

# DENTAL FLUOROSIS, DRINKING WATER AND PARTICIPANT PERSPECTIVES: A CROSS-SECTIONAL STUDY AMONG STUDENTS OF A NATIONAL SCHOOL IN ANURADHAPURA

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**Abstract** - Dental fluorosis is caused by excessive fluoride intake mainly via drinking water during the development stage of teeth. Anuradhapura is a region where fluoride levels in drinking water is high. Thambuttegama divisional secretariat of Anuradhapura is considered to be one of the hotspots for high fluoride concentration. The latest available study at Anuradhapura (2004) revealed a prevalence of 90% for very mild to severe form of dental fluorosis. This study aims at finding knowledge, attitude and prevalence of dental fluorosis among students of a National School in Thambuttegama. A descriptive cross sectional study was performed using a self-administered questionnaire at National Schools of Thambuttegama. Dean's index was used to rate severity of dental fluorosis. Participation rate was good (83% - 248/300). Most were females (53%), 12 years old (44%) and from Thalawa division (54%). Mean age of participants was 12.8 ± 0.76 years. Majority of the participants didn't know about dental fluorosis (64%). Parents were the commonest source of knowledge on dental fluorosis (32%). Most of the participants (73%) were satisfied with the appearance of their teeth. 09% of participants have never visited a dentist. According to the Dean's index 37.5% belonged to very mild to severe form of dental fluorosis. Well water was used by most (44%). Among the well water users, 41% (45/109) had very mild to severe form of dental fluorosis in comparison to 35% (48/139) in other water users. There was no significant difference ( $X^2 = 1.1884$ ;  $P = 0.28$ ) between the two groups. Prevalence of very mild to severe form of dental fluorosis is still high among the school children of Thambuttegama. However their knowledge on dental fluorosis seems to be poor.

**Keywords** - Dental fluorosis, Dean's index, Drinking water, School children

## I. INTRODUCTION

According to World Health Organization (WHO), "Ingestion of excess fluoride, most commonly in drinking-water, can cause fluorosis which affects the teeth and bones. Moderate amounts lead to dental effects, but

long-term ingestion of large amounts can lead to potentially severe skeletal problems" (WHO 2001). It has been recognized that fluoride has both favourable effects (Ten Cate 1990) (promoting mineral deposition, inhibiting mineral dissolution and preventing dental caries) and non-favourable effects such as dental fluorosis (WHO 2001). Dental fluorosis is caused by excessive intake of fluoride via drinking water during the development of the teeth, usually from birth to nearly 6 years of age (WHO 2001). This condition affects children and it is characterized by white discoloured areas of teeth enamel. When the condition is severe teeth become pitted and stained (WHO 2010).

A fluoride concentration of 0.8 - 1.0 mg/l in drinking water has shown to produce dental health benefits (WHO 1994; Petersen & Lennon 2004). The WHO recommended level of fluoride in drinking water is 1.5 mg/l (WHO 2004). Concentrations of fluoride in the range of 1.5-4 mg/l result in dental fluorosis (Mohapatra et al. 2009). High fluoride intake can also result due to consumption of tea leaves which have high levels of fluoride (WHO 2002; WHO 2006). Excessive intake of fluoride has led to millions of cases in endemic areas around the world (WHO 2002).

Several studies have revealed the relation between fluoride content in water and dental fluorosis. A study was done to determine the prevalence and severity of dental fluorosis in young children of Newcastle (a fluoridated area) and Northumberland (a fluoride deficient) (Tabari et al. 2000). The prevalence of fluorosis was 54% and 23% in fluoridated area and fluoride deficient area respectively. Another research conducted in India revealed a prevalence of 59% for dental fluorosis in high fluoride area in comparison to 39% in normal fluoride area (Kotecha et al. 2012).

In dry zones high concentration of fluoride is seen in both dug and deep wells (Dissanayake 1991). Nearly 75% of

the population in Sri Lanka, who live in rural areas, obtain its drinking water from the ground sources (Dissanayake 1996). The daily water consumption by an individual is much higher in Sri Lanka as it is located in the humid tropical zone (Dissanayake 1996). Therefore the incidence of dental fluorosis in dry zones of Sri Lanka is high. It results in psychological problems among school children of the low income rural areas of the dry zone (Dissanayake 1996).

