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ORIGINAL ARTICLE

Prevalence of dental fluorosis in children from non-water-fluoridated Halmstad, Sweden: fluoride toothpaste use in infancy

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Abstract

Objectives. To determine the prevalence and severity of dental fluorosis in children aged 7–9 years from non-water-fluoridated Halmstad, Sweden, and to relate the results to their reported fluoride exposure history during infancy. ***Material and Methods.*** In Spring 2002, a questionnaire distributed to a cluster random sample of 1039 parents enquired into their child's early oral health behaviors and included a "photographic toothpaste menu". The permanent upper anterior teeth (13–23) were examined clinically (+10% repeats) using a modified Thylstrup-Fejerskov Index. ***Results.*** Complete data were available for 53% ($n = 548$) of the sampled children. The prevalence of fluorosis at any level was 49% (95% CI: 45–54%), and of fluorosis with esthetic concern (TF score ≥ 3) 4% (95% CI: 3–6%). Based on repeat observations, reliability was good (kappa = 0.82). There was no statistically significant increased risk of dental fluorosis prevalence associated with any of the fluoride exposure risk factors examined, including reported usage of (1000 ppm) fluoride toothpaste from time of first deciduous tooth eruption. ***Conclusions.*** While there were low levels of dental fluorosis of esthetic concern, half the children had some degree of dental fluorosis. The prevalence of dental fluorosis was not explained by the risk factors, including fluoride toothpaste usage as explored in this study.

Key Words: *Dental fluorosis, dentifrices, prevalence, Sweden*

Introduction

The epidemiology of dental fluorosis is increasingly focusing on the importance of different fluoride sources, the timing of their intake, and the levels of fluorosis of esthetic concern.

A recent systematic review of the efficacy and safety of fluoridation of drinking water found that dental fluorosis was the only recognized side effect [1]. The meta-analysis estimated dental fluorosis prevalence in areas with a water fluoride level of 1.0 ppm of 48%, with only 12.5% at levels of "esthetic concern", compared to areas of non-water-fluoridation of 15% and 6.3%, respectively. The global trend towards increasing prevalence of dental fluorosis since the 1970s has generally been attributed to the establishment of fluoride toothpaste use.

In Sweden, previous epidemiological studies of dental fluorosis included one of the first-ever investigation of fluorosis etiology and prevalence. Here, in 1979, Forsman [2] found a greater prevalence and severity of fluorosis in children from a higher water-fluoride area compared to a low-fluoride control area. Also in Sweden, Koch [3] noted a higher prevalence and severity of dental fluorosis in children born in Uppsala, a naturally water-fluoridated city, compared to children who had moved to the area. A similar study undertaken in 1982 showed, first, a low prevalence of mild dental fluorosis in Swedish areas with fluoridated drinking waters and, second, limited detection of fluorosis at any level in areas with low-water-fluoride concentrations [4].

In a further Swedish study examining enamel changes in 12-year-olds with a known early exposure to

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fluoride tablets and/or fluoride-containing toothpaste, fluorosis was found in 45% of children. Those who had consumed fluoride tablets for a period of at least 12 months from the age of 6 months ran a 5.4 times greater risk of developing enamel fluorosis than children with no consumption. However, no such risk could be shown in children who started to use fluoride toothpaste at 6 or 12 months of age [5]. Since these studies were undertaken, there has been limited epidemiological work published on the prevalence of fluorosis in Sweden.

In addition, debate persists regarding the concentration of fluoride to be used in infant toothpaste; there are concerns that 500 ppm F will provide a suboptimal dental caries-preventive effect, while 1000 ppm F might lead to subsequent fluorosis of the permanent dentition [1,6,7].

This study therefore sought to investigate the prevalence of dental fluorosis, particularly at levels of esthetic concern, in children living in the non-water-fluoridated area of Halmstad, Sweden where, reputedly, 1000 ppm fluoride toothpaste had been commonly used in infant toothbrushing. It also wished to establish the potential sources of fluoride to which those children may have been exposed during infancy, focusing on the reported toothbrushing practices and toothpaste usage behaviors which their parents undertook. In addition, it attempted to examine any associations between these (and other) potential risk factors and dental fluorosis.

