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ORIGINAL ARTICLE

Oral health behaviours in 12-year-olds. Association with caries and characteristics of the children?

Christine Sophie Baumgartner, Nina Johanne Wang and Tove Irene Wigen

Department of Pediatric Dentistry and Behavioral Science, Institute of Clinical Dentistry, University of Oslo, Oslo, Norway

ABSTRACT

Objective: To explore frequency of tooth brushing, dental flossing, fluoride supplements and sugar snacking in 12-year-olds, and to study how these oral health behaviours were associated with background characteristics and caries prevalence.

Material and methods: The study included 4779 children. Data were collected by clinical examination and questionnaires regarding oral health behaviours and child characteristics. Informed consent was obtained from all participants. Data were tested using Chi-square statistics and analyzed by logistic regression. The study was ethically approved.

Results: Of the children, 81% brushed twice daily, 36% flossed once a week or more often, 39% used fluoride supplements daily and 48% consumed sugar between meals once a week or less often. Children who brushed twice daily more often flossed regularly, used fluoride daily and consumed sugar between meals less often than other children ($p < .05$). Girls and children whose parents had long education more often had favourable oral health behaviours than other children; brushed more frequently, more often used floss and fluoride supplements and consumed sugary snacks less often than other children ($p < .05$). In total, 40% of the children were caries-free. Children who brushed less than twice daily had more often caries than other children (OR 1.50, CI 1.29–1.74) when controlling for background characteristics and other oral health behaviours.

Conclusions: The majority of children brushed twice daily and these children had caries less often than other children. The use of dental floss, fluoride supplements or sugar snacking in addition to brushing twice daily, did not reduce the probability of having caries.

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Introduction

Dental caries is a lifestyle disease and may be prevented by removal of dental plaque, exposure to fluoride and avoiding frequent sugary intake [1,2]. Caries prevalence in Western countries has declined in recent decades, but persists as a health problem that affects individuals during their life course [3,4]. Parents have responsibility for children's oral health behaviours up to the age of 10–12 years. After this age, children should be able to maintain their own oral health, but the possibility of doing so is dependent on already established behaviours [5].

Tooth brushing twice daily with fluoridated toothpaste is considered the basic oral self-care behaviour for maintenance of good oral health [6], and is recommended for all individuals to prevent caries [2,7]. About 70% of 10–14-year-olds are reported to brush more than once daily [8,9]. Few studies have focussed on the use of dental floss in teenagers and their frequency of daily flossing is reported to be less than 20% [10,11]. The quality of studies regarding flossing has been considered low and evidence for caries preventive effect inconsistent [12,13].

The use of fluoride supplements such as rinse and lozenges among children varies worldwide. In most countries in Europe and in the US, fluoride supplements are recommended for children considered to be at elevated risk of developing caries and for children who do not use fluoride toothpaste [2,7,14,15]. In Norway, fluoride supplements were recommended for all children until 1996 when risk-based use of fluoride supplements was introduced [16]. There is no water fluoridation in Norway and the fluoride content naturally occurring in water is low.

Frequent intake of sugary food has been considered a major risk factor for caries development [1,17,18]. More research is needed to explore association between sugar snacking and other oral health behaviours and caries in children and adolescents.

Children's caries status has been shown to be associated with background characteristics [19]. Children whose parents had short education, non-Western background, were not living with both parents, have been reported to have more caries than other children [20–22]. The reason for this difference

CONTACT Christine Sophie Baumgartner c.s.baumgartner@odont.uio.no Department of Pediatric Dentistry and Behavioral Science, Institute of Clinical Dentistry, Box 1109, Blindern, 0317, Oslo, Norway

is not fully understood, but differences in oral health behaviours may be one explanation.

At the age of 12 years, permanent teeth erupt, approximal contacts are established and responsibility for oral health behaviours is gradually transferred from parents to children. There may be lifelong consequences for oral and general health if favourable oral health behaviours are not established and caries has developed at this age [1,23].