Anuradhapura district belongs to the dry zone of Sri Lanka, where a maximum fluoride level of 13.7 mg/l in drinking water was recorded (Chandrajith et al. 2012). About 85% of the population in this area obtain their drinking water from shallow or deep ground water (Chandrajith et al. 2012). 19 out of 22 divisions of Anuradhapura district have been identified as containing high levels of fluoride. Thambuttegama, one of those divisions, had 1.6% of its wells with fluoride levels of 4-10 mg/l. 31.4% of the wells had 2-4 mg/l fluoride levels. Therefore Thambuttegama can be considered as one of the hotspots for high fluoride concentration (Chandrajith et al. 2012).

A study in 1999 among 12-14 years old children of Eppawela division of Anuradhapura has revealed 97% prevalence of dental fluorosis (Nanayakkara et al. 1999). A similar study was performed to estimate the prevalence of dental fluorosis in Anuradhapura district in 2004 (Tennakoon 2004). According to Dean's index very mild or greater dental fluorosis was seen in 89.8% of those participants. 33.2% of them needed treatment (Tennakoon 2004). Treatment for dental fluorosis ranges from a conservative bleaching management to an extensive full crown restorations (Sherwood 2010).

Children are the most affected with dental fluorosis because their teeth are in its developing stage. It is important to determine the prevalence of dental fluorosis among them. To the best of our knowledge it has been nearly 12 years from the last estimation of the prevalence of dental fluorosis in Anuradhapura district. The aim of this study was to determine the knowledge, attitude and prevalence of dental fluorosis among 12 – 14 year old students of the National School in Thambuttegama, Sri Lanka.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

### A. Study setting

A descriptive cross sectional study was performed from July to August 2016 in Anuradhapura, the largest district by surface area in Sri Lanka. Total estimated mid-year population of the district is 905,000 (DCS 2016). Main employment (55%) of the district is agriculture (DCS 2014). Household Income and Expenditure Survey of

2012/2013 revealed the district's poverty head count index as 7.6%, whereas the country's value is 6.7% (DCS 2015). Thambuttegama divisional secretariat of Anuradhapura showed an estimated head count index of 7.38% with the number of poor people being 3042 (DCS 2015). Anuradhapura Siddhartha School is the only national school located in Thambuttegama which was selected for our study.

### B. Sampling method and study instrument

All 12-14 year old students of the National School of Thambuttegama, who gave informed written consent, were included. A self-administered questionnaire was used to collect demographic data and information on knowledge, attitude and risk factors of dental fluorosis. The questions were adapted from previous studies conducted in Quetta, Pakistan (Sami et al. 2015) and Kilimanjaro Region, Tanzania (Roman 2010).

### C. Data collection, analysis and description of data

Institutional permission was obtained from the Director, Thambuttegama zonal education office and the Principal of the relevant school. Participants were recruited on the last day of their end of term exam. Both parental consent and assent was obtained. Participants were allowed to discuss the project with their family or friends before making a decision on participation. Following the administration of the questionnaire, teeth were examined under natural light using the criteria for Dean's index (Dean HT 1934). According to Dean's index dental fluorosis was classified under six categories. They were; normal, questionable, very mild, mild, moderate and severe. Data was analysed using Microsoft excel. Descriptive statistics were used to describe the data.

## III. RESULTS

Two hundred and forty eight students (83%) out of three hundred participated in the study. Out of which students from grade-7 were 44 %, grade-8 were 36% and grade-9 were 20%. Majority of the participants were females (53%), 12 years old (44%) and from Thalawa division (54%). The mean age of the participants was  $12.8 \pm 0.76$  years.