Material and methods

Ethical approval for the study was obtained via the Science Ethics Committee of the Medical Faculty, Lund University, Sweden.

The study was a quantitative, cross-sectional, observational, epidemiological investigation assessing the prevalence and severity of dental fluorosis in a sample of children from a non-water-fluoridated community. A retrospective study of the children's history of fluoride exposure risk factors and determinants associated with such exposure was also undertaken. The risk factors were: exposure to water fluoridation, toothbrushing/toothpaste behavior, and fluoride supplement usage during infancy. The risk determinants were: socio-economic status and level of educational attainment of the children's parents.

A cluster sample of 7 to 9-year olds was obtained via the random selection of 13 schools from the complete list of 31 schools in the Halmstad area, which had a total of 2087 pupils aged 7, 8, and 9 years on their roles. The 13 selected schools had 1039 children aged 7–9 years enrolled, and the questionnaire was distributed to all their parents.

The children's fluoride risk factors and determinants were assessed by means of a postal survey using a parental "self-administered" piloted questionnaire, which included a consent form for their child to be included in the field epidemiology. A standard and tested fluoride exposure questionnaire [8] was used. It was translated to Swedish and modified to include a "photograph menu" (Figure 1) from which the parents were asked to indicate which toothpaste was used during infancy, the aim being to aid recall of these vital data. The photographic menu was constructed from all brands of toothpaste available in 1994/1995, i.e. when the children in this study were infants, the information being obtained from a document updated yearly by the Community Dentistry Unit, Alingsås, Västara Götaland, Sweden [9]. A further picture menu to help parents/carers indicate the quantity of toothpaste used was also developed and was similar to previously tested pictorial recall methods used to determine toothpaste quantities and rinsing behaviors employed during toothbrushing routines [10].

To help determine whether the children had been exposed to water fluoridation during the development of their permanent upper anterior teeth, the geographic locations where parents indicated their child had lived during their first 4 years were compared against a list detailing the fluoride levels in public waters, as prepared by the Swedish Water Association (Svenskt Vatten AB) [11].

Parental socio-economic background details were compiled into standardized education attainment level and occupational classification of socio-economic status (SES) formats. Parental education levels are commonly used as a socio-economic measurement in Sweden [12] and these were standardized using the International Standard Classification of Education (ISCED) [13]. The parents' occupation information was related to the relevant occupational socio-economic grouping, using the Registrar General for Scotland Occupational Classification [14] as a proxy measure to stratify the occupation levels.

In addition to positive parental consent being received, the inclusion criteria for children to have their teeth assessed for dental fluorosis by clinical examination demanded they had to have symmetrical bilateral upper permanent anterior teeth which were fully erupted [19,20]. Due to the importance of assessing fluorosis from an esthetic point of view, only the labial surfaces of the upper anteriors (i.e. index teeth: 13, 12, 11, 21, 22, 23) were examined clinically. In Spring 2002, the children were examined (by DIC) in the 13 schools in Halmstad using a "modified" TF Index under standardized conditions, as per the Scottish Health Board's Dental Epidemiological Programme (SHBDEP) criteria [15,16]. The standard SCOT's Index question relating to the child's perception of the status of any possible anterior tooth markings was not included because of the young age of these subjects. Training and calibration in the use of the "modified TF" index had been undertaken previously by assessing projected 35-mm color slides

