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Sociodemographic and behavioural correlates of severe dental fluorosis

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Summary. *Objectives.* The aim of this study was to identify sociodemographic and behavioural factors associated with the prevalence of severe dental fluorosis in moderate- and high-fluoride areas of the Ethiopian Rift Valley.
Methods. Three hundred and six adolescents (12–15 years) and 233 mothers participated in the study. The children were examined for dental fluorosis according to the Thylstrup–Fejerskov Index (TFI). The children and their mothers were subsequently interviewed. Sixty mothers had more than one participating child. In order to perform a paired parent/child analysis, a total of 73 younger siblings had to be excluded.
Results. Among the remaining 233 children, the prevalence of severe dental fluorosis (TFI $\geq$ 5) was 24·1% and 75·9% in the moderate- and high-fluoride areas, respectively. According to bivariate as well as multivariate analyses, a number of sociodemographic and behavioural factors were related to severe fluorosis. The odds for having severe fluorosis varied according to the fluoride concentration of the drinking water, age, consumption of tea, length of breastfeeding and method of storing water. The adjusted odds ratios ranged from 2·6 to 26·1. Breastfeeding for > 18 months and the use of clay pots for storing drinking water helped protect against severe dental fluorosis. Bivariate analyses indicated that being male and consuming fish might be associated with higher TFI scores.
Conclusion. In order to avoid dental fluorosis, low-fluoride drinking water should be provided in the relevant villages. A prolonged period of breastfeeding, the use of clay pots for storing water, and possibly a reduced intake of tea and whole fish in infants might also help to avoid severe fluorosis in children growing up in traditionally fluoride-endemic areas.

Introduction

Dental fluorosis is caused by excessive intake of fluoride during the period of enamel formation, which occurs roughly during the first 10 years of life [1–4]. At the time of tooth eruption, fluorotic enamel exhibits a continuum of clinical features ranging from white opaque lines to entirely chalky white enamel [2,5,6]. The milder degrees of severity may regress as a result of enamel abrasion [3,6–8] or continuous mineralization [6–9]. At higher levels of severity, when teeth erupt with a chalky white appearance, the hypomineralized enamel [2,6] may chip off (especially at the incisal edges and cusps) or develop pits because of posteruptive trauma [3,6,10]. In this way, posteruptive enamel damage may explain the commonly reported increase in the severity of dental fluorosis with age in adolescents [11,12].

High-fluoride drinking water is normally considered to be the major source of ingestible fluoride [13,14]. However, apart from water with a high fluoride content, a number of fluoride sources have been identified as risk factors for dental fluorosis, including: fluoride in dietary supplements [7,15,16], in food and beverages, infant formulas with and without fluoridated water [15,17], fluoride-containing dentifrices [17], mouth rinses [4], and gels [18].

The relationship between the fluoride concentration in drinking water and dental fluorosis has been studied around the world, and a number of reports have discussed the African context [19–21]. Notably, recent papers have reported a high prevalence of dental fluorosis even in areas with a low fluoride

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content (< 0·5 mg/L) in the drinking water [19,22–25]. These findings have been partly ascribed to food habits such as the consumption of tea [26,27] and the use of fluoride-containing trona (*magadi*) [28–30]. Furthermore, demographic factors such as altitude of residence have been considered [31,32].

Dental fluorosis is endemic in Ethiopia [20,33] and drinking water is the major source of fluoride [20,33,34]. However, there is a lack of knowledge concerning other influential factors. The purpose of this study was to identify sociodemographic and behavioural factors associated with the prevalence of severe dental fluorosis in children exposed to drinking water with moderate- and high-fluoride concentrations.

Subjects and methods

Study area

The study was conducted in 1997 in the Wonji Shoa Sugar Estate (WSSE), which covers 5000 ha in an irrigated sugar cane plantation in the Ethiopian Rift Valley. The area is known for endemic fluorosis [33]. The estate has 30 000 inhabitants and is organized in two factory and 14 plantation villages referred to alphabetically by letters from A to N. The WSSE provides free housing, including a water supply (from drilled wells) and electricity, as well as medical service to employees and their families.

