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Original Research

Awareness about Dental Fluorosis among Parents of School Children in Selected Schools in Dimbulagala Educational Zone, Polonnaruwa District, Sri Lanka

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Abstract

Dental fluorosis (DF) is a preventable, common oral health problem characterised by abnormalities in the formation of the enamel structure resulting from repeated exposure to high quantities of fluoride, during critical stage of tooth development. This is the most prevalent among children aged 12-15 years, particularly in regions of Asia and Africa where groundwater contains naturally high levels of fluoride. Parental awareness plays a crucial role in the prevention and early detection of DF, as an essential focus in improving the oral health of children. This study was designed to assess the parental awareness about DF and its associated factors among school children in selected schools in Dimbulagala Educational zone, Polonnaruwa District, Sri Lanka. A descriptive cross-sectional study was conducted among 273 parents of the school children, aged 12-14 years in Dimbulgala Educational zone. Students were selected using multi-stage cluster sampling method and data were collected using a self-administrated questionnaire. Data were analysed using SPSS version 26.0. A greater proportion of the parents (n=154 (56.4%) were female and most of the parents were engaged in farming (n=127, 46.5%). A significant proportion of them (n=267, 97.8%) lived in rural areas. Overall, parental awareness of DF was low. Little more than half of the parents (61.9%) were unaware of DF and the role of fluoride as its primary cause. A majority (86.8%) did not know that fluoride was present in their drinking water and toothpaste. Similarly, most parents (n=230, 84.2%) were unaware that excessive fluoride exposure is the main factor contributing to DF. Furthermore, 44.7% of the participants (n=122) were not aware of water sources with high fluoride concentrations. Although no statistically significant association was found between DF awareness and socio-demographic characteristics such as age, gender, and monthly income, there was a significant association between awareness of DF and both the area of residence and parents' occupation. This study highlights a low level of parental awareness regarding DF including its causes, and the presence of fluoride in commonly used sources. Despite no significant association were observed between awareness and socio-demographic factors such as age, gender or income, significant associations were found with parental occupation and rural residence. Therefore, targeted public health interventions, particularly in rural communities to enhance parental knowledge are essential for the prevention and early identification of DF, ultimately contributing to improved oral health in children.

***Keywords**: Dental fluorosis, Parental awareness, School children*

Introduction

Dental fluorosis (DF) has become a major public oral health problem in many developing countries, despite being a preventable condition [1]. It is characterised by abnormalities in the formation of tooth enamel due to repeated exposure to high levels of fluoride, particularly during the tooth development stage. This excessive fluoride intake reduces the mineral content of enamel and increases its porosity, leading to tooth discoloration [2]. Depending on the severity, DF can be classified as mild, moderate, or severe. Although DF alters the appearance of the enamel, it does not typically affect normal dental function. However, while DF is often considered a cosmetic issue, it may indicate excessive fluoride exposure that can lead to systemic fluorosis. Systemic fluorosis is associated with serious health consequences, including an increased risk of bone fractures, certain cancers, thyroid dysfunction, infertility, weakened immune function, and impaired cognitive development [3].

Mild dental fluorosis is the most common form and typically appears as opaque white spots or streaks on the tooth enamel. These changes may go unnoticed without a professional dental examination. At this stage, small bright white flecks and patches can be seen on the enamel. Moderate fluorosis is more easily identified, as it presents with yellowish or light brown stains and more noticeable discoloration. Severe fluorosis, though rare, is characterised by poorly formed enamel with visible pitting, rough texture, and dark brown staining that may worsen over time [4]. Without proper awareness and knowledge of fluorosis, even moderate and severe cases can go undiagnosed. Fluorosis can present with a range of enamel changes, including stains from yellow to dark brown, surface irregularities, and pits [5]. Importantly, DF is not considered a disease but rather a cosmetic condition that primarily affects oral health [6].

