PREVALENCE, SEVERITY AND FACTORS ASSOCIATED WITH DENTAL FLUOROSIS AMONG CHILDREN AGED 8-10 YEARS IN BANGKOK, THAILAND

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Abstract. This study aimed to evaluate the prevalence and factors associated with dental fluorosis in permanent incisors among children aged 8-10 years in Bangkok, Thailand. We studied 707 children selected by stratified randomization and examined each of them to determine their Dean's fluorosis index. Parents of the studied children were asked to fill out a questionnaire. The study was conducted from July to October 2014. Chi-square test and multiple logistic regression analysis were used to study the association between various factors and fluorosis among study subjects. Dental fluorosis was found in 18.4% of subjects. Sixteen point one percent and 2.3% of 707 subjects had very mild fluorosis and mild fluorosis, respectively. Factors significantly associated with dental fluorosis were family income (aOR=1.77; 95% CI: 1.10-2.86, p=0.02) and history of taking fluoride supplements (aOR=1.66; 95% CI: 1.07-2.61, p=0.03). This study indicated that the prevalence of fluorosis had increased in Bangkok, but the majority was very mild level.

Keywords: dental fluorosis, fluorosis index, associated factors, permanent incisors, children

INTRODUCTION

Dental fluorosis is a developmental disturbance of enamel, associated with excessive ingestion of fluoride during tooth development (Fejerskov and Denbesten, 1996). Mild dental fluorosis is characterized by bilateral, diffuse, opaque and white striations that run horizontally across the enamel following perikymata, cuspal snow capping and a snow flaking appearance (Fejerskov and Denbesten, 1996). In more severe forms, enamel may become discolored and/or pitted (Fejerskov and Denbesten, 1996). The optimal level for daily fluoride intake is 0.05 to 0.07 mg F/kg/day (Burt, 1992). Above this level, there is an increased risk of developing dental fluorosis (Burt, 1992). Excessive fluoride ingestion before age 3 to 4 years increases the risk of fluorosis in permanent dentition, particularly the incisors (Hong *et al*, 2006).

The greatest risk factor associated with dental fluorosis is the total amount of fluoride consumed from all sources during the critical period of tooth development (Aoba and Fejerskov, 2002). Fluoride can be found in water and food but the

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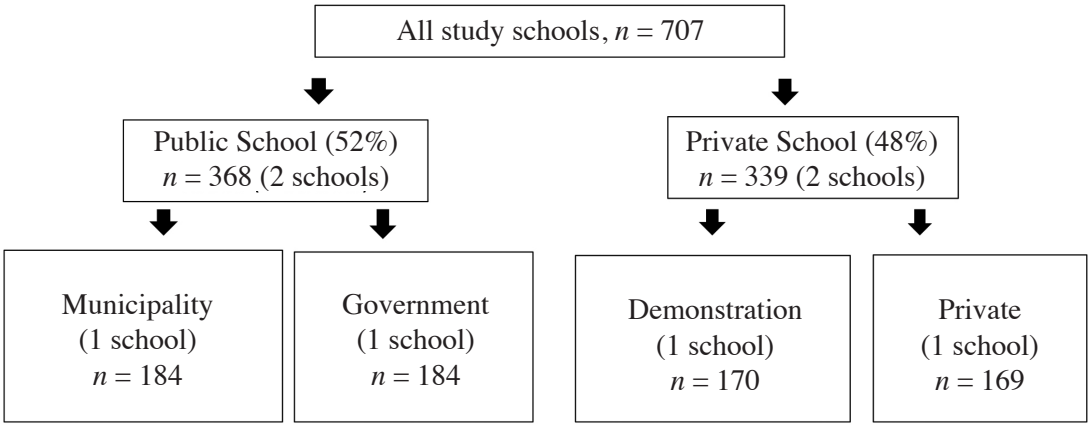

Fig 1–Selection of study subjects.

sources of fluoride intake in areas with no fluoridated water are fluoride dentifrice and fluoride supplements (Pendrys, 2000). The city water in Bangkok, Thailand has no added fluoridation and has a fluoride concentration less than 0.3 ppm (Ministry of Public Health, 2008). However, the prevalence of dental fluorosis has been increasing in Bangkok. The prevalence of dental fluorosis for children aged 12 years in Bangkok increased from 8.8 to 12.3% between 2008 and 2012 (Ministry of Public Health, 2008; Bureau of Dental Health, 2012). However, most cases of dental fluorosis in Bangkok are very mild (Ministry of Public Health, 2008; Bureau of Dental Health, 2012). Few studies have evaluated factors related to dental fluorosis in Bangkok, Thailand.

In this study we aimed to determine the prevalence, severity and factors associated with dental fluorosis among children aged 8-10 years living in Bangkok, Thailand.