Three villages were selected for the present study, based on the fluoride concentration in the drinking water supply: Villages A and M with moderate-fluoride drinking water and village K with a high level. The villages were of approximately the same size and had populations of comparable socioeconomic status. According to the most recent information from the medical service of the WSSE, the level of fluoride in the drinking water ranged between 0·3 and 2·2 mg/L in villages A and M (referred to as the moderate-fluoride area), and 10 and 14 mg/L in village K (the high-fluoride area).

Study population and procedures

The study population included all children aged 12–15 years (census) who were lifetime residents of plantation villages A, M and K (moderate-fluoride and high-fluoride areas), as well as the children's mothers. A total of 306 children and 233 mothers completed structured interviews administered in the field by trained researchers [34]. An equal number of boys and girls participated. Mean age was slightly higher in girls than boys (13·5 vs. 13·1 years, respectively).

In the present study, children were paired with their parents (mothers). In the paired parent/child analyses, however, a total of 73 adolescents (younger siblings) had to be excluded since 60 mothers had more than one participating child. Each parent was paired with the eldest child. Thus, the number of family units was 233: 152 from moderate-fluoride area and 81 from high-fluoride area.

The children were exposed to a written questionnaire, constructed in English and translated into the local language. For control purposes, the questionnaire was translated back into English. Trained local interviewers administered the interviews, which took part before the clinical examination of the children. The mothers were interviewed in separate rooms while the children underwent a dental examination.

Separate questionnaires were used for the interview of the children and the mothers. The children were asked to verify the source of water used for domestic purposes and relevant sociodemographic factors. The mothers were asked questions relating to length of residency in the area, start and duration of (possible) use of fluoride supplements, use of fluoride toothpaste, oral hygiene habits and storage of water. Information on the frequency of intake of various beverages, history of breast- and baby bottle feeding, as well as previous and present diet was also requested from the mothers.

Measures

Sociodemographic characteristics included father's occupational status (field/factory worker vs. temporarily employed daily labourer); and family income level per month: < 100 Ethiopian Birr (low); 101–300 Birr (medium); and > 300 Birr (high). Age at last birthday was dichotomised into (1) 12 years and (2) 13–15 years in order to get closer to a 50% cut-off point between the two categories. Tea consumption was assessed as daily use of tea versus tea served seldom or never. The dietary use of fish was categorized into use of fish meat/fillet only, use of meat/fillet and bone, and fish not eaten at all. Breastfeeding was recorded as being practised from birth to less than 18 months versus breastfeeding for more than 18 months. For storage of water, the questionnaire distinguished between clay pots and metal/plastic containers.

The agreement between the mother's and the children's answers was tested as to father's occupational status. Cohen's kappa (κ) was similar in both age groups: 0·36 for 12-years-olds and 0·35 for 13–15-year-olds, which was within the interval of fair value [35]. These results allowed employment of father's occupational status as reported by their children.

Clinical examination

Informed consent to participate in the clinical examination was obtained from parents and community leaders. Intraoral examination was conducted at the health centre of each village by two examiners (W.F. and A.B.), each with an assistant recording the observations. Dental fluorosis was assessed on buccal, occlusal and lingual surfaces in accordance with the Thylstrup–Fejerskov Index (TFI) [2]. After an initial cleaning of teeth by use of gauze, the dentition was inspected using disposable dental mirrors and probes. Illumination was by indirect sunlight and headlamp.

Except for third molars, all partly or fully erupted teeth were examined. A median TFI score was constructed for each individual based on the highest TFI score on each permanent tooth scored. For this study, each individual had a median TFI score > 0. The severity of fluorosis was assessed as: (1) median TFI score < 5; and (2) median TFI score ≥ 5.

