Orapuh Journal

Severity of dental fluorosis among 12-15 years old school children in Zeway, Oromia Region, Ethiopia

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A B S T R A C T

Introduction

Fluorine is the most electronegative of all chemical elements and is largely found in the chemically combined state of fluoride. Fluoride at an optimum level does not only decrease the incidence of dental caries but also maintains the integrity of oral tissues. While fluoride is accepted as being effective in the prevention of caries, the excessive consumption of fluoride can put bones and teeth at risk of developing fluorosis. Dental fluorosis is a condition affecting teeth and is caused by an increased intake of fluoride over an extended period during tooth development (until the age of six). Clinically it is characterized by hypo-mineralization with opaqueness and brownish discoloration (staining) of tooth surfaces. The degree of hypo-mineralization and staining disclose the severity of the condition.

Purpose

The purpose of this study was to assess the severity of dental fluorosis among 12-15 years old school children in Zeway, Oromia Region, Ethiopia.

Materials and Methods

A descriptive cross-sectional study was conducted between June 5 and July 9, 2018. A total of 1290 school children participated in the study. The severity of dental fluorosis was assessed using Dean`s Dental Fluorosis Index. A questionnaire, which incorporates Dean's fluorosis index was used as a data collection instrument. Careful oral examination was carried out by the calibrated researcher (clinician).

Result

Out of the total 907 study participants with the condition, 30.7% (n=278) had severe dental fluorosis followed by 31.2% (n=283) moderate, 33.8% (308) mild, 2.5% (n=23) very mild, and 1.8% (n=17) questionable. In other words, of those who had the condition, 95.7% of study participants showed mild to severe dental fluorosis. 60.7% of males and 62.9% of females manifested a moderate or severe form of dental fluorosis There was no significant gender variation of severity among the participants.

Conclusion

Majority of the participants manifested mild to severe dental fluorosis. The results of this study suggest the necessity for immediate water defluorination and the creation of oral health awareness in the study area concerning dental fluorosis.

INTRODUCTION

The prominent Greek physician, surgeon, and philosopher in the Roman Empire, Galen (1973) described what is thought to be dental fluorosis. However dental fluorosis was not recognized and scientifically studied until the early 20th century (Levy, 2011). Eager in 1901 published the first description of ''mottle enamel'' and called it ''Denti di chiaie'', named after the Italian professor Stefano Chiaie

(Eager, 1901). Later in 1931, three groups of scientists around the world found out that the disease was caused by a high dose of fluoride in drinking water during childhood (Smith, 1914).

It is hypoplasia or hypomineralization of tooth enamel or dentine produced by chronic ingestion of excessive amount of fluoride during the period when teeth are developing (Dean et al., 1942). Fluorosis can be classified as skeletal and dental based upon its occurrence in bone and teeth respectively (Ng'ang'a & Valderhaug, 1993). It can be manifested as both skeletal and dental in areas endemic to the disease (Horowitz, 1996). Dental fluorosis (also known as mottling of teeth) is an extremely common disease, described by hypomineralization of tooth enamel caused by ingestion of excessive fluoride during enamel development (Neville et al., 2015). Visually it appears as a change in enamel color (discoloration) and in some cases physical damage to the teeth (Lijima et al., 1987). The extent of severity of the condition depends on the dose, duration, and age of the individual at the time of exposure (Akosu et al., 2009). The degree of dental fluorosis can range from very mild to severe depending on the number of teeth surfaces (proportions of teeth) involved and the extent of physical damage (pitting and disfiguring) to the teeth (Dean et al., 1942).

In the past decades, a substantial decline in dental caries has occurred among children of several developed countries mainly the United States of America (USA) and several European countries (Aguilar et al., 2010; Bardesen et al., 1999). Fluoride has been recognized as one of the most influential factors responsible for the observed decline of caries among children as well as adults of these countries (Verma et al., 2017).

