54	(1167)	100	(1167)	
No	46	(989)	0	(0)	
Flossing frequency					
Daily	8	(175)	15	(175)	<0.05
Several times a week	12	(264)	23	(263)	
Once a week	19	(411)	34	(402)	
Seldom	61	(1306)	28	(327)	
How easy to floss 2-3 times a week the next year?					
Very easy	54	(1158)	61	(719)	<0.05
Easy	26	(559)	25	(289)	
Difficult	17	(368)	13	(151)	
Very difficult	3	(71)	1	(8)	

Table 3. Oral health behaviour in teenagers. All teenagers and teenagers who reported flossing.

	All (n=2156)		Flossing (n=1167)		p
	%	(n)	%	(n)	
Tooth brushing frequency					<0.05
Twice daily	78	(1688)	83	(966)	
Once daily or more seldom	22	(468)	17	(201)	
Fluoride supplements					<0.05
Daily	21	(459)	26	(305)	
Sometimes	54	(1157)	58	(679)	
No	25	(540)	16	(183)	
Sugar snacking					<0.05
Once a week or more seldom	72	(1549)	74	(867)	
Several times a week	28	(607)	26	(300)	
Sugary drinks					<0.05
Once a week or more seldom	56	(1199)	60	(696)	
Several times a week	44	(957)	40	(471)	

Table 4. Number of surfaces with approximal enamel caries and approximal dentin caries experience. All teenagers and teenagers who reported flossing.

	All (n=2156)		Flossing (n=1167)		p
	Mean	(SD)	Mean	(SD)	
D ₁₋₂ Sa	1.7	(3.0)	1.8	(3.2)	<0.05
D ₃ FSa	0.5	(1.4)	0.6	(1.5)	<0.05

Table 5. Multivariable logistic regression analysis exploring the association between use of dental floss and approximal caries experience, oral health behaviour and background characteristics (n=1946).

	OR	95% CI
D ₁₋₂ Sa	1.1	(1.0-1.1)
D ₃ FSa	1.0	(0.9-1.1)
Tooth brushing frequency		
Twice daily	1.5	(1.5-1.9)
Once daily or more seldom (ref)	1	
Fluoride supplements		
Daily	3.5	(2.6-4.6)
Sometimes	2.6	(2.1-3.3)
No (ref)	1	
Sugar snacking		
Once a week or more seldom	1.1	(0.9-1.4)
Several times a week (ref)	1	
Sugary drinks		
Once a week or more seldom	1.3	(1.1-1.6)
Several times a week (ref)	1	
Gender		
Girl	1.5	(1.2-1.8)
Boy (ref)	1	
Parental background		
Both Western	0.8	(0.6-1.1)
One or both non-Western (ref)	1	
Parental education		
Both high	1.3	(1.1-1.6)
One or both low (ref)	1	

Statistically significant differences marked in bold

Figure 1. Reasons for using dental floss reported by teenagers who reported flossing. Several answers possible (n=1167).

