

DENTAL FLUOROSIS AND ITS RELATION TO SOCIOECONOMIC STATUS, PARENTS' KNOWLEDGE AND AWARENESS AMONG 12-YEAR-OLD SCHOOL CHILDREN IN QUETTA, PAKISTAN

Erum Sami¹, Tippanart Vichayanrat² and Pratana Satitvipawee³

¹Department of Community Dentistry, Bolan Medical College, Quetta, Pakistan; ²Department of Community Dentistry, Faculty of Dentistry, Mahidol University, Mahidol University; ³Department of Biostatistics, Faculty of Public Health, Mahidol University, Bangkok, Thailand

Abstract. This study aimed to determine the prevalence of dental fluorosis and its relationship to socioeconomic status, knowledge, and awareness among 12-year-old school children in Quetta, Pakistan. A cross sectional study was conducted among 349 school children aged 12 years in Quetta, Pakistan. By interviewing children and questionnaire for parents, socioeconomic status, knowledge, and awareness of fluorosis were collected. Dental fluorosis was examined using Dean's Index and Community Fluorosis Index. Prevalence of dental fluorosis was high (63.6%) among children with a majority of moderate and mild degree at 32.1% and 27.5%, respectively. The community fluorosis index was 1.6. While most children and parents had low-to-moderate levels of fluorosis knowledge, the majority of them worried about dental fluorosis. Most parents (84.8%) were uncertain about the condition of fluorosis in their children, and 87.4% did not know about fluorosis before. Dental fluorosis was found significantly associated with gender, family income, and parents' awareness ($p \leq 0.05$). Multivariate analysis indicated that gender, and parent's awareness significantly predicted children's dental fluorosis. Knowledge and basic information regarding dental fluorosis is lacking in the community. Efforts in dissemination and communication about dental fluorosis should be increased in order to raise awareness and prevent the dental fluorosis in Pakistan.

Keywords: children, dental fluorosis, fluoride knowledge and awareness, health education, socioeconomic status, Pakistan

INTRODUCTION

Dental fluorosis is a dental condition caused by excessive fluoride exposure

Correspondence: Tippanart Vichayanrat, Department of Community Dentistry, Faculty of Dentistry, Mahidol University, Bangkok 10400, Thailand.

Tel: +66 (0) 2200 7809; Fax: +66 (0) 2200 7808

E-mail: tippanartv@hotmail.com

during tooth development (Wondwossen *et al*, 2003). The communities containing high fluoride concentration in the water were related to higher dental fluorosis in the population (Marino, 2013); however, the other sources, such as toothpaste, beverages, and food, pollution from coal, dental products, and dietary supplements can increase the risk of dental fluorosis (Carey, 2014). The presentation of dental

fluorosis can be mild, as white streaks or spots, or dark brown stains with pitted and rough enamel. When the condition of dental fluorosis is severe, the appearance can cause the esthetic concerns (Jodalli *et al*, 2013). Previous studies found that very mild to mild dental fluorosis did not produce negative perceptions; however moderate or severe dental fluorosis were unacceptable and can be detrimental to dentition (Wondwossen *et al*, 2003; Meneghim *et al*, 2007).

In Pakistan, fluoride in water ranges from 0.03-1.4 ppm in various cities, and dental fluorosis was found in 3%-93% among 12-year-old children (Khan *et al*, 2004). In Quetta, the capital of Balochistan Province, fluoride level in drinking water was 0.91 ppm, above the recommended level, and 67% of 12-year-old children had dental fluorosis (Khan *et al*, 2004). While dental fluorosis is endemic in Pakistan, it is questionable how communities perceive or understand this problem. Knowledge and awareness of dental fluorosis are also important factors to self-prevention and control dental fluorosis. However, these factors among children and their parents have not been explored to our knowledge.

The aims of this study were to determine the prevalence and severity of dental fluorosis in 12-year-old children in Quetta, Pakistan and to assess its relationships to children's and their parent's knowledge and awareness.

