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

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ABSTRACT

Introduction
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.

Purpose
The objective of this study was to assess the prevalence of dental fluorosis among school children from 12-15 years of age in Zeway, Oromia Region, Ethiopia.

Materials and Methods
A descriptive cross-sectional study was conducted between June 5, 2018, and July 9, 2018. A total of 1290 school children participated in the study. The prevalence of dental fluorosis among the studied population was assessed by using the World Health Organization's oral health assessment form (1997).

Result
The overall prevalence of dental fluorosis among the studied population was 70.3%. The prevalence varies among residents in different social settings, for example, it was 67.6%, 88.1%, and 88.3% among urban, semi-urban, and rural study participants. The prevalence was more in males (70.7%) than females (70%).

Conclusion
The high prevalence of dental fluorosis suggests that fluorosis is a major public health problem in the study area. In the planning of general strategic interventions, including water treatment and social awareness creation, more attention needs to be given to the rural and semi-urban communities on Oromia Region, Ethiopia.

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 prevalence 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 prevalence of dental fluorosis among 12-15 years old school children in Zeway. The study analysed the data collected from the study participants at a specific point and depicted the prevalence of dental fluorosis, which the researcher aimed to ascertain. The prevalence of dental fluorosis among the studied population was assessed by using the modified World Health Organization's oral health assessment form that incorporates Dean`s Fluorosis Index (1997).

Sampling

The sample size was 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. A 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 prevalence 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. The study was carried out in schools located in the urban area of Zeway town. This explains the significant variation observed in this study between the number of study participants in the urban and semi-urban and rural areas. Moreover, children in semi-urban and rural areas tend to help their families in

household and field works rather than going to school.

Findings on the research's main objective

The prime objective of this study was to assess the prevalence of dental fluorosis among school children, in Zeway. Hence, the results of the study have been organized around the objective.

i. Prevalence of dental fluorosis in the total studied population

The prevalence of dental fluorosis was 70.3% (n=907) among the general study participants. Prevalence of 67.6% (n=785), 88.1% (n=69) and 88.3% (45) among urban, semi-urban and rural respondents were recorded, respectively **(Table 1)**.

Tables 1:
Prevalence of dental fluorosis in the total studied population

Age in years	Sex	Sample	Index	Prevalence of Dental Fluorosis	
				Prevalence of Dental Fluorosis by %	*Prevalence of Dental Fluorosis by %*
	M	250	Dean/CFI	64.9	69.4
12	F	214	Dean/CFI	73.9	
	M	212	Dean/CFI	73.9	68.2
13	F	211	Dean/CFI	62.5	
	M	148	Dean/CFI	74	72.7
14	F	198	Dean/CFI	71.3	
	M	26	Dean/CFI	80	80.4
15	F	31	Dean/CFI	80.7	
Total	M	636	Dean/CFI	70.7	70.3
	F	654	Dean/CFI	70	
Total	M+ F	1290	Dean/CFI	70.3	70.3

ii. Prevalence of dental fluorosis by gender

The prevalence of dental fluorosis was recorded relatively more in males than females with 70.7% (n=450) and 70% (n=458) among the total study participants, respectively **(Table 1)**. Similarly, the prevalence of dental fluorosis in the urban sample was more in males at 71.4% (n=404) than in females at 64% (n=380). The prevalence of dental fluorosis in the semi-urban population studied was also more in males at 90.9% (n=40) than in females at 85.3% (n=29) **(Table 2)**. Furthermore, the prevalence of dental fluorosis in the rural population studied was still more in males at 88.5% (n=23) than in the female [88% (n=22)] of the total studied population **(Table 3)**. Generally, the prevalence of dental fluorosis was found more in males than females in all studied groups, namely in the urban, semi-urban, and rural populations studied.