The aim of this study was to explore frequency of tooth brushing, dental flossing, use of fluoride supplements and sugar snacking in 12-year-olds, and to study how these oral health behaviours were associated with background characteristics and caries prevalence.

Material and methods

Study population and sampling procedure

In Norway, all children and adolescents under 19 years of age are entitled to free dental care in the dental services [24], and 97% of the children were enrolled in the services [25].

All 12-year-old children (7595 children) born in 2002 in one Norwegian county (Akershus) which comprised 11% of the Norwegian population [26] were in 2014 invited to participate in the study at the time of their regular dental examination. In total, 4779 children were included. The socio-economic information obtained from the parents was compaired with the national database, and socio-economic factors in the studied children was similar to national average [27,28]. The proportion of 12-year-old children without dentine caries in the studied county was similar to national average (63% versus 60%) [29].

Methods

Data were collected by clinical examination and questionnaire. The children assisted by parents completed a questionnaire regarding oral health behaviours and background characteristics of the children.

Tooth brushing frequency was reported as twice daily, once daily, sometimes and never and dichotomized as twice daily (favourable) and once daily or less often (unfavourable).

The use of dental floss was reported as daily, several times a week, once a week and less often, and dichotomized as once a week or more often (favourable) and less often than once a week (unfavourable).

The use of fluoride lozenges and fluoride mouthrinses were reported as daily, sometimes and never. Lozenges and rinses were combined into one variable; fluoride supplements and dichotomized as using lozenges and/or rinses daily (favourable) and less often than daily (unfavourable).

Consumption of sugar-containing drinks and sugary snacks was reported as less often than once a week, once a week, several times a week or several times a day. Drinks and foods were combined into one variable, sugar snacking and dichotomized as consuming sugary drinks and/or foods once a week or less often (favourable) and several times a week (unfavourable).

Characteristics of the children included gender, parents' origin, parents' education and family status. Origin of the parents was recorded as mother and father's country of birth. In the analyses, mother and father's origin was combined into one variable and dichotomized as both parents having Western origin and one or both having non-Western origin. Non-Western origin included parents born in Asia, Africa, South America, Central America and Eastern Europe.

Mother and father's education was measured as number of years at school. More than 12 years at school was defined as long education and 12 years or less was defined as short education. Mother and father's education was combined into one variable and dichotomized as both parents having long education and one or both parents having short education.

Family status was dichotomized as children living in nuclear families and children living in single-parent families comprising mostly living with mother, mostly with father and in shared custody.

The clinical examinations including bitewing radiographs were performed by dental hygienists or dentists in dental clinics using mirror and probe after teeth had been dried with air. Caries was reported at tooth level. Teeth were registered and given codes using the DMFT index. Caries lesions extending to dentine were recorded and children dichotomized as caries-free and having caries.

Intra- and inter-examiner agreement

Written and oral information about the clinical caries criteria was given to and discussed with the examiners before data collection started. Agreement was examined using eight bitewing radiographs of permanent molars including 12 approximal surfaces in each radiograph. A 'gold standard' was developed based on the second and third authors' registrations and compared with the examiners' registrations. Intra- and inter-examiner agreements were calculated using Cohen's kappa [30]. Mean intra-examiner and inter-examiner values were 0.69 (SD 0.16) and 0.69 (SD 0.17). Cohen's kappa values were categorized as substantial to almost perfect [30].

Ethical considerations

Written, informed consent was obtained from all parents. The investigation was approved by the Regional Committee for Medical Research Ethics in South-Eastern Norway (2013/1881).

Data analyses

The statistical analyses were performed using the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY)). Data were cross-tabulated and tested with Chi-square statistics. Bivariable and multivariable logistic regression analyses were conducted with children's oral health behaviours and dentine caries prevalence as the dependent variables. Results were reported using odds ratio (OR) and 95% confidence interval (CI). Spearman's correlation was used to explore associations between the

Table 1. Characteristics of the 12-year-old children ($n = 4779$).