MATERIALS AND METHODS

Respondents

Children and parents from Quetta District were randomly selected from both government and private schools: 312 boy schools and 166 girl schools from government schools, and 11 boy schools,

7 girl schools, and 126 mix schools from private schools (Government of Balochistan, 2013). Sample size was calculated using an estimated prevalence of 65% fluorosis in Balochistan and an estimated margin error of 0.05 (Khan *et al*, 2004). The required sample size was 349 children. A stratified two-stage cluster sampling was used to select representative samples from government and private schools, then, students were selected from each school.

Ethical considerations

The Faculty of Dentistry/Faculty of Pharmacy, Mahidol University Institutional Review Board approved this study protocol (MU-DT/PY-IRB 2012/062.2012; 2012 Dec 20). The schools that participated in this study were granted permission from the Education Department, Government of Balochistan. Parents were informed about the objectives, study process, and their right to join the study prior to data collection, and then the written consents were obtained. Children were told about the study and assent forms were signed for their willingness prior to oral examination and questionnaire interview.

Inclusion and exclusion criteria

The 5th and 6th graders who were 12 years old and their parents were invited to participate in this study. Any children who had chronic diseases such as diabetes mellitus, leukemia, and hemophilia, and whose parents did not speak English or Urdu (local language) were also excluded.

Research instrument

Children were interviewed face-to-face, while parents were asked to fill a self-administered questionnaire regarding knowledge and awareness of dental fluorosis. There were seven items for children's knowledge questions. Knowledge

items were scored 1 if the answers were correct. The levels of knowledge were categorized into three levels as low (0-2), moderate (3-5), and high (6-7). There were four items for children's awareness questions: "seeing children in community have dental fluorosis," "knowing or learning about mottled teeth before," "seeing any sign of mottled teeth in your teeth," and "worrying about fluoride might affect your teeth."

The levels of awareness were categorized into three levels as low (4-6), moderate (7-10), and high (11-13). Parent's knowledge and awareness questions were similar to the child's questionnaire, except that one more question on knowledge was added to the parent's questionnaire.

Oral examination was conducted by one investigator (ES). The examiner was trained to assess dental fluorosis using Dean's Fluorosis Index (WHO, 1987) prior data collection. The Community Fluorosis Index (CFI) was calculated and designated as negative (0-0.4), borderline (0.5), slight (0.6-1.0), medium (1.1-2.0), marked (2.1-3.0), and very marked (3.1- 4.0).

Data analysis

Descriptive statistics were used to explain sample characteristics including frequency and percentage distribution of gender, school (government/private), socioeconomic status, educational levels of parents, sources of drinking water, dental fluorosis levels, and CFI. The bivariate relationship between the levels of dental fluorosis and related factors such as parent's knowledge and awareness, dietary factors and access to dental health care facility were analyzed by odds ratios and chi-square test. Logistic regression was used to determine the impact of related variables on dental fluorosis status. The significant variables with *p*-value <0.010

were included in the multivariate model using an enter procedure. The critical significant level was set at 0.05.

RESULTS

Characteristics and fluorosis prevalence of children

Most parents reported drinking water from tube well (99.7%). Among 349 children, 51% were boys, and 71% studied in government schools. About half of parents reported having family income PKR15,000-30,000/ month (approximate USD150-300). Fathers' and mothers' education were mostly primary school (41% and 58.7%, respectively).

Prevalence of dental fluorosis was 63.6% with mostly moderate and mild degree (32.1% and 27.5%, respectively). Community fluoride index (CFI) was 1.6, which indicated a medium level public health problem. General characteristics and fluorosis status of children are shown in Table 1.