### A. Knowledge and awareness

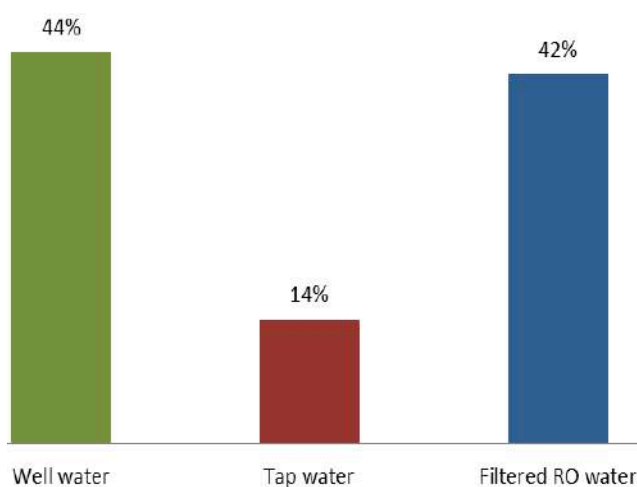
More than 75% of participants did not know the following: the typical appearance of dental fluorosis, that fluoride in drinking water helps to prevent tooth decay, that too much fluoride in drinking water can cause mottled teeth and that tea has high fluoride levels. However more than 50% of participants did know that fluoride can prevent tooth decay

Awareness on dental fluorosis was poor. 64% participants didn't know about dental fluorosis. Most of the

participants who knew about dental fluorosis, acquired knowledge from parents (32%), and rest were from the following sources: teachers (30%), newspapers (20%), television (13%) and internet (5%).

**B. Attitudes and possible risk factors**

Most of the participants used well water (44%) as their water source (Figure 1) and had drunk one to two cups (51%) of tea per day. Majority of the participants (73%) were satisfied with the appearance of their teeth. They thought that brown teeth affect less on their daily activities (Table 1). 9% participants never visited their dentist. 5% of the participants have attempted to remove the brownish discoloration of their teeth by a dentist, 3% by scrubbing teeth with charcoal, 3% by scrubbing teeth with sand and 1% by grinding teeth with stone.



**Figure 2. Percentage use of different sources of drinking water, Thambuttegama 2016**

**C. Prevalence of dental fluorosis**

According to the dean’s index 35.9% subjects were normal. 26.6%, 13.7%, 10.1%, 9.7% and 4% subjects belonged to questionable, very mild, mild, moderate and severe categories respectively. Those who found to have moderate or severe dental fluorosis were offered a referral to the nearest dental clinic, yet only ten participants agreed to proceed.

**D. Drinking water source versus dental fluorosis**

Out of those who had well water as their main source of

drinking water, 41% (45/109) had very mild to severe form of dental fluorosis. Out of those who had other water sources as their main source of drinking water, 35% (48/139) had very mild to severe form of dental fluorosis. There was no significant difference between the main source of drinking water and the severity of dental fluorosis ( $X^2 = 1.1884$ ;  $P = 0.28$ ).

**IV. DISCUSSION**

Participation for the study was satisfactory (83%). Previous Sri Lankan published data on knowledge and attitude of dental fluorosis was lacking. However in a similar study in Pakistan (Sami et al. 2015) 55.6% of children agreed that consumption of too much fluoride can cause dental fluorosis whereas only 40% of our participants agreed on the same. Only 1.4% of children in the Pakistani study agreed that too much fluoride in drinking water can cause mottled teeth whereas our study had 23% (Sami et al. 2015). 4.3% and 23% of the participants of Pakistan and Thambuttegama respectively knew that tea has high fluoride content. Although parents (32%) were the commonest source of information on dental fluorosis in our study, it was the teachers (35%) in Pakistan. According to our study majority (44%) of participants used well water as their water source, while 99.7% participants subjected in Pakistan used tube well water as their water source (Sami et al. 2015). 85.1% of the participants of the study conducted in Tanzania (Roman 2010) agreed that brown teeth is a problem and only 73% of participants of our study agreed on the same. 96.3% of participants in Tanzania agreed that brown teeth need to be treated whereas it was only 71% in our study.

The previous study on prevalence of dental fluorosis in Anuradhapura by Tennakoon T in 2004 revealed that 89.8% of the participants had very mild to severe dental fluorosis (Tennakoon 2004). To the best of our knowledge there was no previous data on the prevalence of dental fluorosis in Thambuttegama division but according to our study, 37.5% belongs to very mild to severe category. This shows a decrease in-comparison to the previous study done in the entire district of Anuradhapura.