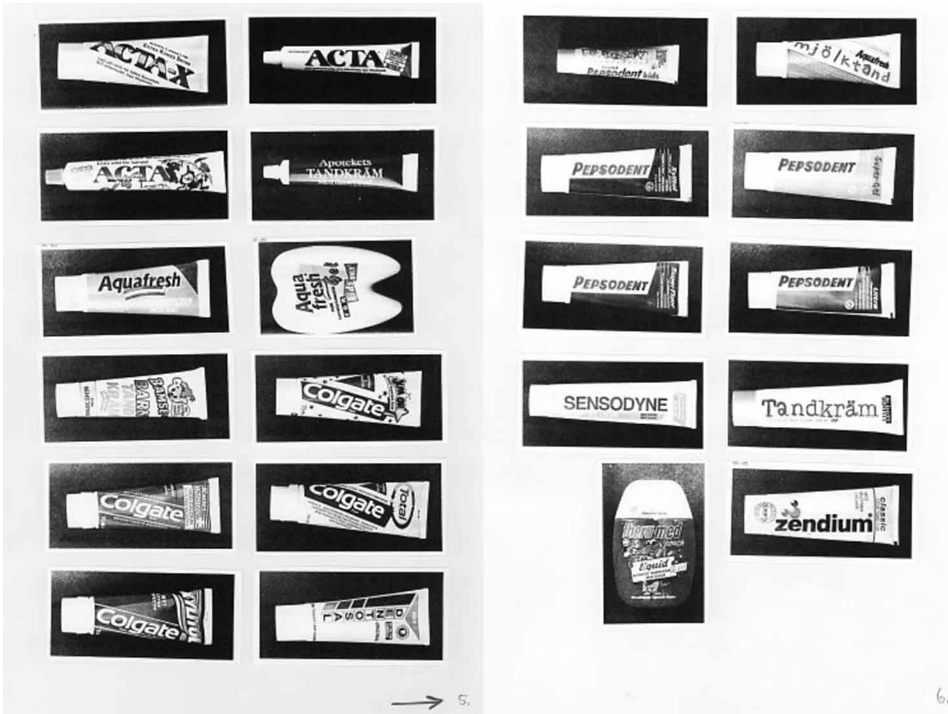

Figure 1. Toothpaste-availability photographic menu to aid parental questionnaire recall accuracy.

from previous studies of children's teeth showing varying degrees of dental fluorosis [8,17,18]. The Thylstrup and Fejerskov criteria [20] were used in assessing the presence and severity of dental fluorosis. Within these criteria, tooth appearance ranges from small diffuse opacities in mild cases to whiter opaque lines corresponding to the perikymata running across the tooth surface in moderate cases, to chalky white enamel appearance in severe cases, with enamel breakdown in the most severe. The criteria also require the within-mouth appearance of the lesions to be symmetrical across the midline.

Non-dental staff randomly selected a 10% sample for re-examination to assess intra-examiner repeatability.

Data from the questionnaires and clinical examinations were translated by Swedish co-workers, then coded and entered in a previously created database using Microsoft Excel software. The data were analyzed using Minitab (release 13.32) statistical software. Frequency tables were produced and cross-tabulations carried out. Cohen's Kappa was used to measure intra-observer agreement of dental fluorosis prevalence and severity [8]. Chi-square tests, where appropriate, were performed to compare percentages of risk factors' exposures between groups of children with and without dental fluorosis. In addition, the relative importance of relevant risk factors and determinants of dental fluorosis were explored with a binary logistic regression model using SPSS (version 10.5). Results are presented for each risk factor (separately) unadjusted and subsequently after adjustment for other factors.

Results

Questionnaire data

Of the 1039 questionnaires distributed, returns were received from 849 (82%) parents. In total, 757 (73%) parents returned a completed questionnaire with a positive consent for their child to be examined, while 92 returned a negative consent response and did not complete the questionnaire. However, of the 757 completed questionnaires with positive consent forms returned, 137 of the children were not subsequently examined due to (i) the return being received too late, i.e. after the visit to the school ($n=76$), or (ii) the child being absent from school on the day of the examination visit ($n=61$). Of the resulting 620 examinations, only 548 could be assessed for dental fluorosis, with 49 having absent upper anterior permanent teeth, and 23 children having only one upper anterior permanent tooth, thus precluding symmetrical assessment across the midline.

Comparison of the parental responses between those examined and those not examined revealed only small differences (Table I). However, the age distribution of the two groups was significantly different, with those not examined being younger than the examined group. The only other significant difference was the reported age when toothbrushing commenced: this occurring before 1 year of age in only 49% of those not examined, compared to 63% of those who were actually examined.

