

The Cities with Inhabitants which Suffering from Dental Fluorosis, Is the Drinking Water the Only Reason? Epidemiologic Report

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Abstract

The most cities which their inhabitants are suffering from fluorosis, located in plain regions or margins of seas. However; there are some other cities located in high and mountainous regions with high prevalence of the fluorosis. Fluoride is not entered to the body only through drinking water, but it could also enter through food products especially teas and sea foods. The high level of fluoride in some food products, in a region, may be due to the high level of fluoride in drinking or agricultural waters and soil of the region or both. Excessive amount of fluoride in air may also cause fluorosis and this is especially true for cities that are located near Volcanoes, coal mine or Aluminum factory. Studies have shown in cities that are located in high regions and fluoride in drinking and agriculture waters is higher than normal range, severity of fluorosis is more than cities with the same level of fluoride in waters but located in lower-high areas. It seems living in high regions is caused relative hypoxia in the tissues as a result of decreased oxygen pressure; therefore there would be more fluoride retention in the tissues. The studies have shown in areas with high fluoride in waters and/or food products, the fluorosis is more prevalent in the rural regions than

neighbor urban regions. It seems malnutrition and nutritional deficiencies are more prevalent in rural regions than urban regions. In the tooth formation process, nutritional deficiencies (particularly proteins, vitamins A, B deficiencies) are result in a weak enamel matrix which is more touched by high levels of fluoride consumed. In these cases, the final result is dental fluorosis with high severity.

Keywords: Fluoride; Fluorosis; Drinking Water

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Introduction

Fluoride is considered as a double-edged sword; lack of it in drinking water and foods will increase dental caries and excessive fluoride may result in dental and skeletal fluorosis. This is due to the fact that 95% of absorbed fluoride can be found in bones and teeth. The main source of fluoride entering body is naturally occurring fluoride in drinking water [1]. It has

been estimated that fluorosis is a public health problem in at least 26 countries of the world. These countries are located so called on fluoride geographical belts and include a wide range of countries; from Turkey to Northern Thailand and China through Iran, Saudi Arabia, Qatar, Yemen, United Arab Emirates, Pakistan, India and Sri Lanka. Another belt is Turkey via Jordan, Israel, Palestine, Egypt, Libya, Algeria to Morocco, Nigeria and from Egypt and Sudan to Kenya, Uganda, Tanzania, and South Africa. In the Americas, a similar belt stretches from USA, Mexico and Central America along the foothills of the Andes to Northern Chile. The concentrations as high as 95 ppm have been recorded in Tanzania and the highest natural fluoride concentration in water ever found was in Lake Nakuru in the Rift Valley in Kenya at 2800 ppm. The soil at the Lake Shore contained up to 5600 ppm and the dust in the huts of local inhabitants contained 150 ppm [2]. In the world, India and China are worst affected. It has been estimated that about 66 million people in India are drinking water with excessive amount of fluoride. In the 15 states in India, in North-west and south of the country, the people drink water with more than 1.5 ppm (milligram per liter) fluoride which causes various degrees of dental and skeletal Fluorosis [1]. We will next refer to countries with the most available published reports on prevalence of fluorosis among residents of their cities and discuss about the reasons for occurrence of fluorosis in the some cities.

Turkey

Dental fluorosis is prevalent in some regions of Turkey [3]. Isparta Province, located in the Southwest of Anatolia with 1.5-4.0 ppm fluoride in drinking water. Dogubeyazit and Caldiran areas, located around Tendurek Volcano in eastern Turkey. Where natural waters contained fluoride levels between 2.5 and 12.5 ppm. It seems Tendurek Volcano is origin of high fluoride in the waters of the areas. - Inhabitants in Gullu village of Esme-Usak, located in south-midwest of the country, have shown mild to moderate levels of dental fluorosis. The fluoride contents of the deep well waters used for drinking in the village, varied from 0.7 to 2.0 ppm. Dental fluorosis has observed in the inhabitants in Kizilcaoren village of Beylikova town in

Eskisehir province situated in the Midwest of Turkey, where the fluoride content of the drinking waters ranged from 3.9 to 4.8 ppm.