Proportion of households using an improved drinking water source in Anuradhapura district has increased from

**Table 1. Participant attitude towards dental fluorosis, Thambuttegama 2016**

Percentage of participants who agreed to the statements on attitude towards brown teeth (%) n=248		Percentage of participants who think that brown teeth affects following daily activities (%) n=248	
Brown teeth is a problem	73	Eating	18
Brown teeth affects smiling	70	Cleaning mouth	09
Brown teeth are difficult to clean	67	Speaking	32
Brown teeth may cause sensitivity	40	Sleeping	04
Brown teeth need to be treated	71	Smiling	54
		School work	11
		Emotion	07
		Social contacts	11

71.7% in 1994 to 95.4% in 2012 (DCS 2012). According to our study 42% of participants used filtered water by reverse osmosis as their drinking water source. This can be a contributing factor for the reduction of very mild to severe form of dental fluorosis in the area of study. There was no significant difference related to the main source of drinking water and the severity of dental fluorosis. Although this seems unexplainable, use of other types of improved drinking water as secondary sources would be a possible reason.

Although the findings of this study were limited to Thambuttegama, Sri Lanka, it has provided useful information to depict the changing pattern of dental fluorosis in this region.

## V. CONCLUSION

Along with the increase in use of improved drinking water, the prevalence of very mild to severe form of dental fluorosis has reduced in the target population. However it is still at 37.5% with a poor knowledge on dental fluorosis among participants. This warrants the need of health education to improve awareness on dental fluorosis.

## VI. DECLARATIONS

### A. Ethical approval and consent to participate

Ethical clearance was obtained from the Ethics Review Committee, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka (ERC/2016/40). Informed written assents were obtained from all the children and informed written consents from their parents.

### B. Competing interests

The authors declare that they have no competing interests.

### C. Funding

This was a self-funded study.

### D. Authors' contributions

All authors participated in designing the study. IJ, DJ, FJ, SK, CK and RK involved in data collection. IJ and DR were involved in analysis of data and all authors were involved in interpretation of data. IJ, DJ, FJ, SK, CK and RK drafted the manuscript. DR critically revised it. All authors read and approved the manuscript.

### E. Availability of data and material

Datasets analyzed during the current study are available from the corresponding author on reasonable request.

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## REFERENCES

- Ten Cate, J.M., 1990. In vitro studies on the effects of fluoride on de- and remineralization. *Journal of dental research*, 69 Spec No, pp.614–9; discussion 634–6.
- Chandrajith, R. et al., 2012. Spatial distribution of fluoride in groundwater of Sri Lanka. *Journal of the National Science Foundation of Sri Lanka*, 40(4), pp.303–309.
- DCS, 2016. Mid-year Population Estimates by District & Sex, 2012 - 2016. *Colombo: Population and Housing, Department of Census and Statistics*, p.2. Available at: [http://www.statistics.gov.lk/PopHouSat/VitalStatistics/MidYearPopulation/Mid-year population by district.pdf](http://www.statistics.gov.lk/PopHouSat/VitalStatistics/MidYearPopulation/Mid-year%20population%20by%20district.pdf).
- DCS, 2012. Proportion of households using an improved drinking water source. *Colombo: Population and Housing, Department of Census and Statistics*. Available at: [http://www.statistics.gov.lk/MDG/indicators update/MDG Web Tables 27.pdf](http://www.statistics.gov.lk/MDG/indicators/update/MDG%20Web%20Tables%2027.pdf).
- DCS, 2014. Sri Lanka Labour Force Survey Annual Report - 2014. *Colombo: Department of Census and Statistics, Ministry of Policy Planning Economic Affairs, Child Youth and Cultural Affairs*. Available at: [http://www.statistics.gov.lk/samplesurvey/LFS\\_Annual Report\\_2014.pdf](http://www.statistics.gov.lk/samplesurvey/LFS_Annual%20Report_2014.pdf).
- DCS, 2015. The Spatial Distribution of Poverty in Sri Lanka. *Colombo: Department of Census and Statistics - Sri Lanka Poverty Global Practice, World Bank Group*, pp.6–39. Available at: [http://www.statistics.gov.lk/poverty/SpatialDistributionOfPoverty2012\\_13.pdf](http://www.statistics.gov.lk/poverty/SpatialDistributionOfPoverty2012_13.pdf).
- Dean HT, 1934. Classification of mottled enamel diagnosis. *J Am Dent Assoc*, 21, pp.1421–6.
- Dissanayake, C.B., 1991. The fluoride problem in the ground water of Sri Lanka — environmental management and health. *International Journal of Environmental Studies*, 38(2-3), pp.137–155.
- Dissanayake, C.B., 1996. Water quality and dental health in the Dry Zone of Sri Lanka. *Geological Society, London, Special Publications*, 113(1), pp.131–140.