Table 4:
Prevalence and Community Fluorosis Index of the rural Studied Population

Age in years	Sex	Sample	Index	Prevalence of Dental Fluorosis	
				Prevalence of Dental Fluorosis by %	*Age-Specific Prevalence of Dental Fluorosis by %*
	M	11	Dean/CFI	100	94.5
12	F	9	Dean/CFI	88.9	
	M	10	Dean/CFI	80.0	85.5
13	F	9	Dean/CFI	88.9	
	M	5	Dean/CFI	80.0	82.9
14	F	7	Dean/CFI	85.7	
	M	15	-	-	-
15 (No Participants)	F	15	-	-	
Total	M	26	Dean/CFI	88.5	88.3
	F	25	Dean/CFI	88	
Total	M + F	51+	Dean/CFI	88.25	88.3
	12 - 15 years				

iii. Prevalence of dental fluorosis by age

The most affected age group was the 15 years old study participants with an 80.4% (n=46) prevalence rate, followed by 14 and 12 years old with 72.7% (n=252) and 69.4% (n=322), respectively. The 13 years old age group revealed a 68.2% (n=289) prevalence rate, which made this group the least affected with the disease. Prevalence of dental fluorosis in 15 years old female study participants was the highest at 80.7% (n=25), followed by 73.9% (n=158), 71.3% (n=141) and 62.5% (n=132) in 12, 14 and 13 years old female age groups, respectively **(Table 1)**.

Table 2:
Prevalence and community fluorosis index of the urban studied population

Age in years	Sex	Sample	Index	Prevalence of Dental Fluorosis	
				Prevalence of Dental Fluorosis by %	*Age-Specific Prevalence of Dental Fluorosis by %*
12	M	221	Dean/CFI	70.6	66.6
	F	192	Dean/CFI	62.5	
13	M	184	Dean/CFI	71.2	64.8
	F	190	Dean/CFI	57.4	
14	M	136	Dean/CFI	72.1	70.7
	F	185	Dean/CFI	69.2	
15	M	25	Dean/CFI	76	80.9
	F	28	Dean/CFI	85.7	
Total	M	566	Dean/CFI	71.4	67.7
	F	595	Dean/CFI	64	
Total	M + F 12 -15 years	1161	Dean/CFI	67.7	67.7

Table 3:
Prevalence and Community Fluorosis Index of the Semi-Urban Studied Population

Age in years	Sex	Sample	Index	Prevalence of Dental Fluorosis	
				Prevalence of Dental Fluorosis by %	*Age-Specific Prevalence of Dental Fluorosis by %*
12	M	18	Dean/CFI	88.9	82.9
	F	13	Dean/CFI	76.9	
13	M	18	Dean/CFI	94.4	88.9
	F	12	Dean/CFI	83.3	
14	M	7	Dean/CFI	85.7	92.9
	F	6	Dean/CFI	100	
15	M	1	Dean/CFI	0	0
	F	3	Dean/CFI	33.3	
Total	M	44	Dean/CFI	90.9	88.1
	F	34	Dean/CFI	85.3	
Total	M + F 12 -15 years	78		88.1	88.1

iv. Prevalence of dental fluorosis by residential settings

The prevalence varies among residents in different social settings, for example, it was 67.6%, 88.1%, and 88.3% among urban, semi-urban, and rural study participants. The prevalence was more in males (70.7%) than in females (70%) **(Table 1-4)**.

The prevalence of dental fluorosis in the semi-urban males' study participants was the highest relative to males in rural and urban study participants with 90.9% (n=40), 88.5% (n=23), and 71.4% (n=404), respectively. On the other hand, the prevalence of dental fluorosis in the rural females' study participants was the highest relative to females in semi-urban and urban study participants with 88% (n=22), 85.3% (n=29), and 64% (n=381), respectively **(Table 3)**.

DISCUSSION

The prevalence of dental fluorosis in this study was found to be 70.3% in the total, 67.6% in urban, 88.1% in semi-urban, and 88.3% in the rural sample. The prevalence was more in males (70.7%) than in females (70%) of the total study participants. The prevalence of dental fluorosis was also found to be more in males than in females in the total urban, semi-urban, and rural studied population at 71.4% to 64%, 90.9% to 88.5%, and 85.3% to 88%, respectively.