Iran

Iran is a vast country with the area and population of more than 76091000 people. Persian Gulf is located in southern margin of Iran. Cities like Bandar Lenge, Bastak, Borazjan and Deir are located along Persian Gulf. In these cities, the level of fluoride in drinking water has been reported 1.35 to 2.12 ppm with associated moderate to severe dental fluorosis among the residents. Apparently; in these cities which are located in plain warm regions, rivers streaming from mountainous areas towards Persian Gulf transfer fluorine with washed soil from mountain to plain areas and consequently the fluoride level in ground water is elevated. Hot weather which increases water consumption and high consumption of sea foods like fish, shrimp will increase prevalence of the fluorosis. Furthermore, the Fluorosis has been reported in central parts of Iran. In southeast of Isfahan (in Jarghooye and Rahmat-abad areas), the level of fluoride in water has been reported about 1.35 ppm. Dental fluorosis has also been reported among the residents of these areas which are located in arid region. In another region located around desert of central Iran, in a town called Aghda (Yazd Province) the level of fluoride in drinking water has been reported 1.41 ppm accompanied with dental fluorosis. It seems in Aghda, Jarghuye and Rahmatabad, the flowing waters from Zagros mountain chains take high amount of fluoride into underground water resources of these regions and consequently the drinking water used by the residents of the region will contain high levels of fluoride [4]. Makoo city in west Azerbaijan province is located in northwest of Iran near the border of Turkey in a mountainous area on relatively high hillsides. The high prevalence of dental fluorosis has been reported in this city [5]. It seems the city's altitude (height from the sea level) and vicinity to Tendurek volcano in Turkey, has contributed to increase the prevalence and severity of dental fluorosis in the area, but there is no published study available on the level of fluoride in drinking water of the city. Khaf is a city in Khorasan province located near the border of Afghanistan in

a desert area, though there are some mountains with more than 2000m height near the city. It has been reported 3.5 ppm of fluorides in drinking water associated with prevalence of dental fluorosis among the residents of the city [4]. In Najmabad village of Ghazvin province the level of fluoride in drinking water has been reported 2.5 ppm associated with prevalence of dental fluorosis among the residents [4]. Najmabad village has been located in a fertile agricultural plain and various rivers flowing from different chain of mountains into the plain area make the soil suitable for agricultural goals. These rivers may probably take too much fluoride into the ground waters used for drinking and agricultural purposes. A small city called Behabad is located in Yazd province in the margins of Lut desert. The city is surrounded by mountains with 3000m height and there are coal and iron mines in these mountains which have been exploited. Some cases of dental fluorosis have been reported, but there is no published study on the level of fluoride in drinking water of the city. It seems the high level of fluoride in water and food products is probably due to existing mines in mountains around the city, because as studies have shown 1kg coal mine could have up to 1000 mg fluoride [6]. In southern part of Behabad city there exists Khoohbanan city (Kerman province) which has been surrounded by continuation of mountains around Behabad. Initially, prevalence of 93% from moderate to severe degree of dental fluorosis was reported among 11-14 students. In 2008, the level of fluoride in drinking water of the city was studied and the obtained results indicated 2.36 ppm fluoride in drinking water, 3.1 ppm in agricultural water and between 0.02 to 8.85 ppm in food products [7, 8]. In another study the level of fluoride intake in Khoohbanan preschoolers and the amount of fluoride excreted in the urine of the children were analyzed. The obtained results showed that the level of fluoride intake in children is higher than normal range [9]. Khoohbanan is a city located among mountains and hills at 2000m above sea level. It seems the increased level of fluoride in drinking and agricultural waters and in soil and air of the city is due to existing coalmines around the city. The high altitude of the city is another reason for higher prevalence of dental fluorosis among the inhabitants.

Saudi Arabia

2.5 ppm of fluoride has been reported in one division of Mecca drinking water with some degrees of dental fluorosis. Inhabitants in Al-Qaseem province have shown different levels of dental fluorosis. 12.5% of the populations examined have shown moderate to severe fluorosis. In the Hail region, over 90% of the children have had fluorosed teeth. In this region fluoride in drinking water is 0.5 to 2.8ppm [10-12].

Qatar

A study in Doha among 4800 people aged 8-50 years have shown which 55.29% of them have had some degrees of dental fluorosis. In that study, has not reported fluoride level in their drinking water [13].