Although the global prevalence of DF is not precisely established, many countries across Africa, America, the Middle East, and Asia report endemic levels of both dental and skeletal fluorosis, primarily due to fluoride concentrations exceeding 1.5 mg/L in drinking water. It is estimated that approximately 25 million people currently have DF, and around 66 million are at risk of developing the condition. More than 23 countries are known to have endemic fluoride levels in their water sources, with nearly 100 million people affected worldwide, as fluoride remains the major contributing factor to fluorosis [7]. Regions such as Asia and Africa are particularly vulnerable due to naturally high fluoride concentrations in groundwater. In high-fluoride villages, the prevalence of DF among children ranges from 30% to 94%, with the highest rates observed among those aged 12 to 15 years. In some areas, nearly two-thirds of school-aged children are affected by DF [8].

In Sri Lanka, the distribution of fluoride in groundwater varies significantly by region, with higher concentrations commonly found in the dry zone areas such as the North Central, Eastern, and North Western Provinces. These regions rely heavily on groundwater for drinking, making their populations particularly vulnerable to excessive fluoride exposure. As a result, a higher prevalence of dental fluorosis has been reported among children in these areas, particularly in

rural communities where access to treated water is limited. The condition is often linked to the consumption of groundwater with fluoride levels exceeding the WHO recommended limit of 1.5 mg/L [9].

DF is a growing public health concern in Sri Lanka, particularly in regions where groundwater fluoride concentrations exceed the recommended threshold of 1.5 mg/L [10]. Several studies have reported a high prevalence of DF among school-aged children, especially in the dry zone. In Kurunegala, 52% of 15-year-olds exhibited signs of fluorosis, while in Vavuniya, the prevalence was as high as 72.9% among children exposed to water containing an average of 1.58 mg/L fluoride [10]. A comparative study across four schools showed DF rates ranging from 51% to 78% in endemic areas, contrasting sharply with just 5.4% in non-endemic zones. In certain high-exposure communities, where water fluoride levels reached up to 9.8 mg/L, nearly 97% of children aged 12–14 were affected, with about 20% displaying moderate to severe forms. These findings indicate a strong correlation between groundwater fluoride levels and the prevalence and severity of dental fluorosis among children in Sri Lanka [11].

The primary determinants of dental fluorosis (DF) are the quantity and timing of fluoride intake, particularly during the critical period of tooth development. While ingestion of fluoride through drinking groundwater with high fluoride concentrations is a major risk factor, several other sources also contribute including the use of fluoride supplements, fluoride-containing toothpaste (especially when swallowed habitually), and infant formulas made with fluoridated water. In addition to these, various modifiable and non-modifiable factors have been identified in previous studies, such as age, gender, ethnicity, household income, parental education level, and child feeding practices [12].

Although DF is not classified as an oral disease, it can significantly affect an individual's physical, psychological, and social well-being. Among these, the psychological and social impacts are often more profound than the physical effects. For example, adolescents in Kibosho with visible signs of DF reported feelings of embarrassment about their appearance and tended to hide their smiles due to the condition of their teeth [13]. As DF is a preventable condition, increasing public awareness and knowledge particularly among parents and caregivers plays a crucial role in preventing its onset and reducing its long-term impact.

Previous epidemiological studies have demonstrated a high prevalence of DF among children and adolescents in these areas, with rates ranging from 43% to over 90% in certain endemic communities. The severity of DF correlates strongly with the level and duration of fluoride exposure during early childhood. Children under the age of eight are most vulnerable to fluorosis, as enamel formation occurs primarily during this period [14].

Despite this, awareness and understanding of DF among parents and caregivers remain limited, especially in rural communities relying heavily on untreated groundwater. Low parental awareness impedes early detection, prevention, and appropriate management, thereby exacerbating the psychosocial impact of DF, which has been

affected children's self-esteem and social interactions. Targeting parents of adolescents aged 12 to 14 years is strategic, as permanent dentition is generally fully erupted by this age, allowing for reliable clinical assessment of fluorosis and enabling parents to recognise its signs and seek timely intervention. This study focuses on the Dimbulagala zonal education area within the Polonnaruwa District an identified high-risk rural dry zone with documented elevated groundwater fluoride levels and significant DF prevalence [11].