Children's teeth were grouped according to eruption age, i.e. early erupting (12 teeth; incisors and first molars) and late-erupting (16 teeth; canines, premolars and second molars). Individual TFI scores were constructed for early erupting and late-erupting teeth, based on the median score of teeth in that tooth group. Ten subjects were re-examined by both examiners for intraexaminer agreement, and furthermore, another 10 subjects were re-examined for interexaminer agreement. The intraexaminer agreement was, respectively, κ = 0·79 and 0·86, while interexaminer agreement for TFI scores was 0·82. These values are considered substantial to almost perfect, according to the scale of Landis and Koch [36].

Statistical analysis

The SPSS for PC, Version 10·0, computer program was used in the analysis. Bivariate analyses were performed using cross-tabulation, chi-square statistics and one-way analysis of variance. The Mann–Whitney *U*-test and Kruskal–Wallis test were used when comparing severity according to selected independent variables. Multiple logistic regression analysis was used to estimate the risk for severe dental fluorosis, calculating odds ratio (ORs) and 95% confidence interval (CI). Collinearity between the independent variables was checked by means of the variance inflation factor (VIF), using x_i as the dependent variable in regression on the other independent variables. All analyses are based on the total number of participating mother/child pairs ($n = 233$).

Results

Table 1 depicts the percentage distribution of sociodemographic characteristics, eating habits and household practices according to participants' place of residence. The gender distribution was 45·4% boys in the moderate-fluoride area, versus 64·2% in the high-fluoride area. The corresponding rates for girls were 54·6% and 35·8% ($P < 0·006$). Most of the participants belonged to the 13–15-year-old age group both in the moderate- and high-fluoride area ($P < 0·05$). Daily tea consumption and intake of fish (meat/fillet and bone) were most common in the high-fluoride area, whereas breastfeeding beyond 18 months was most common in the moderate-fluoride areas.

Table 2 depicts the results from the Kruskal–Wallis test and Mann–Whitney *U*-test in terms of the median distribution of TFI scores for all teeth; early and late-erupted teeth by sociodemographic and behavioural characteristics. With respect to all teeth, the median TFI scores were significantly higher in the high-fluoride area as compared to the moderate-fluoride area ($P < 0·001$). The significant differences by age was confirmed by the distribution based on the median TFI score for all teeth, as well as for the early and late-erupting teeth ($P < 0·001$). Significant difference by gender was observed based only on the median TFI score on all teeth and the early erupted teeth ($P < 0·05$). Significantly higher median TFI scores were also observed among consumers of tea (daily) and fish (meat/fillet and bone), as compared to their counterparts who did not confirm those consumption patterns ($P < 0·05$). Moreover, breastfeeding for < 18 months was associated with higher TFI scores as compared to those who

Table 1. Distribution of children's sociodemographic characteristics and eating habits by area of residence (%).

Variable	Moderate-fluoride area ($n = 152$)	High-fluoride area ($n = 81$)	Total ($n = 233$)
Age (years):			
12	67 (44·1)	25 (30·9)	92 (39·5)
13–15	85 (55·9)	56 (69·1)*	141 (60·5)
Gender:			
male	69 (45·4)	52 (64·2)*	121 (51·9)
female	83 (54·6)	29 (35·8)	112 (48·1)
Tea consumption:			
drink/daily	60 (39·5)	50 (61·7)**	110 (47·2)
seldom/never drink	92 (60·5)	31 (38·3)	123 (52·8)
Fish consumption:			
meat/fillet	130 (85·5)˙	51 (63·0)	181 (77·7)
meat/fillet and bone	7 (4·6)	23 (28·4)*	30 (12·9)
do not eat	15 (9·9)	7 (8·8)	22 (9·4)
Breastfeeding (months):			
0–18	50 (32·9)	39 (48·1)	89 (38·2)
> 18	102 (67·1)	42 (51·9)*	144 (61·8)
Storage of water:			
clay pots	25 (16·4)	23 (28·4)*	48 (20·6)
plastic, metallic	127 (83·6)	58 (71·6)	185 (79·4)
Father's occupation:			
field/factory worker	109 (71·7)	58 (71·6)	167 (71·7)
others/daily labourer	43 (28·3)	23 (28·4)	66 (28·3)
Monthly income (Birr):			
< 100 (low)	26 (17·1)	20 (24·7)	46 (19·7)
101–300 (medium)	96 (63·2)	54 (66·7)	150 (64·4)
> 301 (high)	30 (19·7)	7 (8·6)	37 (15·9)

*$P < 0·05$, **$P < 0·001$.