Fluorine is the most electronegative of all chemical elements and is largely found in the chemically combined state of fluoride (Anandhan, 2013). It is the largest naturally abundant element in the earth's crust. Fluoride is found in varying concentrations at different geographical locations on the earth (Farfan et al., 2011). One of the landmark discoveries in the history of preventive dentistry is the charismatic role of fluoride, which is used in man's battle against dental caries (Baskaradoss et al., 2008). It is considered a double-edged sword because when its level is below optimum, it does not have the caries protective action and when its concentration is above optimum, it causes

dental and skeletal fluorosis in various forms (Yeung, 2008; Forrest, 1956). Fluoride at an optimum level does not only decrease the incidence of dental caries but also maintains the integrity of oral tissues (Manji et al. 1986). While fluoride is accepted as being effective in the prevention of caries, the excessive consumption of fluoride can put bones including maxillofacial and teeth at risk of developing fluorosis (Neville, 2015; Eklund et al., 1987).

Dental fluorosis is a condition affecting teeth and is caused by an increased intake of fluoride over an extended period during tooth development (Bronckers et al., 2009). Clinically it is characterized by hypo-mineralization with opaqueness and brownish discoloration (staining) of tooth surfaces (Whelton et al., 2004; Hiremath, 2011). Fluoride ingested through drinking water during dental development, until the age of six, may promote the development of fluorosis (Hong et al., 2006; Bucher et al., 1987).

According to the world health organization (1997), more than 200 million people worldwide rely on drinking water with fluoride levels exceeding the present WHO norm of 1.5mg/l. India and Brazil are among the most highly affected countries whose drinking water has levels higher than the accepted norm of WHO recommendation (John, 2012).

Rift valley countries in East Africa, such as Kenya, Ethiopia, and Uganda are affected by the high incidence of dental fluorosis (Mulu et al., 2009; Mann et al., 1987). The Ethiopian Central Rift Valley (ECRV) with an estimated 8 million people is at risk of fluorosis (Olsson, 1978). Due to the area's geology and climate, it has some of the world's highest concentrations of fluoride in drinking water, mainly in deep wells in the semi-arid parts (WHO, 1997).

In industrialized countries, the caries decline has been related to the use of fluoride in different forms (Driscoll et al., 1983). The therapeutic range of fluoride is narrow, and an association between fluoride and drinking water and the degree of dental fluorosis has been documented worldwide (Tazawa et al., 1979). While fluoride is accepted as effective in the prevention of caries, the excessive consumption of fluoride can put bones and teeth at risk of developing fluorosis (Hazza et al., 2015). Dental fluorosis is a condition affecting teeth and is caused by an increased intake of fluoride over an extended period during tooth

development (Joshi & Sujan, 2013). Clinically it is characterized by hypomineralization with opaqueness and brownish discoloration (staining) of tooth surfaces (Fuente-Hernandez, 2011). Fluoride ingested through drinking water during dental development, until the age of six years, may promote the development of fluorosis (Farfan et al., 2011). Though fluorosis (Skeletal and Dental) in general has a discernible negative health impact on nearly tens of million world population globally and about 8 million people are at risk of the condition in the rift valley regions of Ethiopia, comparable public health actions and scientific studies have never been conducted (Fantaye et al., 2004). As a result, the global prevalence of dental and skeletal fluorosis is not entirely clear (Heifetz, 1988). This study, therefore, will be used as a base for other large-scale studies to bridge the knowledge gap in the field. The ECRV is known for its world's highest concentration of fluoride, mainly in deep wells in which little yearly rainfall appears (Mulu et al., 2009). In Zeway Town, wells had high fluoride levels (mean: 9.4-10.5 mg/l; range: 1.1 to 68 mg/l), which go beyond the WHO drinking water guideline limit of 1.5mg (WHO, 1997). This study is initiated to investigate the severity of dental fluorosis among school children aged 12-15 years in Zeway Town, Oromia region, Ethiopia.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted to assess the severity of dental fluorosis among 12-15 years old school children in Zeway. The study analyses the data collected from the study participants at a specific point and depicted the severity of dental fluorosis, which the researcher aimed to ascertain. The severity of dental fluorosis among the studied population was assessed by using the Dean`s fluorosis index and the modified World Health Organization oral health assessment form (1997).

Sampling

The sample size is calculated by the sample size formula for prevalence studies. With a 95% confidence interval, 10% non-response rate, and 5% margin of error, 1290 study participants were involved in this descriptive cross-sectional study.

Data Collection Instrument

In this research, a structured data collection approach was applied. Information was gathered from participants in a comparable pre-specified way. The questionnaire that incorporates the Dean`s Fluorosis Index and the WHO oral

health assessment form was used. The questionnaire was completed by the researcher (clinician) after conducting a careful oral examination. Headlight, wooden spatula, and disposable gloves were used during the clinical oral examination.