Therefore, this study assessed the level of awareness about DF and its associated factors among parents of school children in Dimbulagala Educational zone. Assessing parental knowledge and awareness in this context is crucial for developing targeted educational interventions, improving community based preventive strategies to reduce the burden of DF in vulnerable populations. By addressing this knowledge gap, the study aims to contribute to better oral health outcomes and enhance quality of life for affected children and adolescents.

Methods

A descriptive cross-sectional study was conducted to assess parental awareness of dental fluorosis among school children aged 12–14 years in the Dimbulagala Educational zone. The study was carried out in three selected schools, each representing one of the three divisions in the zone: Maguldamana Maha Vidyalaya (Dimbulagala Division), Aselapura Maha Vidyalaya (Welikanda Division), and Alawakumbura Maha Vidyalaya (Aralaganwila Division).

The study population consisted of parents of students aged 12–14 years attending the selected schools. A multi-stage cluster sampling technique was employed. First, the three divisions were considered as separate clusters. From one division, one school type (there are 4 types of schools in Dimbulgala Educational Division. Type 1 – below 200 students, Type 2 - between 201-500 students, Type 3 – between 501-1000 students and Type 4 above 1000 students) was randomly selected as sub-cluster and one school was randomly selected as another sub-cluster from among the Type 2 schools in the zone. Same method was used to all three divisions. In each selected school, 91 students were randomly chosen (students from grades 7, 8, and 9), and their parents were invited to participate in the study. Participants included in the study were parents of male and female students aged between 12 and 14 years. Only those parents who were able to speak and write in either Sinhala or English were considered eligible. Additionally, participants were required to have been permanent residents of the Dimbulagala division for more than five years to ensure adequate exposure to local environmental conditions. The minimum required sample size was calculated using the standard formula proposed by Lwanga and Lemeshow [15], resulting in a required sample size of 273 participants.

$$n=\frac{z^2P(1-P)}{d^2}$$

n- Required sample size

z- The z value for the desired confidence level (95%)

P- Estimation of population percentage (80 %) [11]

d- Absolute error or precision

z=1.96, d=5%

Data were collected using a pre-tested, self-administered questionnaire developed by the investigators based on previous literature. The questionnaire was pre-tested among 30 parents from Manampitiya Sinhala Maha Vidyalaya, and several questions were modified for clarity based on their feedback.

Awareness was measured by using 11 questions regarding the DF. All the correct answers were marked and proportions of the correct answers were considered. The level of awareness was categorised into two categories as adequate awareness (>50% of the marks) and poor awareness (<50% of the marks).

Parents were provided with a detailed explanation of the purpose of the study and procedures through an information sheet, sent via their children, and informed written consent of the parents was obtained before recruitment of them. The questionnaire was sent to them through their children, and receipt of the questionnaire was confirmed via a follow-up telephone call. Participant's anonymity and confidentiality were maintained throughout the study and dissemination of findings.

Data were analysed using SPSS version 26.0. Descriptive statistics, including means, medians, frequencies, and percentages, were used to summarise data. Results were presented using bar charts, pie charts, histograms, and tables. Chi-square test was used to determine associations between variables and to identify group differences where appropriate. A *p*-value of less than 0.05 was considered statistically significant.

Results

Demographic characteristics of the participants

Among 273 parents of the students, the mean±SD age was 39.5±5.8 years. Table 01 shows the socio-demographic characteristics of parents. A greater proportion of the parents were female (n=154, 56.4%) and 98% were residing in rural areas. Among them 46.5% of the parents engaged in farming as the occupation and 56.8% (n=155) of them had less than 20000.00 LKR of monthly income.