MATERIALS AND METHODS

Study population

We carried out a cross sectional study of 707 children aged 8-10 years in Bangkok, Thailand during July-October 2014. The needed sample size was calculated with the formula $(N = Z_{\alpha/2})^2\ pq/d^2$; where d = estimated margin of error = 0.02, p = proportions of dental fluorosis = 0.08, estimated from the prevalence of dental fluorosis study in Bangkok which showed approximately 8.8% (Bureau of Dental Health, 2012), q = 1-p = 0.92. Sample size estimation was performed under the assumption that type I error (α) was 0.05, α = probability of type I error = 0.05, $Z_{\alpha/2}$ = 1.96. The required sample size was 707 children.

The target population included both public and private schools; as the ratio of public to private school students in Bangkok is 52:48 (Bureau of Information and Communication Technology, 2011). We followed the same ratio in our study subjects. We used stratified cluster sampling to select subjects (Fig 1). The study was approved by Faculty of Dentistry/ Faculty of Pharmacy, Institutional Review Board, Mahidol University, Thailand. Inclusion criteria were children aged 8-10 years who had permanent central and lateral incisors and had lived in Bangkok since they were

Table 1
Prevalence and severity of dental fluorosis.

Dental fluorosis status	*n* (%)
Normal or questionable fluorosis	577 (81.6)
Fluorosis	130 (18.4)
Very mild	113 (16.1)
Mild	17 (2.3)
Total	707 (100)

born. Children with orthodontic appliances, a history of restoration for a crown fracture, enamel defects such as enamel hypoplasia, molar incisor hypomineralization (MIH) or who were uncooperative were excluded from the study.

Data collection

Three dentists were trained in fluorosis scoring. Before dental examination, the examiner standardizations were performed at the Pediatric Dentistry Clinic, Mahidol University. The inter-examiner reliability was evaluated by examining a group of 8-10 year-old children. The dentists examined the same 10 children, and compared the individual scores with "gold standard" examiner, who previously trained and routinely uses the Dean's fluorosis criteria. The inter-examiner reliability was good (Kappa = 0.85). At each examination visit, each trained dentist randomly examined 10% of children repeatedly to evaluate the intra-examiner reliability. The Kappa value was 0.91 for intra-examiner reliability.

The teeth were brushed and dried with gauze before examining with a LED light. Dental fluorosis was classified using the modified Dean's Index (Dean,1954) by combining normal and questionable levels. Normal (Fig 2) was defined as smooth, glossy, pale creamy-white translucent surface (score = 0). Very mild fluorosis (Fig 3) was defined as the enamel discloses slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots (score = 2). Mild fluorosis (Fig 4) was defined as small opaque, paper white areas scattered irregularly over the tooth but not involving as much as 25% of the tooth surface (score = 3). Moderate level was defined as the white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50% of the tooth as all enamel surfaces of the teeth are affected, and the surfaces subject to attrition show wear. Brown stain is frequently a disfiguring feature (score = 4). All enamel surfaces are affected and hypoplasia is so marked that the general form of the tooth may be affected. The major diagnostic sign of this classification is discrete or confluent pitting. Brown stains are widespread and teeth often present a corroded-like appearance (score = 5).

The questionnaire filled out by 20 parents in our study was first tested in a pilot study. The reliability of the questionnaire was good (kappa = 0.88).

Data analysis

The data were analyzed with the Statistical Package for Social Science (SPSS, version 18; IBM, Armonk, NY). Ninety-

Fig 2–Definition of a normal tooth. Smooth, glossy, pale creamy-white translucent surface.

Fig 3–Definition of very mild fluorosis. White opaque areas scattered irregularly but not involving 25% of the tooth surface.

Fig 4–Definition of mild fluorosis. White opaque areas are more extensive but do not involve 50% of the tooth.

five percent confidence interval (95%CI), chi-square tests and logistic regression analyses were used to assess differences in dental fluorosis and the factors associated with it. Multivariable regression was used for adjusting variables including fluoride supplement, gender, family income, drinking water, parent brushing for a child, brushing frequency and age beginning toothpaste use. Significance was set at $p < 0.05$.

RESULTS

Seven hundred seven children were included in the study. The mean age of study subjects was 8.8 (SD± 0.6) years. Fifty-nine point five percent of subjects were female. Three hundred sixty-eight subjects (52.1%) were from public schools and 339 (47.9%) were from private schools.

The prevalence of dental fluorosis among study subjects was 18.4% (n=130). The severity of fluorosis was shown in Table 1. A significantly (p=0.01) higher prevalence of fluorosis was found among subjects from private schools (11.2%) than public schools (7.4%).

The return rate of the questionnaire was 83.0%. The majority of parents who answered the questionnaire comprised mothers (70.9%) with mean age 42.07 (SD± 5.82) years. Factors significantly associated with dental fluorosis were family income (p=0.02) and history of fluoride supplement consumption (p=0.03). No association with fluorosis was found for gender, parental education level, kind of drinking water consumed, tooth brushing rate or use of fluoridated toothpaste prior to age 2 years (Table 2).