Children's and parent's knowledge of fluorosis

Children knew the cause of fluorosis (53.9%), benefit of fluoride (55.6%), benefit of drinking water containing fluoride (45.3%), the appearance of severe fluorosis (50.1%), and the appearance of mild fluorosis (43.8%). Very few children knew that tea containing high fluoride (4.3%) and excessive fluoride in drinking water could cause mottled teeth (1.4%). Most parents knew benefit of fluoride (62.5%), excessive fluoride in drinking water could cause mottled teeth (56.7%), and the appearance of severe fluorosis (60.2%). Few parents knew about tea containing high fluoride (18.9%) (Table 2).

When divided into knowledge levels, 48.7% of the children had low knowledge

Table 1
General characteristics of children and parents (N=349).

Characteristics	n (%)
Gender	
Male	178 (51.0)
Female	171 (49.0)
Type of school	
Government	249 (71.3)
Private	100 (28.7)
Source of drinking water	
Tube well	348 (99.7)
Hand pump	1 (0.3)
Education of father	
<High school	143 (41.0)
High school	146 (41.8)
Bachelor or higher	60 (17.2)
Education of mother	
<High school	205 (58.7)
High school	126 (36.1)
Bachelor or higher	18 (5.2)
Family income per month (PKR) ^a	
<15,000	96 (27.5)
15,000-30,000	179 (51.3)
>30,000	74 (21.2)
Caries	
Yes	81 (23.2)
No	268 (76.8)
Dental fluorosis	
None	127 (36.4)
Very Mild	7 (2.0)
Mild	96 (27.5)
Moderate	112 (32.1)
Severe	7 (2.0)

^aUSD1=PKR 101.

of fluorosis, followed by a high level (32.4%). Nearly half of the parents (49.6%) had moderate knowledge of fluorosis, followed by a low level (32.1%) (Table 3).

Children's and parent's awareness of dental fluorosis

Most children were aware of dental fluorosis in community (93%), and 55%

reported knowing about dental fluorosis. Children learned about fluorosis from teachers, television, and parents (35%, 13%, and 7%, respectively). Children reported seeing fluorosis on their teeth (65%) and were very worried about dental fluorosis (51.3%).

Parents were uncertain about dental fluorosis in the community (84.8 %) and were not sure if their child had mottled teeth (62.8%). Parents reported knowing about fluorosis (13%) from television, their parents, and friends or relatives. Most parents were very worried about mottling of their children's teeth (55.3%) (Table 4).

After dividing into levels, 54.2% of children had high awareness about dental fluorosis followed by moderate awareness (30.7%). Most parents had low awareness about dental fluorosis (51%) followed by moderate awareness (43%) (Table 5).

Relationships between dental fluorosis, socioeconomic status, knowledge, and awareness

Boys were 4 times more likely to have dental fluorosis than girls (95% CI: 2.5-6.4, $p < 0.001$). The children with family incomes of less than PKR30,000 were 1.9 times more likely to have fluorosis than children with higher family income (95% CI: 1.1 – 3.2, $p = 0.014$). Parents with moderate-to-high awareness of fluorosis levels were likely to have children with dental fluorosis (95% CI: 24.4-139.8, $p < 0.001$). No significant relationships were found between school types or parent's education, parent's knowledge, and children's fluorosis status (Table 6).

After logistic regression analysis, being male (aOR=3.1; 95% CI: 1.7-5.8) and awareness of parents (aOR = 55.1; 95% CI: 22.5-134.9) were significantly associated with dental fluorosis status (Table 7).

Table 2
Knowledge of dental fluorosis among children and parents.

Items	Children <i>n</i> (%)	Parents <i>n</i> (%)
1. Fluoride can prevent tooth decay.	188 (53.9)	218 (62.5)
2. Consuming too much fluoride can cause dental fluorosis.	194 (55.6)	198 (56.7)
3. Severe dental fluorosis appears as brown and pitted on tooth surface.	175 (50.1)	210 (60.2)
4. Mild dental fluorosis appears as chalky white strips on tooth surface.	153 (43.8)	147 (42.1)
5. Fluoride in drinking water helps to prevent tooth decay.	158 (45.3)	130 (37.2)
6. Too much fluoride in drinking water can cause mottled teeth.	5 (1.4)	91 (26.1)
7. There are high fluoride levels in tea.	15 (4.3)	66 (18.9)
8. Children swallow fluoride toothpaste can cause fluorosis.	^a	117 (33.5)

^aThis question was not for children.