	%	(*n*)
Gender		
Girl	49	(2319)
Boy	51	(2460)
Parents' origin		
Both Western	81	(3879)
One or both non-Western	19	(900)
Parents' education[a]		
Both long	54	(2562)
One or both short	46	(2200)
Family status[a]		
Nuclear family	76	(3644)
Single-parent family	24	(1129)

[a]Reduced number because of internal drop-out.

Table 2. Proportion and number of children according to frequency of oral health behaviours ($n = 4779$).

	%	(*n*)
Brushing		
Twice daily	81	(3867)
Once daily or less	19	(912)
Flossing[a]		
Once a week or more often	36	(1726)
Less than once a week	64	(3016)
Fluoride supplements[a]		
Daily	39	(1842)
Less than daily	61	(2905)
Snacking[a]		
Once a week or less	48	(2292)
Several times a week	52	(2458)

[a]Reduced number because of internal drop-out.

independent variables before the multivariable analyses were conducted. The level of statistical significance was set at 5%.

Results

In Table 1, characteristics of the 12-year-old children are presented. The majority lived in nuclear families and had parents of Western origin. Half of the children had parents with long education.

Table 2 describes the oral health behaviours in children. The majority (81%) brushed twice daily, while one-third used dental floss at least once a week and fluoride supplements daily. Half of the children reported unfavourable sugar snacking behaviours.

Figure 1 shows the number of favourable oral health behaviours reported by the children. One third reported having more than two favourable oral health behaviours, and only 6% reported no favourable behaviours.

Table 3 shows associations between brushing frequency and other oral health behaviours. A higher proportion of children brushing twice daily reported more often other favourable oral health behaviours than children who brushed less than twice daily.

Table 4 shows results from the four multivariable analyses exploring associations between oral health behaviours and characteristics of the children. Brushing, flossing and use of fluoride supplements were associated with all child characteristics. Sugar snacking was associated with gender and parental education.

Table 5 shows results of bivariable and multivariable logistic regression analyses exploring associations between caries

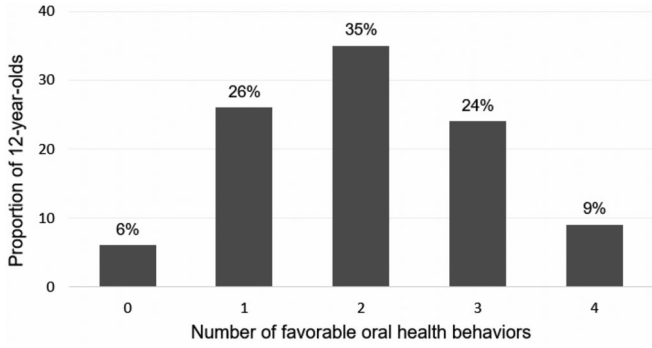

Figure 1. Proportion of 12-year-olds according to number of favourable oral health behaviours.

Table 3. Proportion of children using dental floss, fluoride supplements and sugar snacking according to tooth brushing frequency ($n = 4779$).

		Tooth brushing		
	All children % (*n*)	Twice daily %	Once daily or less %	*p*
Flossing[a]				
Once a week or more often	36 (1726)	85	15	
Less than once a week	64 (3016)	79	21	<.05
Fluoride supplements[a]				
Daily	39 (1842)	86	15	
Less than daily	61 (2905)	78	22	<.05
Snacking[a]				
Once a week or less	48 (2292)	83	17	
Several times a week	52 (2458)	79	21	<.05

[a]Reduced number because of internal drop-out.

prevalence, oral health behaviours and characteristics of the children. Of the studied children, 35% had caries extending into dentine. In the bivariable analyses, tooth brushing frequency, use of fluoride supplements, frequency of sugar snacking, parents' origin, parents' education and family status were associated with having caries. The results of the multivariable analysis showed that children who brushed seldom had a higher probability of having dentine caries than other children (OR 1.50, CI 1.29–1.74). None of the other oral health behaviours was associated with caries prevalence. Parental origin and parental education were associated with caries prevalence. Children having one or both parents with non-Western origin (OR 1.76, CI 1.51–2.04) or short education (OR 1.40, CI 1.23–1.58) had a higher probability of having caries than other children.