Yemen

Fluorosis in South and East of Yemen is more prevalent than other regions of the country. A report indicates the prevalence of the fluorosis in some districts such as Sanaa, Ibb, Dhmar, Taiz, Al-Dhalei and raimah. A survey was doing in the North, South; West, East and Central of the country to evaluate prevalence of dental fluorosis. Fluoride concentration in natural drinking water in the study areas was found to be between 0.5- 3.8 ppm. Adolescents in the south (46.9%) or east (49%) were found to have almost two times or more dental fluorosis than other areas. In these areas, the villages in Jabal Sabir, Al-Howban, Hidhran and Al-Burayhi as well as Tiaz city are the most affected areas by fluoride contamination in ground water resources. The Al-Aiziyah district and its surroundings have had the highest concentration of fluoride in drinking water [14, 15].

United Arab Emirates

The national survey of oral health of schoolchildren in United Arab Emirates has shown 30% of 12-year-old students have had some degrees of dental fluorosis [16].

Pakistan

In the cities of Mianwali, Lahore, Quetta, Risalpur, and Mardan have reported many cases of dental fluorosis. In these cities fluoride level in drinking water are 1.37, 2.62, 2.47, 1.27, and 1.02 ppm respectively. Inhabitants of these cities drink a lot of different types of tea (the amount of fluoride in these

different types of tea has reported from 0.6 to 7.3 ppm). Thus daily consumption of the teas and drinking water give their body a lot of fluoride. This additional ingestion of fluoride was found to enhance dental fluorosis. In the Haronli village (Mianwali district) and Rustam village (Mardan district) only 2% and 15% of the population surveyed have shown no sign of fluorosis respectively [17, 18].

India

As already mentioned at the beginning of the chapter, in India as a vast and populous country like China there have been some reports regarding the prevalence of fluorosis in some regions. The most important regions are: Punjab state and Haryana city (especially Haily mandi, Pataudi and Harsaru villages) located in north India, Nalgonda city (Andhrapradesh state) and Vishakhapatnam region in south of the country. The main source of fluoride in drinking water of these regions are said to be surrounding mountains. Table 1 presents the prevalence of dental fluorosis in different regions of India [1].

Table 1: Dental fluorosis in different regions of India (Arlappa et al. 2013).

State, Region	Prevalence (%)
Vadodara, Gujarat	39.2-59.3
Davangere, Karnataka	13-100
Jhajjar, Haryana	30-94.9
Brigham, West Bengal	61-66.7
Punjab	91.1
Nalgonda, A.P	71.5
Dungarpur, Udaipur	39.2-72.1
Palamau Jharkhand	83.2
Kareka, Shivpuri	86.8
Raigad, Maharashtra	91.7

Sri Lanka

Dental fluorosis has been recognized as an endemic problem affecting different areas of Sri Lanka with naturally occurring fluoride in drinking water. It is found that the

prevalence of very mild or greater dental fluorosis is 89.8% in Anuradhapura area. More than 50% of the inhabitants in this area use water which contains more than 0.7 ppm of fluoride. They drink a lot of water and different types of teas [19].

China

There are a lot of published reports in China regarding the prevalence of dental fluorosis in different regions of this vast and highly populated country. In a village near Tianjin city the level of fluoride in drinking water has been reported 3.15 ppm associated with prevalence of dental fluorosis [20]. In Biji village of Shanxi province the level of fluoride is reported 4.55 ppm with prevalence of severe dental fluorosis [21]. Some villages in Gucheng region of Shanxi studied and it found that there is 7.4 to 9.2 ppm fluoride in drinking water with high prevalence of severe dental fluorosis among residents [22]. In Sima village near Xiaoyi city (Shanxi province), the level of fluoride is reported 4.12 ppm causing dental fluorosis among residents [23]. Although the level of drinking water fluoride in Hongxi region of Xinshao city (Xinshao County, Hunan province) is lower than 0.5 ppm, but due to using coal as fuel for Cooking and heating the homes (15-25 kg coal is burnt daily) foods and air are polluted as a result of released fluoride of burning coals. The studies have shown that the level of fluoride in coal smokes is 0.028 mg per cubic meter of air. The residents of this region suffer from dental fluorosis [24]. In the southwest of country (Tibet), at Xiege`er town (Dingri county) and at Zhangmu town (Nielamu county) Incidence of dental fluorosis among the children has been reported 75.93% and 25.86% respectively. About 68% of Xiege`er children and 33% of Zhangmu children have shown medium to sever dental fluorosis. These towns located in a mountainous region, near to China - Nepal border (Xiege`er altitude 4300 m and Zhangmu altitude 2000 m). In these towns fluoride level of soil and fresh water are 0.37 to 0.55ppm and 0.03 to 0.05ppm respectively. The major source of the fluorosis in the two cities has been reported to be the beverage and food mixed with brick tea water (Buttered tea up to 3.07 ppm and Zangba up to 4.12 ppm of fluoride). At the higher altitude (Xiege`er) the findings have also been directly related to the poor economic situation. Thus,