Table 2. Median Thylstrup–Fejerskov Index (TFI) scores (first and third quartiles) in all teeth, early erupted teeth and late erupted teeth by sociodemographic and behavioural characteristics ($n = 233$).

		Median TFI score (first quartile; third quartile)		
Variable	Number	All teeth	Early erupting teeth	Late erupting teeth
Area of residence:				
moderate fluoride	152	2·0 (1·0; 3·0)	1·5 (1·0; 3·0)	2·0 (1·0; 4·0)
high fluoride	81	5·0 (4·0; 5·0)**	4·5 (4·0; 5·2)**	5·0 (4·5; 5·5)**
Age (years):				
12	92	2·0 (1·0; 4·0)**	1·5 (1·0; 3·0)**	2·0 (1·0; 4·0)**
13–15	141	4·0 (1·5; 5·0)	4·0 (1·5; 4·5)	4·0 (2·0; 5·0)
Gender:				
male	121	3·0 (1·5; 5·0)*	3·0 (1·0; 5·0)*	4·0 (2·0; 5·0)
female	112	2·5 (1·0; 4·5)	2·0 (1·0; 4·0)	3·0 (1·5; 5·0)
Breastfeeding (months):				
0–18	89	4·5 (2·0; 5·0)**	4·5 (1·5; 5·5)**	5·0 (2·0; 5·0)**
> 18	144	2·5 (1·0; 4·0)	2·0 (1·0; 4·0)	3·0 (1·5; 4·3)
Tea consumption:				
drinks tea/daily	110	4·5 (1·5; 5·0)**	4·0 (1·3; 5·0)**	4·5 (2·0; 5·0)**
seldom/never drink	123	2·5 (1·0; 4·0)	2·0 (1·0; 3·5)	3·0 (1·5; 4·5)
Fish consumption:				
meat/fillet	181	3·0 (1·0; 4·5)	2·0 (1·0; 4·5)	3·5 (1·5; 5·0)
meat/fillet and bone	30	4·5 (3·7; 5·1)*	4·5 (2·8; 5·5)*	5·0 (4·0; 5·1)*
do not eat	22	2·5 (1·0; 3·6)	2·0 (0·8; 3·0)	3·0 (1·0; 4·2)
Storage of water:				
clay pots	48	1·5 (1·0; 4·3)	1·5 (0·6; 4·0)	2·0 (1·1; 5·0)
metallic/plastic	185	3·0 (1·5; 5·0)*	3·0 (1·0; 4·5)*	4·0 (2·0; 5·0)*

*$P < 0·05$, **$P < 0·001$.

Table 3. Result of logistic regression for severe dental fluorosis based on the median for the whole dentition. The dependent variable is categorized as: (0) median Thylstrup–Fejerskov Index (TFI) score < 5; and (1) median TFI score ≥ 5.

