Fluoride distribution in drinking water and survey of dental Fluorosis among schoolchildren in the North West of Libya

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Abstract

Fluoride in drinking water has become a significant issue worldwide since it puts 200 million people at risk for developing dental and/or skeletal fluorosis, most of whom are from tropical nations. One of the most significant toxicological and geo-environmental problems nowadays is the issue of high fluoride concentrations in groundwater sources. It is a well-known geochemical association that there is a correlation between the geochemistry of the water in a region and the prevalence of dental and skeletal fluorosis.

Objective: This study aimed to determine the fluoride accumulations in the drinking water of North West of Libya and evaluate the detected data in terms of teeth health of local people.

Materials and methods: The area of North West of Libya consists of five cities and villages that we included in the study, Essabria, West Zawiya, Surman, Sabratah, Al Ajaylat. In most of the cities, groundwater is the only source of drinking water and the selected stations. In order to explore fluoride's impact on dental health and compliance, the fluorosis data was collected from school children (ages 6–9) who had lived in the cities for at least a couple of decades and consumed drinking water from the same source.

Results: the water samples collected from five cities of the west of libya showed fluoride concentration in the range 1.03–2.05 mg/L. The mean value of fluoride was highest in Essabria city (2.05 mg/L) and Al Ajaylat city (2.03 mg/L), and the lowest was found in West Zawiya Villages (1.03 mg/L).A total of 315 individuals were screened, of whom 209 (66.3%) were observed to be affected by dental fluorosis. While 106 cases (33.7%) was unaffected by dental fluorosis.

Keywords: Dental fluorosis; Drinking water quality; Ground water; Teeth health

Introduction

One of the most important chemical elements for human health is fluoride. Human health is closely related to levels of fluoride in the environment [1]. Intake of too much fluoride can cause skeletal and dental changes, which is called fluorosis [2]. It is known as dental fluorosis, and it occurs when fluoride interferes with the processes involved in the formation of the dental hard tissues.

The macroscopic alterations associated [3,4,5,6,7-8]. As a result of a high fluoride concentration in groundwater sources, Libya is experiencing one of its most important toxicological problems. Geochemical evidence links fluoride geochemistry of water in an area with dental fluorosis. Fluoride's need for human health is still debated, but its toxicity is a major concern in many countries where excessive amounts of fluoride are introduced into their water supply [9]. Early childhood exposure to fluoride may damage tooth-forming cells, A defect in the enamel is known as dental fluorosis as a result of this condition.As per the recommendations of the World Health Organization (WHO) [10], 1.0 mg/L of fluoride is allowed in drinking water. Fluoride-induced dental fluorosis, tooth mottling, skeletal fluorosis (more than 6 mg/l), and bone deformation are some of the major health problems caused by excessive fluoride [11]. Fluoride is considered as an essential element that prevents dental caries (WHO) and hence added to many water supply schemes and toothpastes. However, when fluoride exceeds 1.5 mg/L in drinking water, it could cause dental mottling and discolouration, commonly known as dental fluorosis. Excessive intakes of fluoride also deform bones and crippling ensures. The World Health Organization (WHO) therefore has set guidelines for fluoride levels in drinking water (Table 1). This study aimed to determine the fluoride accumulations in the drinking water of North West of Libya and evaluate the detected data in terms of teeth health of local people.

Table 1: WHO guideline for fluoride in drinking water

Concentration of fluoride (mg/L)	Impact on health
0.0-0.5	Limited growth and fertility, dental carried
0.5-1.5	Promotes dental health, prevents tooth decay
1.5-4.0	Dental fluorosis (mottling of teeth)
4.0-10.0	Dental fluorosis, skeletal fluorosis (pain in back and neck bones)
>10.0	Crippling fluorosis

Materials and methods:

Study area:

The area of North West of Libya consists of five cities and villages that we included in the study, Essabria, West Zawiya, Surman, Sabratah, Al Ajaylat. In most of the cities, groundwater is the only source of drinking water and the selected stations are given in Fig 1. The groundwater source was taken by pumps, and desalinated by Home Desalination Plants (HDP).