altitude, economics, and the common practice of drinking brick tea water are related to the fluorosis in Tibetan children [25].

Thailand

Dental fluorosis is generally prevalent in Thailand but is more prevalent in the north of the country. In the north, 35-76% of inhabitants suffer from dental fluorosis. Although, the severity is very mild to mild and percentage of severe fluorosis is less than of 1%. Fluoride is found in the drinking waters in a wide range. The range is from no detectable fluoride in Haadyai to 0.8 ppm in one area in Chiangmai. There is no apparent relationship between the amount of fluoride in the drinking waters and presence of the dental fluorosis. Hence, probably there are other sources for the fluoride intake [26].

Jordan

In a survey among Jordanian students in the different areas of the country about 79% of them presented severe forms of dental fluorosis. But drinking water analysis revealed fluoride concentration ranging from 0.27 to 1.4 ppm. Another study have shown the average fluoride concentration in drinking water supplying 11 provinces and Jordan valley is from 0.10 ppm (in Mafrq province) to 2.15 ppm (in Aqaba province). Of course, only in Aqaba province has been reported drinking water fluoride concentration up to 2.15 ppm and in the other provinces and Jordan valley the water fluoride concentration is less than of 1.61 ppm. It seems high annual temperature mean, daily drinking of high quantities of some types of tea (analysis of tea prepared on Jordanian way has revealed a concentration of 1.2 mg F/L), and airborne fluoride ejected from phosphate mining (the largest industry in Jordan) are important reasons for explain the high severity of dental fluorosis in Jordan [27, 28].

Israel

Several years ago a study reported the existence of fluorosis in Neger region of Israel. The later study conducted in 1998 reported mild fluorosis in some regions of Israel, despite optimal fluoride in water. These finding confirmed in national survey of the country in 2002 and it concluded that the incidence of fluorosis in those regions is not due to fluoridated water but other sources of fluoride have been effective in its creation [29].

Palestine

A study among the students in Gaza Strip has shown the prevalence 78% for dental fluorosis. Prevalence and severity of dental fluorosis in the students which consumed a high level of proteins products was less than the students which had low level protein products in their diet [30].

Egypt

Prevalence of dental fluorosis among teenagers in Zagazig center has been reported 25.6% and in this area, fluoride concentration of the waters is 0.26ppm to 0.88ppm. With respect to risk factors of the fluorosis, it has found that the most important contributing variables are relatively high fluoride concentration in the waters, and frequently fish eating [31].

Libya

Many of people in the city of Zawia suffer from dental fluorosis. The overall prevalence in this city is about 63%. There are no any documents in related to the sources for fluoride intake [32].

Algeria

In Algeria, the water of Souf area is characterized by high concentrations of fluoride, associated with dental fluorosis. Fluoride content of the drinking waters in the cities, which located in this area, is from 0.46 ppm to 2.61 ppm. These cities are including Mars city (1.87 ppm), Mastur city (1.90 ppm), 400city (1.92 ppm), 8May city (1.84 ppm), 1November city (1.94), Nezla city (0.46 ppm), and Shuhada city (2.61ppm). In Souf area, the hot and dry climate has forced people to consume a lot of water, which leads to rise the daily intake rate of fluoride, in addition the eating many dates and tea leads to increase prevalence and severity of the fluorosis [33].