Independent variable	Number	Odds ratio	Ninety-five per cent confidence interval	Median TFI score ≥ 5 [% (*n*)]
Area of residence:				
moderate fluoride	152	–	–	24·1 (19)
high fluoride	81	26·1	10·3–66·0	75·9 (60)
Age (years):				
12	92	–	–	25·3 (20)
13–15	141	2·6	1·1–6·0	74·7 (59)
Gender:				
male	121	0·9	0·4–2·1	60·8 (48)
female	112	–	–	39·2 (31)
Breastfeeding (months):				
0–18	89	4·7	2·4–9·4	63·3 (50)
> 18	144	–	–	36·7 (29)
Tea consumption:				
drinks/daily	110	3·6	1·5–8·6	69·6 (55)
seldom/never drink at all	123	–	–	30·4 (24)
Fish consumption:				
meat/fillet	181	0·8	0·2–2·8	70·9 (56)
meat/fillet and bone	30	1·2	0·3–4·0	24·1 (19)
do not eat	22	–	–	5·1 (4)
Storage of water:				
clay pots	48	–	–	17·7 (14)
metallic/plastic	185	2·9	1·1–7·9	82·3 (65)
Father's occupation:				
field/factory worker	167	–	–	70·9 (56)
others/daily labourer	66	1·1	0·4–3·0	29·1 (23)
Monthly income (Birr:				
< 100 (low)	46	0·3	0·1–1·2	16·5 (13)
101–300 (medium)	150	2·4	0·8–7·1	74·7 (59)
> 301 (high)	37	–	–	8·9 (7)

confirmed breastfeeding beyond 18 months. A significantly lower median TFI score was also found when clay pots were used for water storage ($P < 0{\cdot}05$).

In the moderate-fluoride area, a total of 24·1% of all teeth had median TFI scores ≥ 5 versus 26·1% and 33·0%, respectively, in the group of early and late-erupting teeth. The corresponding figures in the high-fluoride area were 75·9%, 73·9% and 67·0% ($P < 0{\cdot}001$). Severity of dental fluorosis (TFI score ≥ 5 vs. TFI score = 0–4) was regressed on all sociodemographic and behavioural variables presented in Table 1, using multiple logistic regression analysis. Being a resident of a high-fluoride area, in the 13–15-year-old age range, breastfed for < 18 months, taking tea daily and storing water in metallic/plastic containers were associated with higher odds for having a TFI score ≥ 5. The adjusted ORs ranged from 2·6 to 26·1 (Table 3).

Table 4 shows the results of multiple logistic regression analysis with median TFI scores ≥ 5 regressed on sociodemographic and behavioural characteristics separately for early and late-erupting teeth. In early erupting teeth, being a resident of high-fluoride area, breastfed for < 18 months, taking tea daily and storing water in metallic/plastic containers were associated with higher odds of having a TFI score ≥ 5. The adjusted ORs were in the range of 2·3–14·3. In the late-erupting teeth, being a resident of a high-fluoride area, in the 13–15-year-old age range, taking tea daily and storing water in metallic/plastic containers were associated with higher odds of having a TFI score ≥ 5. The adjusted odds ratios were in the range of 1·8–17·6 (Table 4).

To check for collinearity (correlation among the predictors in multiple regression), breastfeeding was regressed on moderate- and high-fluoride areas, and other independent variables. The VIF and/or tolerance values ranged from 1·6 to 5·1. Because the value of the VIF was below 10, collinearity was regarded as of no concern [37].

Table 4. Result of logistic regression for severe dental fluorosis. The dependent variable (early and late erupting teeth) is categorized as: (0) median Thylstrup–Fejerskov Index (TFI) score < 5; and (1) median TFI score ≥ 5. Abbreviations: (OR) odds ratio; and (95% CI) 95% confidence interval.