Water samples were collected from each city from (HDP). A total of five samples were collected from selected sources of each city to represent the water quality of the whole area. The samples were collected in pre-cleaned bottles and transported to the laboratory.

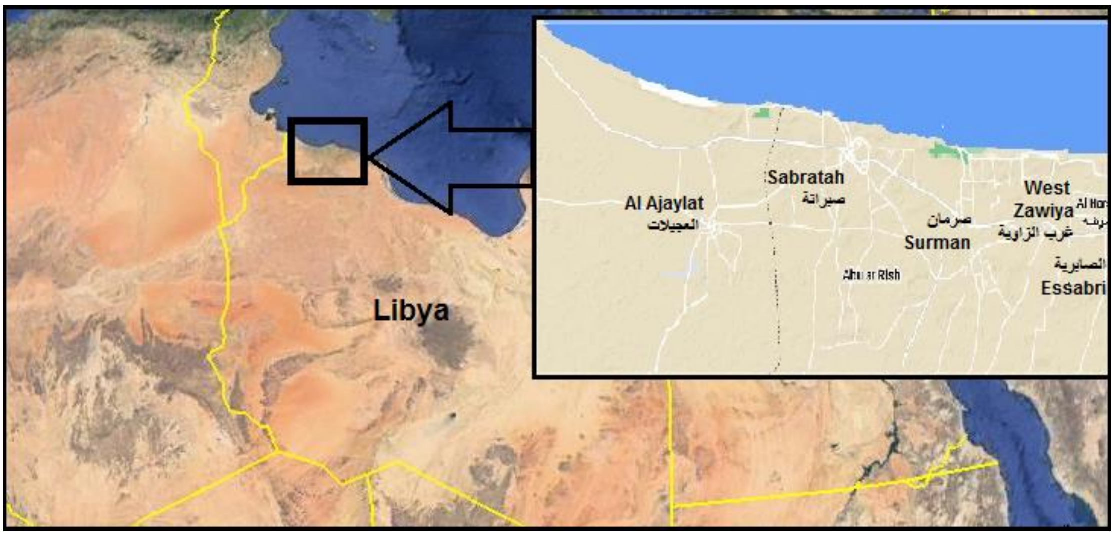

Fig 1. Location map of water sampling in North West of Libya.

Source of data

In order to explore fluoride's impact on dental health and compliance, the fluorosis data was collected from school children (ages 6–9) who had lived in the cities for at least a couple of decades and consumed drinking water from the same source as they did when they were young.

The data were collected through interviews and clinical examinations. To learn more about fluorosis' natural history, we conducted a face-to-face interview. Questionnaires with pre-coded information were used for data collection. This survey is intended to identify the causes of dental fluorosis in children resulting from the high fluoride concentrations in drinking water. As well as the dental fluorosis survey, six water samples were collected at different locations across the region. Samples were analyzed in laboratory for fluoride concentration (Table 2). The fluoride content in the water samples was determined by the DR6000 UV VIS Spectrophotometer with RFID Technology.

Chemical Analysis

Fluoride parameter was determined by using the spectrophotometric method during the laboratory studies with a "Hach Lange DR 3900 Spectrophotometer" device (wavelength range 320 – 1100 nm). Cuvette Test LCK 323 was used in spectral photometer. This method provides fluoride ions to react with zirconium to form a colorless zirconium fluoride complex. This causes the red zirconium lake which is present to lose color (https://tr.hach.com/).

Statistical Analysis

Data were statistically analyzed by using IBM Statistical Package for Social Science (SPSS), Version 21.0 (SPSS, Chicago, IL, USA). Descriptive statistics includes tables and graphs. One-Sample T- Test and one-way ANOVA test calculated the analyses of dental fluorosis concentration. A *p*-value of <0.05 was considered statistically significant.

Result:

The study included 5 cities and villages, and Results of investigated showed that fluoride parameter in Essabria was 2.05 **mg/L** and Al Ajaylat was 2.03 **mg/L**. additionally, fluoride parameter in Surman was 1.57 **mg/L** and Sabratah was 1.41 **mg/L**. While, fluoride parameter in West Zawiya was 1.03 **mg/L**, with a minimum, maximum and mean values and some national and international water quality standards are given in Table 2.