Of the 548 children assessed for fluorosis, the vast majority were born in Sweden (532; 97%) and were not exposed to fluoridated water in their first 4 years of life (537; 98%). Over half the parents had attended

Table I. Comparison of potential fluorosis risk factors in the children examined versus those not examined

Risk factor		Examined ($n=564$)	Not examined ($n=193$)	Chi-square
Sex distribution	M	46%	52%	$\chi^2=1.655$
($n=757$)	F	54%	48%	$p=0.20$
Age distribution	7	34%	54%	$\chi^2=23.22$
($n=747$)	8	54%	37%	$p<0.001$
	9	12%	9%	
Born in Sweden		97%	97%	$\chi^2=0.001$
($n=738$)				$p=0.97$
Exposure to water F		2%	3%	$\chi^2=0.155$
($n=723$)				$p=0.69$
SES occupation	I/II	59%	51%	$\chi^2=3.597$
classification	III	30%	38%	$p=0.17$
($n=663$)	IV/V	10%	11%	
Parent education	1	5%	5%	$\chi^2=6.197$
level ($n=727$)	2	38%	36%	$p=0.10$
	3	6%	12%	
	4	51%	47%	
Age start brushing ($n=735$)	<12 months	63%	49%	$\chi^2=10.78$
	>12 months	37%	51%	$p=0.001$
Frequency of brushing ($n=738$)	<2×/day	22%	26%	$\chi^2=1.332$
	≥2×/day	78%	74%	$p=0.25$
F Conc. of toothpaste ($n=675$)	250/500 ppm	8%	7%	$\chi^2=0.035$
	≥1000 ppm	92%	93%	$p=0.85$
Amount of toothpaste	≤pea-size	71%	70%	$\chi^2=0.016$
($n=582$)	>pea-size	29%	30%	$p=0.90$
F supplement		24%	23%	$\chi^2=0.075$
($n=737$)				$p=0.78$

University or tertiary education (279; 51%) and only 27 (5%) had not gone further than basic-level education. Of those who answered the question relating to parental occupation, 323 (59%) of stated occupations were in SES occupational classification groups I or II ("professional" or "managerial and technical", respectively), and only 49 (9%) were in SES groups IV or V ("partly skilled occupations" or "unskilled occupations", respectively). In addition, there was high correlation between (the Scottish) SES and the ISCED level of parental education ($p<0.01$).

With regard to toothbrushing behaviors, 345 (63%) parents stated that they commenced their child's toothbrushing between 6 and 12 months of age, and the vast majority (428; 78%) brushed twice or more each day (Table I). Most parents reported using a toothpaste containing at least 1000 ppm fluoride (504; 92%). The majority also revealed that they used small amounts of toothpaste (389; 71%), such as a "pea-size" or "smear". With regard to fluoride supplement usage, only 132 (24%) had ever taken these (0.25 mg tablets). However, the stated frequency with which these supplements were actually taken was variable. In the majority of cases (77; 58%), the reported frequency of usage was once-a-day, while 24 (18%) parents indicated they were given once every second day. However, 13 (10%) stated they had given them only once each week, 9 (7%) less than once a week, and 12 (9%) parents did not appear to know how often they had given fluoride supplements. Of those who had done so ($n=132$), 12 (9%) did not know at what ages their child had taken them, with 24 (18%) reportedly taking them at 1 year of age, increasing to 54 (41%) at 2 years of age, and rising further with increasing age, the vast majority of children reportedly taking them at ages 3 (114; 86%) and 4 (100; 76%) years.

Data from the Swedish Water Association revealed that fluoride levels of the drinking water supplying the communities around the schools in the Halmstad area were low—ranging from less than 0.1 ppm F (from Söndrums Waterplant-lokal ground-level water) to 0.13 ppm F (from Halmstad's water plant mainly sourced from lakes in Småland).