In the total respondents, the most affected age group with the highest prevalence was 15 years at 80.4%, followed by the 14 years old age group at 72.7%- and 12-years old age group at 69.4%. The 13 years old age group revealed a 68.2% prevalence rate, which made this group the least affected by the condition. Similar studies conducted in different parts of the world revealed comparable findings. For example; descriptive data obtained from 253 subjects in Saudi Arabia, has revealed almost similar findings. The overall prevalence of dental fluorosis among the different age groups was 73.5% (Hazza et al., 2015). The prevalence of dental fluorosis among 12- and 15-years old school children concerning fluoride concentration in drinking water in an endemic fluoride belt of Andhra Pradesh, Indian was found to be high (Shekar et al., 2012). A study undertaken to evaluate caries and dental fluorosis among Mexican preschoolers and school-aged children, in a non-endemic zone, revealed that 60% of the 11- to 12-year-old children had dental fluorosis (María Dolores Jiménez-Farfá et al., 2011).

The cross-sectional assessment of dental fluorosis and dental caries prevalence among 12-15 years old children in Nalgonda District, Andhra Pradesh, India in 2014, has also established a 76.8% prevalence rate with no gender

difference. Similar to this descriptive cross-sectional study, there was an increment of the prevalence of dental fluorosis with increasing fluoride concentration (Akosu et al., 2009). On the other hand, unlike this study, there were no gender differences in the prevalence of dental fluorosis. However, there was no statistically significant difference in the prevalence of dental fluorosis between 12 and 15-years-old children (Bajaj & Shetty, 2013). Similarly, a descriptive study in Nairobi, Kenya in 1993 has shown a 76% prevalence rate in 13-15 years old primary school children with permanent dentition (Ng'ang'a & Valderhaug, 1993).

Unlike this study, studies in developed countries have revealed a much lower prevalence rate. For example, the study which was conducted in Western Norway to assess the prevalence and severity of dental fluorosis among persons exposed to moderate to high and low fluoride drinking water has revealed 14.3% among the consumers of low-fluoride water compared to 78.8% in the group consuming moderate- to high-fluoride water (Bärdsen et al., 1999).

The National Centre for Health Statistics assessed the prevalence and severity of dental fluorosis in the United States, 1999-2004. The statistics showed that adolescents aged 12-15 had the highest prevalence of fluorosis with 40.6% (Neurath et al., 2019). However, several developing countries have a lower prevalence and severity of dental fluorosis (Pretty, 2016). Unlike this descriptive cross-sectional study, the prevalence was lower among older age groups. The lowest prevalence was among those aged 40-49 (8.7%). The prevalence of dental fluorosis among children aged 6-11 (33.4%) was lower than the prevalence among those aged 12-15 (40.6%). A study that assessed the 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, India has shown corresponding findings (Shekar et al., 2012).

CONCLUSION

To continue developing evidence-based health care, relevant and well-designed research is essential. Dental fluorosis is an extremely common teeth disorder characterized by hypomineralization of tooth enamel caused by ingestion of excessive fluoride during enamel formation. But there are limited scientific studies done in Ethiopia, particularly in the Rift Valley regions including Zeway on the prevalence of dental fluorosis. The 70.3% prevalence rate finding in this study is an indication of how highly and seriously the communities in the town are affected by the problem. It is also a signal to the responsible professionals, officers, and authorities to take extensive actions to overcome the condition.

The corresponding declining prevalence rate of dental fluorosis with urbanization in this study revealed the importance of prioritizing the potential intervention. The information obtained from this study could be baseline data to conduct further detailed epidemiological studies in the region to evaluate the risk factors, prevalence, and severity of dental fluorosis. On the other hand, oral health education regarding oral hygiene, diet, and water consumption should be initiated by appropriate authorities. Defluorination or water treatment to remove excess fluoride from drinking water should be improved.

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Ethical Approval: 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 school directors to assist, facilitate and cooperate with the researcher to conduct the research.

Conflict of Interest: The authors declare no conflict of interest.

ORCID iDs: Nil identified

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