Table 3
Dental fluorosis knowledge scores and levels among children and parents.

Respondents	Knowledge levels, <i>n</i> (%)			Knowledge scores	
	Low (score 0-2)	Moderate (score 3-5)	High (score 6-8)	Median	Range
Children	170 (48.7%)	66 (18.9%)	113 (32.4%)	3	0-6
Parents	112 (32.1%)	173 (49.6%)	64 (18.3%)	4	0-8

DISCUSSION

Because most children drank water from the tube that contained high fluoride levels, twice higher than recommendation (Khan *et al*, 2004), the high prevalence of dental fluorosis in this study was not surprising. In a study in Egypt (Tezcan *et al*, 2009), the concentration of fluoride in drinking water was successfully reduced by an electrochemical system. No campaign had been launched to attenuate this problem in Quetta until now.

The prevalence of fluorosis among 12-year-old school children in Quetta was 54.2 % in a previous study (Baloch *et al*, 2009). Another study (Khan *et al*, 2004),

also reported in 2004 that 65% of 12-year-old children in Quetta had dental fluorosis, very similar to our study (63.6%). However, the results in the present study showed a higher frequency of moderate fluorosis (32.1%) as compared to 18% in the previous study. This higher trend of dental fluorosis needs to be closely monitored, as it may be related to global climate change (Samal *et al*, 2014).

Boys had more dental fluorosis than girls in this study. The results were similar to other previous studies that dental fluorosis were more prevalent among males (Kadir and Al-Maqtari, 2010; Kotecha *et al*, 2012; Shekar *et al*, 2012). The reasons why boys are more likely to have dental

Table 4
Awareness of dental fluorosis among children and parents (N=349).

Items	Children n (%)	Parents n (%)
Many of children in our community have dental fluorosis		
Disagree	4 (1.1)	11 (3.2)
Uncertain	21 (6.0)	296 (84.8)
Agree	324 (92.8)	42 (12.0)
Know/learn about mottled teeth before		
Disagree	136 (39.0)	305 (87.4)
Uncertain	20 (5.7)	0 (0.0)
Agree	193 (55.3)	44 (12.6)
See any sign of (child's) mottled teeth		
Disagree	121 (34.7)	125 (35.8)
Uncertain	0 (0.0)	219 (62.8)
Agree	228 (65.3)	5 (1.4)
Level of worry among parents /children		
No, not worry	14 (4.0)	104 (29.8)
Not sure /not know	23 (6.6)	36 (10.3)
Yes, a little worry	133 (38.1)	16 (4.6)
Yes, very worry	179 (51.3)	193 (55.3)

Table 5
Dental fluorosis awareness levels and scores among children and parents.

Respondents	Awareness levels, n (%)			Awareness scores	
	Low (score 5-8)	Moderate (score =9)	High (score 10-13)	Median	Range
Children	53 (15.2)	107 (30.7)	189 (54.2)	10	6-13
Parents	178 (51.0)	105 (43.0)	21 (6.0)	8	5-12

fluorosis than girls have was not clear, and the future study is needed to further investigate this observation.

In this study, the family income had inverse relation to children's dental fluorosis status; however, it could not predict fluorosis status as shown in the multivariate analysis. Other studies also found the mix results, that higher socioeconomic status related with higher dental fluorosis, or

vice versa, or no significant different were found, which may due to the influence of local factors in various contexts (Benazzi *et al*, 2012; Pontigo-Loyola *et al*, 2014).