Morocco

More than 90% of Khouribga populations, an area in Morocco, suffering from dental fluorosis and more than one-third of them have shown the moderate level. Youssoufia is another city in the country which dental fluorosis is prevalent. In this city, soil and to a lesser extent water are rich in fluoride (948.6 ppm and 1.03 ppm respectively [34, 35].

Nigeria

Dental fluorosis is prevalent in some parts of Plateau state. It seems occurrence of fluorosis could be because of the high altitude of the area and the fluoride concentration of the waters consumed in the district [36].

Sudan

Fluorosis is found in certain regions of Sudan, especially in the northern and western provinces. A study in various provinces in the northern part has shown fluoride concentration in the waters is 0.08 ppm to 3.55 ppm. In two village in Khartoum area, Treit el Biga (0.25ppm) and Abu groon (2.5ppm), dental fluorosis has been assessed. In the Treit el Biga village 91% of children have shown some degrees of dental fluorosis but in the second village, all the children have had fluorosis. It seems in the first village, the drinking water is not the only fluoride source and the additional sources such as, tea, fish and fluoride containing trona maybe effective [37].

Kenya

Prevalence of Dental fluorosis ranges from 44% to 72% in Kenya. It varies from area to area and the severity increases with increasing concentrations of fluoride in water. In some areas, the fluorosis is found to be substantially higher than would be expected from the levels of fluoride in drinking water. Altitude and fluoride ingestion from other sources have been suggested as other reasons. 76% of Nairobi teenagers have shown dental fluorosis. The degree of fluorosis in most of the students which served with river water (0.2-0.4 ppm F) is of a very mild form. However, in the students which served with borehole waters, the fluorosis is more sever [38, 39].

Uganda

A study in Uganda among the children in two high altitude areas with 0.5 and 2.5 ppm fluoride in drinking waters has shown dental fluorosis is prevalent in both two areas and is less prevalent in the area with 0.5 ppm fluoride in drinking water. Altitude has stated as a risk indicator after controlling for potential confounders [40].

Tanzania

During a research, prevalence and severity of dental fluorosis has been assessed In the 18 villages in four districts

(Pangani, Muheza, Singida and Iramba). In the districts, water supplies containing 0.2 ppm (Pangani) to 0.8 ppm (Iramba) of fluoride. The prevalence of dental fluorosis in nine villages in Pangani and Muheza districts where tea and sea fish were regularly consumed ranged from 7% to 46%. In contrast, the prevalence of fluorosis in nine villages located inland at 1500 m altitude (Singida and Iramba districts) where fluoride-containing trona tenderizer (Magadi) was consumed ranged from 53% to 100%. Data on dental fluorosis from the Magadi-consuming communities provide strong evidence that consumption of Magadi has an important role for increase in prevalence and severity of dental fluorosis [41].

South Africa

The Western Cape, Kwazulu-Natal, and North-West provinces have areas which the inhabitants suffering from dental fluorosis. The prevalence in South Cape Karoo (Western Cape Province), Ladysmith (KwaZulu-Natal Province), Moretele (North-West Province) and Ganyesa (North-West Province) are 48.7%, 57.8%, 74.4% and 73.3% respectively. In these areas the amount of fluoride in groundwater sources is high [42]. Leeu Gamka has 3.0 ppm fluoride ion in drinking water and in this area, the prevalence of dental fluorosis among the school children has been reported 95% [43].

Mexico

The prevalence of dental fluorosis has been reported in Mexico ranged from 30% to 100%. The Prevalence in Ensenada (Baja California Norte State), Chihuahua (Chihuahua State), San Luis Potosi (San Luis Potosi State), Durango (Durango state), and Aguascalientes (Aguascalientes State) is more than other areas. In these areas, fluoride content of the tap water is above of optimal level and the altitudes of the areas are above 1400 m, with exception of Ensenada 10 m [44].

Chile

There is a report which water fluoride concentration in Mamina is up to 2.4 ppm and dental fluorosis is prevalent among the inhabitants [45].

Conclusion

Fluoride is not entered to the body only through drinking water, but it could also enter through other ways and

routs. In conclusion, it is important to investigate all conditions and sources leading up to an increase in the severity and prevalence of fluorosis and not just focusing on the levels of fluoride in the drinking water sources.

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