Data Analysis

The Statistical Package for the Social Sciences (SPSS) Version 20.0 was used to analyze the quantitative data. Data were checked for completeness before analysis.

Ethical Clearance

The Oromia regional health authority approved the in-country clearance after investigating the research proposal. Furthermore, the Zeway Town health and educational authorities wrote permission letters to all primary schools directors to assist, facilitate and cooperate with the researcher to conduct the research.

RESULT

The main objective of this study was to assess the severity of dental fluorosis among 12-15 years old school children in Zeway. The findings have been organized around this objective.

Socio-Demographic Characteristics

The socio-demographic characteristics of the respondents are described according to gender, age group, and residential areas.

i.   *Gender of the studied population*
     Out of the total 1290 studied population, 636 (49.2%) were males while the remaining 654 (50.8%) were females. Relatively, more females than males participated in the study.

ii. *Age of the studied population*
     37.05% (n=478) of the total studied population were 12 years old, followed by 13- and 14-years old children with 31.9% (n=411) and 26.7% (n=345), respectively. The rest 4.3% (n=56) were 15 years old.

iii. *Residential conditions (areas) of the studied population*
     Out of the total respondents, 90% (n=1161) were urban residents followed by 6% (78) and 4% (51) semi-urban and rural residents, respectively.

Findings on the research main objective

The prime objective of this study was to assess the severity of dental fluorosis among school children, aged 12-15 years

in Zeway. Hence, the results of the study have been organized around the objective.

i. *Occurrence of dental fluorosis in the total studied population*
   Dental fluorosis was seen among 70.3% (n=907) of the total study participants. The condition occurred among 67.6% (n=785), 88.1% (n=69) and 88.3% (45) urban, semi-urban and rural respondents. Out of the total presentations, dental fluorosis appeared among 70.7% (n=450) male and 70% (n=458) female study participants.

ii. *The severity of dental fluorosis in the total studied population*
   From the total 907 study participants with the condition, 30.7% (n=278) had severe dental fluorosis followed by 31.2% (n=283) moderate, 33.8% (308) mild, 2.5% (n=23) very mild, and 1.8% (n=17) questionable. **(Table 1)**.

iii. *The severity of dental fluorosis by residential settings*
   Out of the total 785 urban study participants with the condition, 23% (n=181) had severe dental fluorosis. 30% (n=235), 32.5% (n=255), 6.6% (n=52) and 7.9% (n=62) had moderate, mild, very mild, and questionable respectively. Similarly, from the total 69 semi-urban study participants with the condition, 21.2% (n=15) were with severe dental fluorosis. 29.9% (n=21), 36.5% (n=25), 5% (n=3) and 7.4% (n=5) were moderate, mild, very mild, and questionable respectively **(Table 2 & 3)**.

   On the other hand, out of the total 45 rural respondents with the condition, 36.8% (n=17) were with severe dental fluorosis. 35.6% (n=16) and 27.6% (n=12) had moderate and mild, respectively. There were no very mild and questionable cases in the rural studied population. In other words, the rural study participants are severely affected compared to the urban and semi-urban **(Table 4)**.

iv. *The severity of dental fluorosis by gender*
   From the total 450 male participants with the condition, 29.6% (n=133) had severe dental fluorosis followed by 31.1% (n=140), 33.8% (152), 3.4% (n=15) and 2.1% (n=10) who had moderate, mild, very mild, and questionable respectively. On the other hand, out of the total 458 female participants with the condition, 31.6% (n=145) had severe dental fluorosis followed by 31.3% (n=143), 33.9% (n=155), 1.7% (n=8) and 1.6% (n=7) who had moderate, mild, very mild and questionable,

respectively. Comparatively, female study participants had presented more severe and moderate cases **(Table 1)**.

v. *The severity of dental fluorosis by age group*
   The severity of dental fluorosis increased with increasing age except in the 13 years old study participants **(Table 1)**.