Awareness of the parents about Dental Fluorosis

Majority of parents (n=227, 83.2%) demonstrated poor awareness regarding DF with only 16.8% had adequate awareness of the condition. Notably, 70.7% of the parents were unaware of the term DF itself. Table 02 shows the frequency distribution about awareness of DF among parents of school children in Dimbulagala Education zone. There were 158 participants (57.9%) who had known that their children were having mottled teeth and 60 (22%) of them had taken treatments for that condition. A considerable number of people thought that tooth forming age (n=68, 24.9%) and infancy (n=66, 24.2%) were the most vulnerable age groups for developing DF. Majority of the parents (n=230, 84.2%) were not aware that fluoride was the main factor of DF whereas 44.7% were not aware of the water sources in which has high fluoride

concentration. Of the sample, 49 participants (17.9%) thought that the ground water was having a high fluoride content.

The majority of the parents (n=237, 86.8%) were not aware that their water sources contain fluoride and also 60.8% did not know that their toothpaste contain fluoride as an additive. When consider awareness of the impact of DF, 48% of participants had wrong understanding on the matter that DF impact on maintenance of oral hygiene. The majority of the parents (84.25%) did not aware that fluoride is the main factor of causing DF.

Table 1 Socio-demographic characteristics of the parents (n=273)

Socio-demographic characteristics		**Frequency**	**Percentage (%)**
Parent's gender	Male	119	43.6
	Female	154	56.4
Occupation	Employed in government sector	49	17.9
	Employed in private sector	33	12.1
	Farming	127	46.5
	Engaged in trade	10	3.7
	Unemployed	40	14.7
	Other	14	5.1
Monthly income (LKR)	<20000	155	56.8
	20000 - 40000	75	27.5
	40000 - 60000	24	8.8
	>60000	19	7.0
Living area	Rural	267	97.8
	Urban	6	2.2

Concerning the awareness of parents about dental hygienic practices of their children, just over half of the parents (n=169, 61.9%) did not know whether their children are using fluoride contained tooth paste or non-fluoride toothpaste. Nearly 37% were using fluoride toothpaste while 1.5% were using non-fluoride toothpastes. Most of the parents (74%) knew that their children were using pea sized toothpaste for tooth brushing (Table 03).

Table 02 Awareness of Dental Fluorosis among parents (n=273)

Questions	Responses	No. of participants	Percentage (%)
How do you know about dental fluorosis?	From television	19	7.0
	From dentist	38	13.9
	From teacher	15	5.5
	From parents	8	2.9
	Not aware	193	70.7
Does your child has molted teeth?	Yes	158	57.9
	No	109	39.9
	Not known	6	2.2
Do you take a treatment for that condition?	Yes	60	22.0
	No	213	78.0
Which age category is/are high risk for dental fluorosis?	Infant age	66	24.2
	Tooth forming age in child	68	24.9
	Adolescents	33	12.1
	Younger age	16	5.9
	Adult age	14	5.1
	Old age	76	27.8
	No idea	0	0.0
Do you aware that fluoride is the main factor of dental fluorosis?	Yes	43	15.8
	No	230	84.2
Which water source/s have high fluoride concentration?	Ground water	49	17.9
	Lake water	26	9.5
	Tap water	29	10.6
	Filtered water	15	5.5
	Bottled water	2	0.7
	Boiled water	30	11.0
	Not known	122	44.7
Does fluoride is in your drinking water?	Yes	36	13.2
	No	237	86.8
Does fluoride is in your toothpaste?	Yes	107	39.2
	No	166	60.8

Which food/s contain in fluoride?	Tea	86	31.5
	Coffee	14	5.1
	Grapes	4	1.5
	Cow's milk	29	10.6
	Cola & soda drinks	75	27.5
	No idea	65	23.8
What is/are the impact of dental fluorosis?	Esthetic impact	44	16.1
	Impact of emotional stability	21	7.7
	Impact of oral hygiene maintenance	131	48.0
	Impact of speaking	6	2.2
	Impact of work	4	1.5
	No idea	67	24.5

Table 4 shows the parental awareness of dietary habits and drinking water hygienic habits. Approximately 44.7% of participants reported using filtered water for drinking purposes, while 36.6% relied on well water and 7.3% obtained their drinking water from lakes. Most of the parents (82.1%) concerned the quality of their drinking water and 47.3% had used water from wells for cooking. Nearly, 52% of children were given tea since early age and 89% did not drink tea often.