Discussion

The purpose of this study was to explore oral health behaviours in 12-year-old children and to study associations between brushing, flossing, use of fluoride supplements, sugar snacking, characteristics of the children and caries prevalence. The main findings were that a majority brushed twice daily and that these children more seldom had caries than other children. In addition, nearly half of the children reported one or more other favourable oral health behaviours, but these behaviours were not associated with caries prevalence.

This study was based on data from the dental services and included a large group of 12-year-olds. One-third of the

Table 4. Tooth brushing frequency, use of dental floss, use of fluoride supplements and sugar snacking related to characteristics of the children.

	Brushing less than daily ($n = 4757$)	Flossing[a] less than once a week ($n = 4720$)	Fluoride supplements[a] less than daily ($n = 4725$)	Snacking[a] less than once a week ($n = 4729$)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender				
Girl (ref)				
Boy	**1.37 (1.18–1.58)**	**1.31 (1.16–1.47)**	**0.86 (0.76–0.96)**	**1.19 (1.06–1.34)**
Parents' origin				
Both Western (ref)				
One or both non-Western	**1.24 (1.04–1.49)**	**0.79 (0.68–0.92)**	**1.18 (1.01–1.38)**	0.90 (0.78–1.05)
Parents' education[†]				
Both long (ref)				
One or both short	**1.44 (1.24–1.67)**	**1.32 (1.17–1.49)**	**1.35 (1.20–1.53)**	**1.37 (1.22–1.55)**
Family status[a]				
Nuclear family (ref)				
Single-parent family	**1.68 (1.43–1.97)**	**1.35 (1.17–1.56)**	**1.24 (1.08–1.44)**	1.08 (0.94–1.24)

ref: reference category. Statistically significant results ($p<.05$) marked in bold. Multivariable logistic regression analyses.
[a]Reduced number because of internal drop-out.

Table 5. Children with caries related to oral health behaviours and characteristics of the children.

	Children with caries	
	Bivariable ($n = 4779$)	Multivariable ($n = 4681$[a])
	OR (95% CI)	OR (95% CI)
Brushing		
Twice daily (ref)		
Once daily or less	**1.59 (1.38–1.84)**	**1.50 (1.29–1.74)**
Flossing[a]		
Once a week or more often (ref)		
Less than once a week	1.00 (0.88–1.12)	0.93 (0.82–1.06)
Fluoride supplements[a]		
Daily (ref)		
Less than daily	**1.18 (1.05–1.34)**	1.09 (0.96–1.24)
Snacking[a]		
Once a week or less (ref)		
Several times a week	**1.17 (1.04–1.31)**	1.12 (0.99–1.27)
Gender		
Girl (ref)		
Boy	0.94 (0.83–1.05)	0.91 (0.81–1.03)
Parents' origin		
Both Western (ref)		
One or both non-Western	**1.94 (1.68–2.25)**	**1.76 (1.51–2.04)**
Parents' education[a]		
Both long (ref)		
One or both short	**1.58 (1.40–1.78)**	**1.40 (1.23–1.58)**
Family status[a]		
Nuclear family (ref)		
Single-parent family	**1.25 (1.09–1.43)**	1.14 (0.99–1.32)

ref: reference category. Statistically significant ($p<.05$) results marked in bold. Bivariable and multivariable logistic regression analyses.
[a]Reduced number because of internal drop-out.