DISCUSSION
The severity of dental fluorosis in the urban, semi-urban, and rural samples was calculated. The rural study participants were more severely affected compared to the urban and semi-urban. Out of the total 907 study participants with the condition, 30.6% (n=278) had severe dental fluorosis followed by 31.2% (n=283), 33.8% (308), 2.5% (n=23) and 1.8% (n=17) who had moderate, mild, very mild, and questionable, respectively. From the total 450 male study participants with the condition, 29.6% (n=133) had severe dental fluorosis followed by 31.1% (n=140), 33.8% (152), 3.4% (n=15) and 2.1% (n=10) who had moderate, mild, very mild, and questionable respectively. On the other hand, out of the total 458 female study participants with the condition, 31.6% (n=145) were with severe dental fluorosis followed by 31.3% (n=143), 33.9% (n=155), 1.7% (n=8) and 1.6% (n=7) who had moderate, mild, very mild, and questionable respectively. In other words, comparatively female study participants had presented more severe and moderate cases. A study that assessed the prevalence and severity of dental fluorosis in adolescents aged 12 and 15 living in communities with various fluoride concentrations has shown similar findings (Pontigo-Loyola & Medina-Solis, 2010).

Other similar studies on the severity of dental fluorosis have measured the severity of dental fluorosis in terms of Thylstrup-Fejerskov (TF) (Bhagavatula, et al., 2016). A study that was conducted to assess the prevalence and severity of dental fluorosis in 513 primary school children in Nairobi revealed the severity as TF > 5 (Ng'ang'a & Valderhaug, 1993; Manji, et al. 1986). Furthermore, another cross-sectional descriptive study to assess the severity of dental fluorosis among 6-12 years old school children reported a TF measurement of 6. Thylstrup-Fejerskov score > 5 is equivalent with severe categories of Dean's fluorosis classification (Akosu et al., 2009).

Like this descriptive cross-sectional study, a research conducted in Gaza strip, Israel, which consisted of 182 adolescents 15- 16 years old that showed a 100% prevalence rate, with 53 subjects demonstrating mild fluorosis, 83 and 46 demonstrating moderate and severe dental fluorosis, respectively (Mann et al., 1987). Similarly, a study conducted in Ethiopia in 2004 to assess the sociodemographic and behavioral correlates of severe dental fluorosis among 233, 12-15 years old children reported a prevalence of severe dental fluorosis as 24.1% (Fantaye, et al., 2004).

Unlike the findings of this study, the cross-sectional survey that was conducted in two cantons of Switzerland to assess the prevalence of enamel fluorosis among 12 year-old children reported mild and very mild conditions. Out of the 373 school children studied in 1999 in Basel-Stadt, 119 (31.9%) presented fluoride-associated enamel opacities with 66 (17.7%) a very mild and 47(12.6%) a mild form (Bucher, et al., 1987). The prevalence and severity of dental fluorosis were reported to be significantly low in European countries compared to the findings of this study (Pretty, et al., 2016). The main factor to this variation is that most European countries have managed to defluorinate their drinking water several decades ago (Buzalaf, 2018). Moreover, unlike the age-related finding of this study, a cohort study has shown a decline in dental fluorosis severity during adolescence (Curtis et al., 2020).

Several studies in developing countries have revealed that dental fluorosis is a public health problem (Nadeef, 1998). The present study has also revealed the severity of dental fluorosis among school children, aged 12-15 years. Of those who had the condition, 95.7% of study participants manifested mild to severe dental fluorosis. This is considered high.

CONCLUSIONS

This study has explored the grievousness of dental fluorosis among 12-15 years old school children in Zeway Town, Ethiopia. In addition to the high fragility of teeth with dental fluorosis, the aesthetic and psychological impact among youth is very high (Anandhan, 2013). Therefore, the findings of this study indicated the necessity for immediate interventions to tackle the problem in Zeway and across the Rift Valley regions. The findings of this study should provide public health professionals, governmental and non-governmental officers baseline evidence-based data for interventional policy development. Furthermore, the information should be used as baseline data for further research. Last but not the least, the importance of delivering treatment modalities to restore the aesthetic disharmonies among the youth should not be undermined.