		Early erupting teeth		Late erupting teeth	
Independent variable	Number	OR	95% CI	OR	95% CI
Area of residence:					
moderate fluoride	152	–	–	–	–
high fluoride	81	14·3	6·2–32·8	17·6	7·0–43·8
Age (years):					
12	92	–	–	–	–
13–15	141	1·8	0·7–4·3	2·7	1·2–5·9
Gender:					
male	121	0·9	0·4–2·0	0·6	0·3–1·3
female	112	–	–	–	–
Breastfeeding (months):					
0–18	89	3·3	2·0–11·6	2·0	0·5–8·6
> 18	144	–	–	–	–
Tea consumption:					
drinks/daily	110	2·3	1·0–5·2	1·8	1·0–3·2
seldom/never drink at all	123				
Fish consumption:					
meat/fillet	181	1·1	0·3–3·3	0·5	0·1–1·7
meat/fillet and bone	30	0·8	0·2–2·6	1·7	0·5–5·2
do not eat	22	–	–	–	–
Storage of water:					
clay pots	48	–	–	–	–
metallic/plastic	185	3·6	1·3–9·6	3·5	1·2–9·7
Father's occupation:					
field/factory worker	167				
others/daily labourer	66	1·0	0·4–2·4	1·5	0·6–3·5
Monthly income (Birr):					
< 100 (low)	46	0·4	0·1–1·3	0·4	0·2–1·5
101–300 (medium)	150	1·7	0·5–5·3	2·1	0·7–5·5
> 301 (high)	37				

Discussion

The subjects participating in this study belonged to different but closely related Ethiopian tribes. Lifestyle and standard of living were similar for all participants. Ethnicity, which may play a role in the development of dental fluorosis [38], does not seem to be a relevant factor in the present study.

The predominant source of fluoride, and thereby, the main cause for dental fluorosis in the East African Rift Valley, is high-fluoride drinking water [20,33]. According to a recent multi-element analysis [39], of 138 groundwater sources in the Ethiopian Rift Valley, 60% of the wells provided water with fluoride concentrations of ≥ 0·7 mg/L, while 33% contained water with a fluoride content above 1·5 mg/L, which, according to the World Health Organization, should be an upper 'safe level' [40].

Since alternative sources of adequate drinking water are scarce or nonexistent in these arid areas, defluoridation of high-fluoride waters is needed if dental and skeletal fluorosis is to be avoided in the future. Until now, however, the available technology has proved too expensive or too complicated to be of great practical use in rural Ethiopia. It is of interest to note that simple technology based on indigenous soils may be used to remove excessive fluoride in potable water [41].

Over 90% of the children examined in the villages with moderate- and high-fluoride water showed signs of dental fluorosis. The severity of enamel changes was strongly influenced by the fluoride concentration of the water. Thus, the individual median TFI score in the villages with a moderately high fluoride concentration in the drinking water was 2·0 versus 5·0 in the village with high-fluoride water.

Similarly, the prevalence of severe fluorosis (TFI score ≥ 5) was significantly higher in the high-fluoride area than in the area with a moderate-fluoride concentration in the water (Table 3). Subjects in the high-fluoride area were, in fact, 26 times more likely to develop severe fluorosis than were children in the moderate-fluoride area.

Statistical evaluation of these findings showed that significant associations existed between severe fluorosis (TFI score ≥ 5) and age. No systematic change in the fluoride content of the relevant water sources had taken place over the years [42], and in all probability, the recorded age-related increase in severity was caused by progressive wear and tear of fluorosed enamel. Thus, the more severe fluorosis found in the older children is an indirect consequence of fluoride ingestion, which is in accordance with previous findings [42]. According to the results (Table 3), area of residence is the main statistically significant risk factor. This should be expected since the inhabitants of the different villages depended upon local wells of different fluoride concentrations for drinking water.

Some additional factors were found to be of importance for the development of dental fluorosis. These were consumption of tea and (possibly) fish, duration of breastfeeding, and the containers used for storage of drinking water. Control of these factors can be a practical and inexpensive approach in the prevention of severe fluorosis.

The tea plant is known to accumulate fluoride [43,44], which is easily released into water. Tea production is important in Ethiopia, and the tea made from locally produced tea leaves and fluoride-free water may contain more than 2·0 mg/L fluoride [44]. In a previous study in Ethiopia, Olsson [27] found that, in an area with low-fluoride water (0·2–0·3 mg/L), consumption of tea accounted for 18% of the observed (very mild) dental fluorosis. According to the present authors' findings, tea is consumed daily by about half of the children investigated. Both bivariate and multivariate analyses indicated that a daily intake of tea was a significant factor in the development of dental fluorosis in the examined children from WSSE villages. Under the present conditions, avoiding tea drinking during the first years of life might not stop the development of dental fluorosis, but it would help to reduce its severity.