Table 2: Results of detected data with area of North West of Libya

Cities	F- (mg/L)
Essabria	2.05
West Zawiya	1.03
Surman	1.57
Sabratah	1.41
Al Ajaylat	2.03
TS266 (2005)	1.50
EC (2007)	1.50
WHO (2011)	**1.50**

TS266 – Turkish Standards Institute; EC – European Communities;
WHO – World Health Organization

In addition, the water samples collected from five cities of the west of libya showed fluoride concentration in the range 1.03–2.05 mg/L. The mean value of fluoride was highest in Essabria city (2.05 mg/L) and Al Ajaylat city (2.03 mg/L), and the lowest was found in West Zawiya Villages (1.03 mg/L).A total of 315 individuals were screened, of whom 209 (66.3%) were observed to be affected by dental fluorosis. While 106 cases (33.7%) was unaffected by dental fluorosis (Table 2, 3. Figs. 2).

Table 3: Cities and Fluoride Concentration Crosstabulation

			Fluoride concentration		Total
			unaffected	affected	
Cities	Essabria	Count	33	39	72
		% of Total	10.5%	12.4%	22.9%
	West Zawiya	Count	17	39	56
		% of Total	5.4%	12.4%	17.8%
	Surman	Count	26	30	56
		% of Total	8.3%	9.5%	17.8%
	Al Ajaylat	Count	25	51	76
		% of Total	7.9%	16.2%	24.1%
	Sabratah	Count	5	50	55
		% of Total	1.6%	15.9%	17.5%
Total		Count	106	209	315
		% of Total	33.7%	66.3%	100.0%

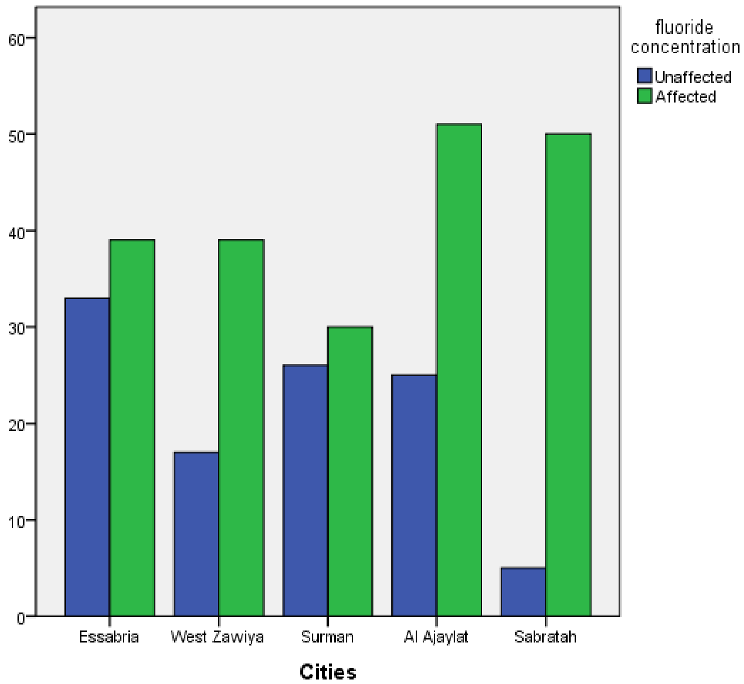

Fig.2. Cities and Fluoride Concentration distribution

In addition to, the result showed that the analyses of dental fluorosis concentration when calculated by One-Sample T- Test showed that Mean value of sample to STD was 1.65 ± 0.391 and A *p*-value of <0.05 in One-Sample T- Test (p= 0.001) and when compare it with cities p-value of <0.05 in one way – ANOVA test (p=0.001) so By collecting the samples and comparing them with the control value, there were high significant statistically differences as shown in table 4.

