Original Article

Health Impact of Supplying Safe Drinking Water on Patients Having Various Clinical Manifestations of Fluorosis in an Endemic Village of West Bengal

Kunal K. Majumdar, Shunmuga N. Sundarraj[1]

Department of Community Medicine, KPC Medical College, Jadavpur, [1]Department of Water and Environmental Sanitation, UNICEF, Kolkata, India

Abstract

Background: Excessive fluoride in drinking water causes dental, skeletal and non-skeletal fluorosis which is encountered in endemic proportions in several parts of the world. The World Health Organization (WHO) guideline value and the permissible limit of fluoride as per the Bureau of Indian Standards (BIS) is 1.5 mg/L. Studies showed that withdrawal of sources identified for fluoride, often leads to reduction of fluoride in the body fluids (re-testing urine and serum after a week or ten days) and results in the disappearance of non-skeletal fluorosis within a short duration of 10-15 days. **Objective:** To determine the prevalence of signs and symptoms of suspected dental, skeletal and non-skeletal fluorosis along with food habits, addictions and use of fluoride-containing toothpaste among participants taking water with fluoride concentration above permissible limit and to assess the changes in clinical manifestations of the above participants after consumption of safe drinking water with fluoride concentration below permissible limit. **Materials and Methods:** A longitudinal intervention study was conducted from October 2010 to December 2011 in a village selected randomly in Purulia District of West Bengal which is endemic for fluorosis. Thirty-six families with 104 family members in the above village having history of taking unsafe water containing high level of fluoride were selected for the study. The occurrence of various dental, skeletal and non-skeletal manifestations of fluorosis along with food habits, addictions and use of fluoride-containing toothpaste among the study population was assessed; the impact of taking safe water with fluoride concentration below permissible limit from a supplied community filter on these clinical manifestations was studied by follow-up examination of the above participants for six months. The data obtained is compared with the collected data from the baseline survey. **Results:** The prevalence of signs and symptoms of dental, skeletal and non-skeletal fluorosis was (18.26%), (18.26-43.26%) and (12.49-38.46%) among the study population. Withdrawal of source(s) identified for fluoride by providing community filters supplying safe water along with nutritional interventions lead to 1.92% decrease of manifestation of dental fluorosis, 2.88-18.26% decrease of manifestations of skeletal fluorosis and 3.8-5.77% decrease in manifestations of non-skeletal fluorosis within six months. Following repeated motivation of participants during visit there was also 2.88% decrease in the usage of fluoride-containing toothpaste, 4.81% decrease in consumption of black lemon tea, supari and tobacco which are known sources of fluoride ingestion in our body. **Conclusion:** Increased prevalence of dental, skeletal and non-skeletal fluorosis was found among the study population. Withdrawal of sources(s) identified for fluoride by supplying community filter, dietary restriction and other nutritional interventions led to decrease of manifestations of the three types of fluorosis within six months. The government should play a vital role in ensuring drinking water safety at the household and community level by supplying domestic filters at affordable costs and community filter along with nutritional intervention to the fluorosis-affected villages on a priority basis to mitigate the problem.

Keywords: Diet, fluorosis, health impact, intervention, safe water

Introduction

Fluoride is one of the important factors in water quality management due to its adverse health effects. The problem of high fluoride concentration in groundwater resources has become one of the most important toxicological and geo-environmental issues in India. Excessive fluoride in drinking water causes dental, skeletal and, non-skeletal fluorosis which is encountered in endemic proportions in several parts of the world.[1] About 20 states out of 35 states and Union Territories of India were identified as endemic for fluorosis[2] and about 66 million people

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/2249-4863.109953

Address for correspondence: Dr. Kunal K. Majumdar, Department of Community Medicine, KPC Medical College, Jadavpur, Kolkata, India.
E-mail: kunalmajumdar1@gmail.com

in these regions are at risk of fluoride contamination including 6 million children below 14 years of age and affecting about 25 million people.[3]

Fluoride ingestion through water is the major cause of fluorosis. Dental fluorosis can occur in both deciduous teeth and in the permanent teeth. Dental fluorosis is a good indicator of exposure to excessive amounts of fluoride. Fluoride leaches from the geological crust contaminate drinking water. The WHO guideline value and the permissible limit of fluoride as per the Bureau of Indian Standards (BIS) is 1.5 mg/L[3] Fluorides are released into the environment naturally through the weathering of minerals, emissions from volcanoes and marine aerosols. The main natural source of inorganic fluorides in soil is the parent rock. Fluorosis is a crippling disorder/condition known to occur due to the entry of fluoride into the body. It is a slow, progressive, crippling malady that affects every organ, tissue and cell in the body and results in health complaints that overlap with several other disorders. The extent of affection may vary depending upon the chemical constitution of the tissue/organ. The disease manifestations occur over a period of time. The time/duration required for clinical manifestations to appear varies depending on several factors, viz., age, hormonal status, nutritional status, efficiency of the kidney to excrete fluoride, the quantum of fluoride entry into the body, climatic conditions and perhaps other factors that are presumably not so pronounced.[3] Most of the fluorides are readily soluble in water.