A string of 'alkali lakes' are found in the Ethiopian Rift Valley. Some of the lakes are rich in fish like tilapia and Nile perch. Fishing is also popular in the Awash River, which runs through the WSSE area. The fluoride content of fish may vary according to the nature of the water, the type of fish and the various tissues of the fish [45]. The highest fluoride concentration is found in bone, and according to Berg and Haug [46], the fluoride content in African freshwater species is positively related to the weight. In bivariate analysis, a significant association was found between intake of fish and the prevalence of severe fluorosis. However, this relation was not verified in the logistic regression analysis.

The fluoride content of human milk is very low; approximately 0·01 mg/L [18], and seems to be very little influenced by the fluoride concentration of the water consumed by mothers [47]. For many reasons, breastfeeding of infant children is highly recommended by paediatricians [48]. During the first one or 2 years of life, which coincide with the period of most active enamel formation, breastfeeding would seem to provide the ideal prevention of fluorotic damage to teeth. According to Tessema and Hailu [49], prolonged breastfeeding is common in low-income countries. This is confirmed by this study, which found a mean duration of breastfeeding of 24 months. Similar results have also been reported from other parts of Ethiopia [49,50]. According to the findings, a prolonged period of breastfeeding actually protects against dental fluorosis, and consequently, children who had been breastfed for less than 18 months were at greater risk of developing severe dental fluososis (TFI score ≥ 5) compared to children who had been breastfed for ≥ 18 months. Similar findings have been reported by Brothwell and Limeback [51]. Two variables are said to be collinear if they are approximately (or exactly) linearly dependent, or in other words, if there is a high correlation between the two variables. For this reason and diagnostic purpose, the presence of collinearity variance inflation factor has been used in the multiple regressions. When breastfeeding was regressed on other independent variables, the value of the VIF was below 10, and as such, collinearity was regarded as of no concern [37].

In a study by Hauge *et al*. [52], simple pottery (clay pots) were shown to remove fluoride from high-fluoride water. An interesting finding in the present study was that children who were brought up in households using clay pots for storage of the daily water supply were less prone to develop severe dental fluorosis. To the authors' knowledge, this is the first time a relationship has been demonstrated between the clinical symptoms of dental fluorosis and the use of clay pots for water storage.

The fluoride-binding capacity of various clays varies greatly. According to a recent study by Bjorvatn *et al*. [41], red, lateritic clays from the central part of Ethiopia are well suited for the removal of excessive fluoride in drinking water. Practical application of this finding could mean a return to traditional methods of African storage of water, which should be tested out at a household/community level.

It has been indicated (e.g. by Fejerskov *et al*. [53]) that dental fluorosis is more severe in late-erupting than in early erupting teeth. The findings of this study confirm this observation.

What this paper adds

- The odds of having severe dental fluorosis varied according to the fluoride concentration of the drinking water, age, consumption of tea, length of breastfeeding and method for storage of drinking water.

Why this paper is important for paediatric dentists

- Even in areas with high-fluoride drinking water, prolonged breastfeeding and the use of clay pots for water storage may reduce the severity of dental fluorosis.

Conclusions

Breastfeeding for 18 months or more may protect children from developing severe dental fluorosis in the early erupting teeth. More severe fluorosis in older age may be partly explained by age-related wear and tear of fluorotic enamel. A significant decrease in the severity of dental fluorosis has been observed to be related to the consumption of water in clay pots. Since clay pots can be made at low cost with simple technology and from locally available components, their production and use should be encouraged.

Future study should make an in-depth investigation of the effects of ingestion of tea and fish during the tooth formation period. Furthermore, more soils should be collected and tested to identify the best material for fluoride removal. This is particularly important for areas of endemic fluorosis such as the Ethiopian Rift Valley.

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