Association between socio-demographic factors and awareness of the DF

As indicated in the Table 5, there was no statistically significant associations between socio-demographic characteristics of the parents such as gender, monthly income, and awareness of the DF. There was a statistically significant association between living area, parent's occupation and awareness of the DF.

Table 03 Parent's awareness of dental hygienic practices among children (n=273)

Question	Responses	Frequency	Percentage (%)
Does your child use fluoride containing toothpaste?	Yes	100	36.6
	No	4	1.5
	Not known	169	61.9
How much of toothpaste does your child use to brushing?	Pea sized	202	74.0
	Brushing surface of a tooth brush	66	24.2
	Not known	5	1.8

Table 04 Frequency distribution of drinking water hygienic practices (n=273)

		Frequency	Percentage (%)
Source of drinking water	Filtered water	122	44.7
	From well	100	36.6
	Tap water	26	9.5
	From lake	20	7.3
	Bottled water	5	1.8
Concern about the quality of drinking water	Yes	224	82.1
	No	49	17.9
Source of your water for cooking	From well	129	47.3
	Filtered water	65	23.8
	Tap water	47	17.2
	From lake	31	11.4
	Bottled water	1	0.4
Giving tea for the child since early age	Yes	142	52.0
	No	131	48.0
Child drink tea often	No	243	89.0
	Yes	30	11.0

Table 05 Association between socio-demographic factors and awareness of Dental Fluorosis among parents

Socio-demographic factors		Awareness of DF		*p*-value
		Adequate awareness (n)	Poor awareness (n)	
Gender	Male	20	99	0.560
	Female	26	128	
Monthly income	<20,000 (LKR)	13	142	0.254
	20000 - 40 000	20	55	
	40 000 - 60 000	08	16	
	>60 000	05	14	
Living area	Rural	42	225	0.008
	Urban	04	02	

Occupation	Employed in government	33	16	0.000
	Employed in private sector	03	30	
	Farming	07	120	
	Engaged in trade	01	09	
	Unemployed	01	39	
	Other	01	13	

Discussion

In this study sample, almost half of the parents were engaged in farming (46.5%), and a little over half (56.8%) reported a monthly household income of less than 20,000 LKR (~70 USD). These socio-economic characteristics are consistent with rural populations in Sri Lanka, particularly in dry-zone districts where agriculture remains the primary livelihood. Comparatively, a study conducted in Pakistan reported that approximately half of the families (51.3%) had a monthly income ranging from 15,000 to 30,000 Pakistani Rupees (approximately 150–300 USD) [16]. The observed difference in income levels may reflect broader economic disparities between the two countries, as Pakistan's per capita income is generally higher than that of Sri Lanka. This economic contrast may also influence health literacy and access to oral health information and services.

One of the key objectives of the present study was to assess parental awareness of dental fluorosis (DF), a preventable condition with significant aesthetic and psychosocial consequences. To date, there is limited published research in Sri Lanka exploring parental knowledge of DF, highlighting the significance of this study in addressing a notable gap in the literature. The current findings demonstrate that 70.7% of parents were aware of dental fluorosis, and 57.9% recognised that their children had signs of mottled teeth. These findings indicate a relatively higher level of awareness when compared with a similar study in Pakistan, where 62.8% of parents were unsure whether their child had mottled teeth, and 84.8% were unsure of the broader societal impact of dental fluorosis [16]. Furthermore, only 13% of parents in the Pakistani study had heard of fluorosis, mostly through informal sources such as family, friends, or television.