Clinical examination data

As indicated in Table II, just over half the children examined did not have fluorosis, and only 22 (4%) had fluorosis at TF score 3, with none scoring greater than TF3. The intra-examiner (DIC) agreement for

Table II. Dental fluorosis assessment, modified TF Index

TF score	No.	% of total (95% CI)
0	278	50.7 (46–55%)
1	138	25.2 (22–29%)
2	110	20.1 (17–24%)
≥3	22	4.0 (3–6%)
Total	548	100

identification of fluorosis presence in the 10% random sample of children, compared to their original examination, gave a Cohen's Kappa score of 0.92 (96% agreement). For identification of the severity of fluorosis (using the modified TF Index), Kappa was 0.82 (86% agreement).

When analyzing the risk factors for dental fluorosis individually, only factors relating to socio-economic status were found to be significantly related to dental fluorosis in the sample children. As indicated in Table III, both parental occupational classification ($p = 0.02$) and level of parental educational attainment ($p = 0.03$) were found to be related significantly to the presence of dental fluorosis, but not to the severity of fluorosis (i.e. fluorosis at TF 3 level). There were no relationships with the other risk factors or determinants explored in the questionnaire, nor with the presence or absence of dental fluorosis, nor indeed the level of fluorosis recorded.

All 11 risk factors and determinants were included in a multiple logistic regression analysis to determine those which were important predictors of fluorosis after adjusting for the effects of all the others. This analysis was carried out for the subgroup of 413 children for whom this complete data set was available. The results are given in Table IV. For consistency, the unadjusted odds ratios and p-values were computed on the same subset of 413 children and are also given in Table IV. Exposure to water fluoridation and "born in Sweden" were not included in the multiple logistic regression owing to the very small numbers born outside Sweden or having lived in water-fluoridated areas. Table IV indicates that neither educational level nor occupational socio-economic status were significantly associated with fluorosis prevalence after adjusting for other factors; in fact none of the explanatory variables was significant in the multiple logistic model. When stepwise methods were used, the only significant factor in the model was educational level. The same result was obtained from both forward selection and backward elimination of variables.

Discussion

In order to investigate factors relating to prevalence of dental fluorosis it is essential to take into account the range of fluoride exposure sources which could potentially pose a fluorosis risk. Halmstad is a non-water-fluoridated area, and from anecdotal local information it was expected that 1000 ppm F toothpaste would have been used regularly from infancy. However, it became evident that this behavior was not entirely uniform, and that it would be necessary to examine the relative importance of each of the fluoride exposure risk factors investigated. While only 548 children from an original sample of 1039 seven to nine-year-olds were assessed for dental fluorosis, it was calculated that the study had adequate power to detect clinically important associations between risk factors and the presence of fluorosis. Thus, for example, if there was a background 40% risk of fluorosis and a risk factor prevalence of 25% (e.g. fluoride supplement usage), then a sample of 548 children gives 80% power to detect, at the 5% significance level, an odds ratio for fluorosis of 1.75, if this risk factor was present.

Those who were not assessed for fluorosis due either to being late responders or to not having sufficient examinable index teeth were comparable to the children examined. However, as one would expect, those not examined were generally younger than those who were, as younger children have fewer permanent upper teeth. Nevertheless, the 7–9 age group was chosen to reduce recall bias associated with the time-lapse between infant behavior and permanent tooth appearance [21]. Thus, the children had to be young enough to reduce the relative time-period from infancy, and hence reduce the period of parental recall, yet old enough to ensure they would have paired upper anterior permanent tooth-types assessable for dental fluorosis scoring as per the inclusion criteria. Moreover, accurate information on toothpaste availability was only obtainable from 1994/1995 (9).

The original TF Index methodology involving 2 min of initial air-drying detects dental fluorosis that is barely discernible to the clinical examiner and is not esthetically apparent. Hence, the modification first employed by Stephen et al. [8,15,18], of scoring the teeth without prior drying, was introduced as a means to allow for epidemiological assessment at a more natural and realistic level. The overall prevalence of dental fluorosis in this study was 49.7% (95% CI: 45–54%), comparing similarly with a historical Swedish investigation which reported a prevalence of 45% in 1982, when using the TF index [5]. In the current investigation, most individuals (96%) with dental fluorosis had it detected at the "very mild" (TF score 1) or "mild levels" (TF score 2). Only 4% of those examined had "more marked" or "severe" fluorosis (TF score 3). These data compare with recent findings for non-water-fluoridated areas where the *York Review* [1] estimated fluorosis of esthetic concern levels to be 6.3%, while Tabari [24] recorded only 0.5% in a UK study. In addition, a recent multicenter European Union funded project has been undertaken [25], and while the study did not include Sweden a number of both water-fluoridated and non-water-fluoridated areas around Europe were involved. The main findings