Table 4:- Statistical Analysis

	Mean	Std. Deviation	Sig. (2-tailed)
One-Sample T- Test	**1.6563**	**.39631**	**.0001**
one way – ANOVA	**-**	**-**	**.0001**

Discussion:

Groundwater's availability and safety have become issues of concern all over the world due to its significance to human survival [12]. It is the principal wellspring of drinking water, and there are numerous toxins in groundwater that might antagonistically affect human well-being [13]. Nitrate and fluoride are the most common of these contaminants. Fluoride can be ingested directly through drinking water, and depending on the concentration and amount consumed daily; It can be beneficial to human health or harmful [14]. Drinking water with ideal fluoride levels preventively affects dental caries. Between 0.7 and 1.2 mg/L, fluoride provides protection against dental caries in children and reduces the risk of dental fluorosis in drinking water, which is the recommended and permitted level for preventing dental caries [15, 16]. However, consuming an excessive amount through drinking water may be harmful to one's health. Fluorosis can occur when a person is exposed to fluoride levels that are higher than the recommended level (14, 17–18). This study's findings support a number of other recent studies that show the prevalence of dental fluorosis increases with fluoride concentration in drinking water [19, 20, 21-22]. Dental fluorosis was found in 66.3% of children in this study. This suggests that even in areas with almost identical fluoride levels in drinking water, the prevalence of dental fluorosis can vary greatly. According to these findings, the prevalence of dental fluorosis is influenced by a number of other factors in addition to the concentration and duration of exposure to water fluoride.

These factors include nutrition, habits, and dissolved salts in drinking water. The majority of fluoride intake comes from water. According to WHO guidelines, the optional fluoride concentration in drinking water should remain below 1.0 mg/l (1.0 ppm) in warm regions, while it can rise to 1.2 mg/l in cooler regions. The difference is caused by the fact that we sweat more and consume more water in hot weather. The WHO rule an incentive for fluoride in water isn't widespread. Environmental fluoride levels are closely linked to human health [10]. The human body's inhibition of active enzymatic processes, which disrupts the endocrine system and causes fluorosis [23], is the cause of fluorosis, which is caused by the destruction of metabolic calcium and phosphorus [24]. It has long been known that taking in too much fluoride can have serious health effects. The mineral hydroxyl apatite (Ca5(PO4)3OH) makes up the enamel of a human tooth, which is the body's hardest part. Fluoride ions begin to replace the hydroxyl ions in the apatite structure when an excessive amount is ingested. This results in the formation of fluoroapatite [Ca5(PO4)3F], which causes the tooth to become brittle and discolored. Dental fluorosis is the term for this. Dental fluorosis, or discolored, blackened, mottled, or chalky-white teeth, is a clear sign that the teeth were exposed to too much fluoride when they were young. Skeletal fluorosis, characterized by severe and enduring bone and joint deformations, can result from consuming an excessive amount of fluoride on a regular basis. However, physical tooth damage from fluorosis is not the only cause for concern. The National Institute of Mental Health (NIMH) expressed concern about the psychological effects that dental fluorosis may have on children more than two decades ago. The study found that children with severe dental fluorosis are more likely than their peers to view them as less intelligent, less attractive, less social, less happy, less careful, less hygienic, and less reliable, which may have a significant impact on a child's sense of self-worth [24,25]. Whether dental or skeletal, fluorosis is irreversible and no treatment exists. Preventing tooth decay by consuming fluoride within safe limits is the only option. Utilizing alternative water sources, removing excess fluoride, and improving the nutritional status of the population at risk can all reduce or prevent fluoride poisoning. As a result, fluorosis is mostly caused by fluoride in drinking water in these villages. According to Xiang et al.'s findings, there were significant dose-response relationships between the prevalence of dental fluorosis, serum fluoride, and water fluoride [23]. This study aids in the implementation of programs to achieve children's optimal health by providing an overview of the current prevalence of caries and the treatment requirements among schoolchildren in the west of Libya.

Conclusion:

The concentration of fluoride in five identified sources of water west of Libya was revealed by this study. In some instances, the prevalence of dental fluorosis was slightly higher among individuals who consumed water from Home Desalination Plants (HDP). Dental fluorosis was less common in Sabratah and the West Zawiya Villages than in Essabria and Al Ajaylat. Except in two instances, the results showed that nitrate and fluoride levels were generally lower than the WHO's recommendations. Since drinking water directly affects human health, this is an important finding. It is evident from the present study's findings that infants and children are more likely than adults to experience adverse health effects from drinking water containing fluoride and nitrate.

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