- Kotecha, P. V et al., 2012. Prevalence of dental fluorosis & dental caries in association with high levels of drinking water fluoride content in a district of Gujarat, India. *The Indian journal of medical research*, 135(6), pp.873–7.
- Mohapatra, M. et al., 2009. Review of fluoride removal from drinking water. *Journal of environmental management*, 91(1), pp.67–77.
- Nanayakkara, D., Chandrasekera, M. & Wimalasiri, W.R., 1999. Dental fluorosis and caries incidence in rural children residing in a high fluoride area in the dry zone of Sri Lanka. *The Ceylon Journal of Medical Science*, 42, pp.13–17.
- Petersen, P.E. & Lennon, M.A., 2004. Effective use of fluorides for the prevention of dental caries in the 21st century: the WHO approach. *Community dentistry and oral epidemiology*, 32(5), pp.319–21.
- Roman, F., 2010. *Dental fluorosis. Impact on quality of life and treatment need among adolescents with dental fluorosis in an endemic area, Kilimanjaro Region, Tanzania*. Muhimbili university of Health and Allied Sciences. Available at: [http://ihi.eprints.org/2612/1/FRANCIS\\_ROMAN0001\\_1\(1\).pdf](http://ihi.eprints.org/2612/1/FRANCIS_ROMAN0001_1(1).pdf).
- Sami, E., Vichayanrat, T. & Satitvipawee, P., 2015. Dental fluorosis and its relation to socioeconomic status, parents' knowledge and awareness among 12-year-old school children in Quetta, Pakistan. *Southeast Asian Journal of Tropical Medicine and Public Health*, 46(2), pp.360–368. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/26513940>.
- Sherwood, I.A., 2010. Fluorosis varied treatment options. *Journal of conservative dentistry : JCD*, 13(1), pp.47–53.
- Tabari, E.D. et al., 2000. Dental fluorosis in permanent incisor teeth in relation to water fluoridation, social deprivation and toothpaste use in infancy. *British dental journal*, 189(4), pp.216–20.
- Tennakoon, T., 2004. Dental Fluorosis in Anuradhapura District, Sri Lanka. In *Proceedings of the 4th international workshop on fluorosis prevention and defluoridation of water, Colombo, Sri Lanka*. pp. 19–22.
- WHO, 2006. Fluoride in drinking-water. *Geneva: World health organization*. Available at: [https://www.who.int/water\\_sanitation\\_health/publications/fluoride\\_drinking\\_water\\_full.pdf](https://www.who.int/water_sanitation_health/publications/fluoride_drinking_water_full.pdf).
- WHO, 2004. Fluoride in drinking-water. Background document for preparation of WHO Guidelines for Drinking-water Quality. *Geneva: World health organization*. Available at: <http://www.who.int/ipcs/features/fluoride.pdf>.
- WHO, 2002. Fluorides. *International Programme on Chemical Safety (Environmental Health Criteria 227)* *Geneva: World health organization*. Available at: <http://www.inchem.org/documents/ehc/ehc/ehc227.htm>.
- WHO, 1994. Fluorides and oral health. Report of a WHO Expert Committee on Oral Health Status and Fluoride Use. *Geneva: World health organization*. Available at: [http://apps.who.int/iris/bitstream/10665/39746/1/WHO\\_TRS\\_846.pdf](http://apps.who.int/iris/bitstream/10665/39746/1/WHO_TRS_846.pdf).
- WHO, 2010. Inadequate or excess fluoride: a major public health concern. *Geneva: World health organization*. Available at: <http://www.who.int/ipcs/features/fluoride.pdf>.
- WHO, 2001. Water Related Diseases. *Geneva: World health organization*. Available at: [http://www.colinmayfield.com/waterhealth/course2/content/Resources/WHO Microbial Fact Sheets/WHO Water-related diseases\\_fluorosis.htm](http://www.colinmayfield.com/waterhealth/course2/content/Resources/WHO%20Microbial%20Fact%20Sheets/WHO%20Water-related%20diseases_fluorosis.htm).