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APPENDIX

Table 1:
The severity of dental fluorosis in the total studied population

Age in years	Sex	Sample	Index	The severity of Dental Fluorosis by %					
				Normal	*Questionable*	*Very Mild*	*Mild*	*Moderate*	*Severe*
	M	250	Dean/CFI	35.1	2.4	1.7	23.8	21.5	15.5
12	F	214	Dean/ CFI	26.1	3	2.1	32.4	22.1	14.3
	M	212	Dean/CFI	26.1	2.9	2.2	29.1	27.2	12.5
13	F	211	Dean/CFI	37.5	1.2	1.2	24	22.6	13.5
	M	148	Dean/CFI	26	2.5	2.7	25.3	22.4	21.1
14	F	198	Dean/CFI	28.7	1	2.3	22.2	26.1	19.7
	M	26	Dean/CFI	20	None	4.5	18.2	32.7	24.6
15	F	31	Dean/CFI	19.3	4.1	5.2	12.5	30.1	28.8
Total	M	636	Dean/CFI	29.3	1.5	2.4	23.9	21.97	20.9
	F	654	Dean/CFI	30	1.1	1.2	23.7	21.9	22.1
Total	M+ F	1290	Dean/CFI	29.7	1.3	1.8	23.8	21.94	21.5

Table 2:
he severity of dental fluorosis in the urban studied population

Age in years	Sex	Sample	Index	The severity of Dental Fluorosis by %					
				Normal	*Questionable*	*Very Mild*	*Mild*	*Moderate*	*Severe*
	M	18	Dean/CFI	11.1	6.7	6.7	32.7	27.1	15.7
12	F	13	Dean/CFI	23.1	None	9.1	20.3	29.4	18.1
	M	18	Dean/CFI	5.6	None	6.3	48.2	15.5	24.4
13	F	12	Dean/CFI	16.7	10	None	28.3	25	20
	M	7	Dean/CFI	14.3	None	None	33.3	52.4	None
14	F	6	Dean/CFI	None	20	None	None	80	None
	M	1	Dean/CFI	100	None	None	None	None	None
15	F	3	Dean/CFI	66.7	33.3	None	None	None	None
Total	M	44	Dean/CFI	9.1	2.6	5.3	32.4	30.1	20.5
	F	34	Dean/CFI	14.7	10.3	3.5	31.9	22.7	16.9
Total	M + F	78		11.9	6.45	4.4	32.15	26.4	18.7
	12 -15 years								

Table 3:
The severity of dental fluorosis in Semi-urban studied population

Age in years	Sex	Sample	Index	The severity of Dental Fluorosis by %					
				Normal	*Questionable*	*Very Mild*	*Mild*	*Moderate*	*Severe*
	M	11	Dean/CFI	None	None	None	30	20	50
12	F	9	Dean/CFI	11.1	None	None	13.9	25	50
	M	10	Dean/CFI	20.0	None	None	11.1	34.4	34.5
13	F	9	Dean/CFI	11.1	None	None	50	38.9	None
	M	5	Dean/CFI	20.0	None	None	50	30	None
14	F	7	Dean/CFI	14.3	None	None	None	33.3	52.4
	M	15	-	-	-	-	-	-	-
15 (No Participants)	F	15	-	-	-	-	-	-	-
Total	M	26	Dean/CFI	11.5	None	None	26	38.5	24
	F	25	Dean/CFI	12.0	None	None	22.7	24.4	40.9
Total	M + F	51	Dean/CFI	11.75	None	None	24.35	31.45	32.45
	12 - 15 years								

Table 4:

The severity of dental fluorosis in the rural studied population

Age in years	Sex	Sample	Index	The severity of Dental Fluorosis by %					
				Normal	*Questionable*	*Very Mild*	*Mild*	*Moderate*	*Severe*
	M	18	Dean/CFI	11.1	6.7	6.7	32.7	27.1	15.7
12	F	13	Dean/CFI	23.1	None	9.1	20.3	29.4	18.1
	M	18	Dean/CFI	5.6	None	6.3	48.2	15.5	24.4
13	F	12	Dean/CFI	16.7	10	None	28.3	25	20
	M	7	Dean/CFI	14.3	None	None	33.3	52.4	None
14	F	6	Dean/CFI	None	20	None	None	80	None
	M	1	Dean/CFI	100	None	None	None	None	None
15	F	3	Dean/CFI	66.7	33.3	None	None	None	None
Total	M	44	Dean/CFI	9.1	2.6	5.3	32.4	30.1	20.5
	F	34	Dean/CFI	14.7	10.3	3.5	31.9	22.7	16.9
Total	M + F	78		11.9	6.45	4.4	32.15	26.4	18.7
	12 -15 years								