DISCUSSION

In this study we determined the

Table 2
Factors associated with dental fluorosis.

Factors	Fluorosis *n* (%)	No fluorosis *n* (%)	Crude OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Gender								
Male	48 (36.9)	238 (41.2)	1.0		0.36	1.0		0.70
Female	82 (63.1)	339 (58.8)	1.2	0.81-1.78		0.92	0.60-1.41	
School								
Public	52 (40.0)	316 (54.8)	1.0		0.01			
Private	78 (60.0)	261 (45.2)	1.8	1.23-2.68				
Monthly family income in Baht								
≤ 30,000	32 (27.1)	174 (37.1)	1.0		0.04	1.0		0.02
> 30,000	86 (72.9)	295 (62.9)	1.58	1.01-2.48		1.77	1.10-2.86	
Parental education level								
≤ Bachelor 's degree	86 (72.9)	326 (69.5)	1.0		0.48			
> Bachelor's degree	32 (27.1)	143 (30.5)	0.85	0.54-1.33				
Drinking water								
Filtered tap	55 (46.6)	217 (46.3)	1.0		0.84	1.0		0.99
Bottle	56 (47.5)	230 (49.0)	0.96	0.63-1.46		1.0	0.65-1.53	
Other	7 (5.9)	22 (4.7)	1.26	0.51-3.10		1.47	0.57-3.67	
Taking fluoride supplement								
No	32 (27.1)	177 (37.7)	1.0		0.03	1.0		0.03
Yes	86 (72.9)	292 (62.3)	1.63	1.04-2.55		1.66	1.07-2.61	
Brusher								
Child	23 (19.5)	77 (16.4)	1.0		0.43	1.0		0.15
Parent	95 (80.5)	392 (83.6)	0.81	0.48-1.36		0.67	0.36-1.16	
Brushing frequency								
≤ Twice/day	114 (96.6)	428 (91.3)	1.0		0.05	1.0		0.07
> Twice/day	4 (3.4)	41 (8.7)	0.37	0.13-1.04		0.37	0.13-1.07	
Age beginning toothpaste use								
< 2 years old	54 (45.8)	228 (48.6)	1.0		0.58	1.0	0.75-1.71	0.55
2 years old	64 (54.2)	241 (51.4)	1.12	0.79-1.68		1.13		
Who applies toothpaste to toothbrush								
Child	12 (10.2)	68 (14.5)	1.0		0.22			
Parent	106 (89.8)	401 (85.5)	1.5	0.78-2.87				

CI, confidence interval; OR, odds ratio.

prevalence and severity of dental fluorosis among children aged 8-10 years from public and private schools in Bangkok, Thailand. The overall prevalence of dental fluorosis among study subjects was 18.4%, 16.1% with very mild and 2.3% with mild fluorosis. Our findings are similar to the United States and other nations without high levels of naturally-occurring fluoride that the majority of the fluorosis cases were very mild and mild levels (Chankanka *et al*, 2010). No cases of severe degree fluorosis were seen in our study. Community Fluorosis Index (CFI) in the present study was 0.29 which suggests that dental fluorosis is not a major problem in our study population.

In our study, family income and school type were significantly associated with dental fluorosis. Having a higher income could make it easier to purchase fluoride products. Therefore, it is important to educate parents of children in those families about the appropriate use of fluoride products.

One study found children from a family with a higher socio-economic status use more dentifrice on their toothbrushes and spend more time brushing their teeth (Puppin Rontani *et al*, 2002). Another study also found children from private schools had a higher prevalence of dental fluorosis, but they found no direct association with dental fluorosis and family income or parental education (Maltz and Silva, 2001).

In our study, children who used fluoride supplements were significantly more likely to have fluorosis. A systematic review of fluorosis and fluoride supplements found taking fluoride supplements during the first 3 years of life was associated with a significant increase in mild-to-moderate dental fluorosis (Ismail and Hasson, 2008). In our study, there was a significant increasing only very mild and mild fluorosis. Our results differ from those of Eckersten *et al* (2010) who performed a randomized control trial and found introduction of fluoride tablets at age 2 years was not associated with a higher prevalence of dental fluorosis; they suggested dental fluorosis would be due to early introduction of fluoride toothpaste.

Although, Pendrys *et al* (2010) found tooth brushing and use of fluoridated toothpaste at tooth eruption (<2 years old) was associated with dental fluorosis, we did not find this association in our study. Fluoridated toothpaste is a main method of caries prevention in children but should be used under adult supervision.

In conclusion, the prevalence of dental fluorosis among study children aged 8-10 years old in Bangkok was 18.4%. The majority of dental fluorosis cases were very mild. Factors associated with dental fluorosis in our study were family income and history of taking fluoride supplementation.

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