Table III. The relationship between risk factors/determinants and dental fluorosis

Risk factor		Dental fluorosis presence	No dental fluorosis	Chi-square
Sex distribution ($n=548$)	M ($n=253$)	49%	51%	$\chi^2=0.08$
	F ($n=295$)	50%	50%	$p=0.78$
Age distribution ($n=547$)	7 ($n=186$)	48%	52%	$\chi^2=4.524$
	8 ($n=296$)	47%	53%	$p=0.10$
	9 ($n=65$)	62%	48%	
Born in Sweden ($n=547$)	Yes ($n=530$)	50%	50%	$\chi^2=0.47$
	No ($n=17$)	41%	59%	$p=0.49$
Exposure to water F ($n=539$)	Yes ($n=12$)	25%	75%	$\chi^2=2.868$
	No ($n=527$)	50%	50%	$p=0.09$
SES occupation classification ($n=501$)	I/II ($n=296$)	54%	46%	$\chi^2=7.642$
	III ($n=153$)	46%	54%	$p=0.02$
	IV/V ($n=52$)	35%	65%	
Parent education level ($n=539$)	No higher education ($n=262$)	45%	55%	$\chi^2=4.473$ $p=0.03$
	Higher education ($n=277$)	54%	46%	
Age start brushing ($n=545$)	$\leq$12 months ($n=343$)	49%	51%	$\chi^2=0.014$ $p=0.91$
	$>$12 months ($n=202$)	50%	50%	
Frequency of brushing ($n=547$)	$<2\times$/day ($n=118$)	50%	50%	$\chi^2=0.025$ $p=0.88$
	$\geq 2\times$/day ($n=429$)	49%	51%	
F Conc. of toothpaste ($n=511$)	250/500 ppm ($n=40$)	48%	52%	$\chi^2=0.007$ $p=0.93$
	$\geq$1000 ppm ($n=471$)	48%	52%	
Amount of toothpaste ($n=485$)	$\leq$pea-size ($n=343$)	49%	51%	$\chi^2=0.048$ $p=0.83$
	$>$pea-size ($n=142$)	48%	52%	
F supplements ($n=547$)	Yes ($n=133$)	48%	52%	$\chi^2=0.108$
	No ($n=414$)	50%	50%	$p=0.74$

were that fluorosis at the level of TF score 3 or more ranged from 4% in Cork (Ireland) and non-fluoridated Haarlem (The Netherlands) to zero in Oulo (Finland) and Athens (Greece). However, it must be noted that the levels at which fluorosis becomes a public aesthetic problem remain to be determined in the context of local and cultural norms [8,22,23,25,26].

As with any study using an historical information questionnaire, respondent recall is an issue. The accuracy and validity of such historical recall data regarding infants' oral health behavior and practices has been criticized [27], and much weight is often given to conclusions drawn from studies using such information, with limited emphasis on the potential problems of the methodology. In an attempt to overcome these memory-related aspects, a "photo-aid" was developed, not dissimilar to previously tested pictorial-recall methods [10], which comprised a picture list of all toothpaste brands available when the study children were infants (Figure 1). This aimed to take advantage of the concept of recognition over recall by attempting to improve parents' memory of their toothpaste choice when brushing their infants' teeth through visually stimulated recognition facilitated by retrieval cues. However, further validation of the method is still required.

It must be acknowledged that respondent recall bias could account for the excellent compliance with the recommendations for toothpaste use by parents with their infants and young children. Requesting parents to demonstrate the amount of toothpaste used has been undertaken in some studies [24,28]. However, in relation to the present project, this was felt to be logistically impractical and would not overcome distant recall bias resulting from the time-lag.