invited children did not participate, non-attenders were children who refused to participate, did not show up for the scheduled examination and children who the dental clinicians forgot to invite. Non-participation may cause selection bias. Selection bias may influence the level of the variables, but has been shown to a lesser extent to influence associations between the variables [31]. In the studied children, parents' origin, educational level and caries prevalence did not differ from the national average [27–29]. It was reasonable to assume that the results from the study were representative for the country in general. The present study was partly based on questionnaires. Limitations such as nonresponse, misconceptions and errors like giving answers that are socially acceptable are present in all questionnaire studies. The probability of reporting errors in the present study was considered limited as most questions were related to daily routine of oral health behaviours in children and self-reporting of oral health behaviours has been shown to be a valid measurement [32]. Experienced dentists or dental hygienists performed the clinical examinations of the children. Calibration of clinicians showed substantial intra- and interexaminer agreement [30].

The results showed that the majority of children brushed twice daily. The proportion who reported brushing was slightly higher than previously reported [10]. Several studies have shown that tooth brushing frequency has increased among schoolchildren in many countries [8,33]. The present study showed that one of the five children did not perform the recommended brushing twice daily, and brushing frequency was associated with caries prevalence. It has been well documented that tooth brushing with fluoridated toothpaste is an effective caries-preventive method [2]. Children who reported brushing twice daily more often reported other favourable behaviours indicating that brushing behaviours is important for chance of establishing other favourable oral health behaviours. Brushing frequency was associated with child characteristics, showing that some children may need tailored oral health advice to be able to establish favourable brushing behaviour.

One-third of the children in the present study reported flossing more than once a week. Few studies have reported the use of dental floss in teenagers and the frequency of use varies [10,11,13]. The results showed no association between flossing and having caries at 12-year of age when controlled for the other oral health behaviours and characteristics of the children. It has been shown that the use of dental floss or interdental brushes in addition to tooth brushing may reduce interproximal gingivitis or plaque more than tooth brushing alone, but the evidence for use of dental floss to prevent caries development is limited [12].

In this study, nearly half of the 12-year-old children used fluoride supplements daily. The results from the present study found no association between this behaviour and caries prevalence. The scientific evidence for fluoride supplements in caries prevention is poor, and there is no support in recent research that the use of fluoride supplements

prevents additional caries in children who use fluoridated toothpaste [14].

More than half of the 12-year-olds reported sugar snacking several times a week. Frequent sugar consumption has been associated with caries development [1], though studies including children and adolescents have shown contradictory results [34]. These findings have been explained by methodological differences in study design and recording of sugar intake. In this study, sugar snacking was not associated with caries prevalence in the multivariable analysis, suggesting that tooth brushing frequency should be emphasized when informing children about caries prevention.

The results show that characteristics of the children were associated with oral health behaviours and caries prevalence. Socioeconomic factors have been shown to influence children's oral health [9,19]. Children of parents with short education or non-Western origin are reported to have higher caries prevalence than other children [21,22]. The present results confirmed these findings and show that though 12-years-old are starting to behave independently, family background still influences children's oral health behaviours and caries prevalence.

This study shows that although all children in Norway are recalled regularly for individualized oral health care, socioeconomic inequalities in oral health behaviours and caries prevalence still exist. Establishing favourable brushing routines before the eruption of permanent teeth seems to be the most effective preventive oral health behaviour as brushing was associated with caries prevalence controlled for other oral health behaviours. Regularly performed tooth brushing before age 12 years often will become a lifelong routine as previous behaviours predict future behaviours [35].

In conclusion, favourable tooth brushing behaviours were established in the majority of 12-year-olds. Children with unfavourable brushing behaviours, having parents with non-Western background or short education were caries risk children. The use of dental floss, fluoride supplements or sugar snacking was not associated with caries prevalence.

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ORCID

Christine Sophie Baumgartner http://orcid.org/0000-0001-7936-9625
Nina Johanne Wang http://orcid.org/0000-0003-0606-6644
Tove Irene Wigen http://orcid.org/0000-0003-4082-6520

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