The results of the current study also reflect positive oral hygiene practices among children. Nearly all participants (99.6%) reported using toothpaste, and the majority of school children brushed their teeth twice daily. These findings are in line with those reported by Sami (2016), [17] where 93% of children in Pakistan used a toothbrush and toothpaste, although brushing frequency was lower, with most children brushing only once daily. The similarities in toothpaste usage across studies suggest a generally good level of access to basic oral hygiene products, even in rural settings.

The study conducted in Thailand revealed that 50.5% of the parents knew the cause of DF and 40.7% of the parents acknowledge the prevention of this condition. Furthermore, 41.8% knew the treatment method while 30.5% recognised the relationship between DF and consuming over

standard fluoride drinking water. According to this study 78% of parents were not aware about the treatment of DF [18].

Despite relatively high awareness regarding the good oral hygiene practices, there are still gaps in knowledge regarding the fluoride content in drinking water and toothpaste, as well as the potential systemic effects of excessive fluoride intake. This underscores the need for targeted health education programs, especially in fluoride-endemic rural areas. Public health interventions should focus not only on improving awareness but also on promoting safe water practices, the use of low-fluoride toothpaste for children, and timely recognition of early signs of fluorosis.

Conclusion

The findings of this study indicate that the majority of parents in the Dimbulagala Educational zone of the Polonnaruwa District has overall poor awareness of DF and it highlights a significant gap in parental awareness regarding DF, indicating an urgent need for targeted educational interventions. A significant proportion of parents were unaware that fluoride is the primary causative agent of DF and lacked knowledge about the presence of fluoride in commonly used sources such as drinking water and toothpaste. Moreover, the majority were unaware that their local water sources, particularly groundwater and lake water could contribute to the development of DF in children.

Although no statistically significant associations were found between DF awareness and socio-demographic factors such as age, gender, or monthly income, significant associations were observed with parental occupation and residential area. These findings suggest that rural residency and agricultural occupations may be linked to lower levels of awareness, likely due to limited access to health information and preventive services in these settings.

Given that DF is a preventable condition, these findings underscore the need for targeted awareness and educational interventions. It is recommended that future research to be conducted across all schools in the Dimbulagala Educational zone to gain a broader and more representative understanding of parental knowledge and awareness. School-based awareness programs should be developed for teachers and parents, promoting understanding of fluoride levels in water sources, the importance of filtered or fluoride-free drinking water, and the use of non-fluoridated toothpaste. Parents can be empowered to support community-based water purification initiatives and disseminate health information to others.

Awareness initiatives should also include education on fluoride-rich foods, the clinical manifestations of dental fluorosis (DF), and preventive strategies as part of a broader primary health care approach. Additionally, early identification of children with DF and providing timely treatment can contribute to improving their quality of life. To address the issue comprehensively, support from government agencies and community stakeholders is essential in mobilising resources and implementing safe water and fluoride mitigation programs in rural regions.

This study was limited to a sample size of 273 parents from three selected schools within the

Dimbulagala Educational zone and, therefore, findings may not be generalizable to the entire district or other regions. Further, the applicability of the findings to other demographic or occupational groups may be limited because the majority of participants were farmers with low socioeconomic status. Future research involving larger and more diverse populations is recommended to draw broader and more representative conclusions.

List of abbreviations

DF- Dental Fluorosis

SPSS- Statistical Package for Social Sciences

WHO – World Health Organization

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Ethical considerations

Ethical approval was obtained from the Ethics Review Committee, Faculty of Allied Health Sciences, University of Ruhuna (Ref No.156.11.2022). Institutional approvals were also obtained from the Dimbulagala Zonal Education Office and the principals of the selected schools.

Declaration of conflicting interest

The authors declare that they have no competing interests.

Author contributions

All authors involved in conception of the study and design of the work. TP involved in data collection, analysed the data and initially draft the manuscript. HD and IK involved in reviewing of the manuscript. IK contributed for critically reviewing the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

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