The lack of knowledge about fluorosis in this study suggested that about half of parents knew that consuming excessive fluoride caused dental fluorosis, and only 26% knew that high fluoride level in drinking water could cause mottled

Table 6
Association between socioeconomic status, parent's knowledge and awareness, and fluorosis (N=349).

Characteristics	Fluorosis, <i>n</i> (%)		OR	95%CI	<i>p</i> -value
	Yes	No			
Gender					
Male	140 (78.7)	38 (21.3)	4.0	2.50-6.4	<0.001 ^b
Female ^a	82 (48.0)	89 (52.0)			
School type					
Government	160 (64.3)	89 (35.7)	1.1	0.7-1.4	0.690
Private ^a	62 (62.0)	38 (38.0)			
Family income(PKR)					
< 30,000	184 (66.9)	91 (33.1)	1.9	1.1-3.2	^b 0.014 ^b
≥ 30,000 ^a	38 (51.4)	36 (48.6)			
Father education					
≤ High school	167 (65.0)	90 (35.0)	1.2	0.8-2.0	0.374
> High school ^a	55 (59.8)	37 (40.2)			
Mother education					
≤ High school	201 (65.3)	107 (34.7)	1.8	0.9-3.5	0.079
> High school ^a	21 (51.2)	20 (48.8)			
Knowledge of parents					
Low	185 (64.9)	100 (35.1)	1.4	0.8-2.4	0.286
Moderate-high ^a	37 (57.8)	27 (42.2)			
Awareness of parents					
Moderate-high	165 (96.5)	6 (3.5)	58.4	24.4-139.8	<0.001 ^b
Low ^a	57 (32.0)	121 (68.0)			

^aReference group; ^bChi-square test, significant difference at $p < 0.05$; cOR, crude odds ratio.

Table 7
Multivariate analysis: association with fluorosis among 12-year-old children (N=349).

Characteristics	Fluorosis, %	aOR	95%CI	<i>p</i> -value
Gender				
Male	78.7	3.1	1.7-5.8	<0.001 ^b
Female ^a	48.0			
Family income (PKR)				
<30,000	66.9	1.7	0.8-3.5	0.176
≥30,000 ^a	51.4			
Mother education				
≤High school	65.3	0.6	0.3-1.5	0.269
>High school ^a	51.2			
Awareness of parents				
Moderate-high	96.5	55.1	22.5-134.9	<0.001 ^b
Low ^a	32.0			

^aReference group; ^bSignificant difference at $p < 0.05$; aOR, adjusted odds ratio.

teeth. To our knowledge, there has been no study about knowledge of fluorosis among parents in Pakistan; therefore, the present study has highlighted many areas of knowledge where parents still do not know about fluorosis. Measures that aim to increase knowledge of fluorosis among newly parents and general population could be another approach to help reduce the fluorosis prevalence in this community.

Findings indicated that most parents were less aware about the dental fluorosis and had superficial knowledge about fluorosis. The results also suggested that parents' awareness about dental fluorosis was found significantly associated with children's fluorosis status. This observation was not surprising, as the mothers who had children with the fluorosis appearance, may tend to find out about this condition, and were more likely to recognize the problem of fluorosis in the community as resulting in an overall higher awareness than those parents with non-fluorosis children. Therefore, the awareness of the fluorosis was the consequence rather than the preceding factor in this study.

It is important to point out that parents in this study mostly finished high school or lower and represented the low socioeconomic family in Pakistan. Therefore, the results may not be applicable to other populations.

The dissemination and education about dental fluorosis are urgently needed and should be tailored to reach this population. Easy and short messages in oral health educational media should be encouraged and tested with an awareness of low literacy levels. The knowledge about sources of fluoride and its effect on dental fluorosis should be introduced in the children's education because of the

magnitude of the problem. However, the major issue regarding fluorosis prevention would be to optimize fluoride level in drinking water, or the other sources of drinking water need to be available and accessible. To prevent dental fluorosis in this community a policy should be formulated to strictly adhere to a safety level of fluoride in drinking water.