Unfortunately, due to the small number ($n=22$) of children with fluorosis of esthetic concern ($TF=3$), it was not possible to examine the risk factors for fluorosis

Table IV. Risk of fluorosis, risk factors and risk determinants logistic regression model (based on 413 children with complete data)

	Unadjusted		Adjusted	
Variable	Odds ratio (95% CI)	*p*-value	Odds ratio (95% CI)	*p*-value
Age		0.14		0.10
7	1.00		1.00	
8	0.82 (0.54, 1.25)		0.80 (0.52, 1.24)	
9	1.53 (0.75, 2.96)		1.61 (0.89, 3.17)	
Sex		0.52		0.33
Female	1.14 (0.77, 1.67)		1.22 (0.82, 1.84)	
Born in Sweden		0.82	–	–
Yes	1.20 (0.26, 5.41)			
Water fluoride		0.58	–	–
Yes	0.67 (0.16, 2.82)			
SES occupation classification		0.10		0.24
I/II	1.00		1.00	
III	0.76 (0.49, 1.17)		0.88 (0.52, 1.47)	
IV/V	0.50 (0.25, 0.99)		0.52 (0.24, 1.11)	
Education 'Higher'	1.62 (1.10, 2.40)	0.015	1.48 (0.92, 2.37)	0.11
Amount >pea-size	0.80 (0.52, 1.23)	0.31	0.77 (0.50, 1.20)	0.26
Toothpaste F ≥1000 ppm	1.01 (0.50, 2.03)	0.99	1.19 (0.57, 2.47)	0.64
Brushing freq. >2×per day	1.14 (0.69, 1.89)	0.62	1.04 (0.60, 1.81)	0.89
Brushing began ≤12 months	1.08 (0.72, 1.63)	0.72	1.05 (0.67, 1.64)	0.82
Fluoride tablets Yes	1.29 (0.82, 2.02)	0.27	1.40 (0.87, 2.23)	0.16

severity, and detailed analysis had to be limited to investigating factors related to fluorosis presence (or absence). Thus, using univariate analysis (Table III), parental occupational socio-economic status (SES) was significantly associated with dental fluorosis, whereby there was a higher prevalence of clinical fluorosis in "professional and managerial" SES groups I and II (68% and 52%, respectively), which was lower in the "skilled occupations" group III (46%) and lower still in the "partly/non-skilled occupation" groups IV and V (37%). However, this must be interpreted with caution owing to use of the Register General for Scotland classification criteria (SES) [14], which may not confer the same social or economic status in Swedish society. Nevertheless, analysis showed high correlation between parental SES occupational classification and parental educational attainment level (using ISCED [13]), which is a commonly accepted socio-economic measure in Sweden [12]. The fact that children from more deprived backgrounds were found to have a lower risk of fluorosis confirms the association found in other studies [24,29], albeit the reasons are not entirely clear. However, the loss of significance in the logistic regression analysis (Table IV) demonstrates that socio-economic status, as expected, is not independently associated with fluorosis, but is confounded by the other risk factors, such as oral health behaviors. Indeed, it is well documented that parents from more affluent backgrounds, or with higher levels of education, are more likely to comply with professional advice in caring for their young children; importantly, in this case, advice on tooth-brushing and fluoride supplement use [30]. However, this study failed to identify which factors were particularly important. Higher socio-economic status is also linked to higher income, which has been shown to affect ability to access both oral health products and dental services in Sweden [31].

This study did not discover that any particular source of fluoride exposure was a risk factor for fluorosis prevalence or severity. Most studies find one or two risk factors to be significantly associated with fluorosis and give them much weight, in terms of clinical importance, despite the problems associated with the reliability of recall questionnaires described earlier [32]. However, dental fluorosis is more likely, at the population level, to be a result of a combination of the multiple sources of fluoride available [33].

Conclusions

In the non-water-fluoridated area of Halmstad, Sweden, there were low levels of dental fluorosis of esthetic concern. However, half the children had some degree of dental fluorosis, the vast majority being at "very mild" or "mild" levels. The prevalence of dental fluorosis was not explained by the risk factors, including fluoride toothpaste usage as investigated in this study.

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