ACKNOWLEDGEMENTS

The authors would like to express sincere thanks to all parents and students who participated in this study. We would like to extend our appreciation to Asst Prof Yaowaluk Ngoenwiwatkul for her support and guidance.

REFERENCES

- Baloch H, Baloch MUR, Mengal N, Saeed M, Khan N, Ahmed J. Prevalence of dental caries among 12 year old school children in Quetta, Balochistan. *Med Forum Mon* 2009; 20: 31-5.
- Benazzi AS, da Silva RP, de Meneghim M, Ambrosano GM, Pereira AC. Dental caries and fluorosis prevalence and their relationship with socioeconomic and behavioural variables among 12-year-old schoolchildren. *Oral Health Prev Dent* 2012; 10: 65-73.
- Carey CM. Focus on fluorides: update on the use of fluoride for the prevention of dental caries. *J Evid Based Dent Pract* 2014; 14(suppl): 95-102.
- Government of Balochistan. Gateway to all government services of Balochistan. Balochistan: Government of Balochistan, 2013. [Cited 2012 Jul 30]. Available from: <http://www.balochistan.gov.pk/index>
- Jodalli PS, Ankola AV, Hebbal M, Vikneshan M. Aesthetic perceptions regarding fluorosis by children from an area of endemic fluorosis in India. *Community Dent Health* 2013; 30: 249-53.

- Kadir RA, Al-Maqtari RA. Endemic fluorosis among 14-year-old Yemeni adolescents: an exploratory survey. *Int Dent J* 2010; 60: 407-10.
- Khan A, Whelton H, O'Mullane D. Determining the optimal concentration of fluoride in drinking water in Pakistan. *Community Dent Oral Epidemiol* 2004; 32: 166-72.
- Kotecha P, Patel S, Bhalani K, Shah D, Shah V, Mehta K. Prevalence of dental caries and fluorosis in association with high level of drinking water fluoride content in a district of Gujrat, India. *Indian J Med Res* 2012; 135: 873-7.
- Marino R. The prevalence of fluorosis in children is associated with naturally occurring water fluoride concentration in Mexico. *J Evid Based Dent Pract* 2013; 13: 100-1.
- Meneghim M, Kozlowski F, Pereira A, Assaf A, Tagliaferro E. Perception of dental fluorosis and other oral health disorders by 12-year-old Brazilian children. *Int J Paediatr Dent* 2007; 17: 205-10.
- Pontigo-Loyola AP, Medina-Solis CE, Lara-Carrillo E, *et al*. Impact of socio-demographic, socioeconomic, and water variables on dental fluorosis in adolescents growing up during the implementation of a fluoridated domestic salt program. *Odontology* 2014; 102: 105-15.
- Samal AC, Bhattacharya P, Mallick A, Ali MM, Pyne J, Santra SC. A study to investigate fluoride contamination and fluoride exposure dose assessment in lateritic zones of West Bengal, India. *Environ Sci Pollut Res Int* 2014 Nov 19. [Epub ahead of print].
- Shekar C, Cheluvaiiah M, Namile D. Prevalence of dental caries and dental fluorosis among 12 and 15 years old school children in relation to fluoride concentration in drinking water in an endemic fluoride belt of Andhra Pradesh. *Indian J Public Health* 2012; 56: 122-8.
- Tezcan U, Koparal A, Ogutveren U. Electrochemical process for the drinking water. Hurghada: Thirteen International Water Technology Conference, 2009: 129-37.
- Wondwossen F, Astrøm A, Bårdsen A, Bjorvatn K. Perception of dental fluorosis amongst Ethiopian children and their mothers. *Acta Odontol Scand* 2003; 61: 81-6.
- World Health Organization (WHO). Oral health survey basic methods. Geneva: WHO, 1987.