Ten to forty percent districts are affected in Assam, Jammu and Kashmir, Kerala, Chhattisgarh and West Bengal.[3] In West Bengal fluoride was first detected at Bhubanandapur in Nalhati I block of Birbhum district in 1996. During the last habitation survey conducted by PHED (Public Health Engineering Department, Government of West Bengal) in the year 2003, fluoride was found in 663 habitations in West Bengal spread over 45 blocks in nine districts. Subsequently, by rapid assessment survey (in the year 2005), 729 sources were found contaminated with fluoride above 1.5 mg/L in 43 blocks of seven districts of West Bengal with an affected population of approximately 2.26 lakhs. Fluoride level in West Bengal varies from 1.1-4.47 mg/L.[4]

As fluorosis is an impending public health problem in West Bengal affecting a large section of the population and Purulia is one of the affected districts, the following study has been conducted to see the impact of drinking safe water which is the main known intervention for prevention and treatment of the toxicity, on the clinical course of fluorosis, with the following objectives.

Objectives

To determine the effect of taking safe water on participants having various clinical manifestations of fluorosis and presently taking safe water from the community filter but having a past history of taking unsafe water containing high amount of fluoride.

Materials and Methods

A longitudinal intervention study was started in the month of October 2010 in ChotoIrga village of Purulia District of West Bengal which is one of the endemic districts of West Bengal and completed in the month of December 2011 to assess the occurrence of various dental, skeletal and non-skeletal manifestations of fluorosis and the impact of taking safe water on these manifestations.

Seventeen blocks of Purulia district of West Bengal were endemic for fluorosis. Out of these 17 blocks, one block i.e., Para Block was selected randomly for the study. Within this block one village i.e., ChotoIrga was selected randomly as there was no safe source in that village and a community filter was installed there. Fluoride content of the tube well in that area varied from 1.15 mg/lit to 4.16 mg/lit (PHED report Govt. of West Bengal 2008) with permissible limit <1.5 mg/lit. Thirty-six families belonging to two hamlets (Mahatopara and Mudipara) in ChotoIrga village having 104 family members (62 from Mahatopara and 42 from Mudipara) taking water solely from a particular ChhotaIrga primary school tube well with Flouride level 4.16 [Source: Bengal Science and Engineering College (BESU)] were selected as study population. After installation of a community filter in the month of March 2011 at the above site of the ChhotaIrga primary school tube well the above families started using community filter water with fluoride level 0.96 mg/lit (Source: BESU) for drinking and cooking purposes.

So all the selected families had a past history of taking water from an unsafe source before taking water from the community filter.

The supplied filter removes fluoride by adsorption method with activated alumina used as adsorbent along with electrocoagulation which is a standardized method of removing fluoride from water and accreted by PHED, Govt. of West Bengal.

Ethical clearance was done prior to the initiation of the study

After taking informed consent and explaining the purpose of the visit, the members of the families were interviewed with a predesigned and pretested oral questionnaire and clinically examined for identification of signs and symptoms of suspected dental, skeletal and non-skeletal fluorosis along with their food habits, addictions and use of fluoride-containing toothpaste using a checklist to obtain the baseline data in the first visit (October 2010). The prevalence of various clinical manifestations of suspected fluorosis among them before they started using safe water from the supplied community filter was then obtained as baseline data. The family members were then motivated to use only filter water for their drinking and cooking purposes and the use of filter water by the family members was monitored continuously by the fieldworkers.

The family members were subsequently reexamined at alternate months in the months of June '11, July '11, Aug '11 and Dec '11

for six months to determine the changes in clinical manifestations after consumption of safe drinking water from the supplied community filter. The data obtained is compared with the collected data from the previous visit and baseline survey at first visit at the time of analysis. During each follow-up visit enquiries were made regarding the presence and absence of any difficulties in using the filter water and their satisfaction level and the user friendliness of the filter. Counseling, advice and treatment of minor ailments were also given to family members.

Water was also collected from the filters for chemical (including fluoride level) and bacteriological testing and the efficacy of the filters in removal of fluoride and bacteria was monitored regularly. Dental fluorosis, skeletal fluorosis and non-skeletal flourosis was assessed by case definitions and diagnostic criteria developed by Fluorosis Research and Rural Development Foundation, New Delhi.[2,5-7]

Data collected were analyzed by suitable statistical methods.

Results

Pain in the stomach (32.69%), polyurea/polydypsia (26.92%), loss of appetite (24.04%), fatigue or depressions (23.07%), muscle weakness (23.07%), constipation with diarrhea (17.30%) and bloating or flatulence (6.73%), were the common non-skeletal fluorosis symptoms. There was a decrease in these symptoms after taking safe water from the community filter by 5.77%, 4.81%, 5.76% in case of pain in the stomach, polyurea/polydypsia and loss of appetite respectively, where as 3.85% decrease in muscle weakness, fatigue or depressions, and constipation was observed, followed 5.76% decrease in bloating or flatulence [Table 1]. There was a marked decrease in the symptoms of pain and stiffness of joints by 18.26% after taking safe water compared to baseline survey but 25% of the population was still having pain and stiffness of joints. Most common sign among skeletal fluorosis in the study population was the inability to bend to touch the toes (32.69%) followed by inability to touch the chin with chest (31.73%) and inability to stretch arm to touch the back of the head (15.38%). There was a decrease in the prevalence of these signs by 8.65% and 3.84% in case of inability to touch the chin with chest and inability to bend to touch the toes. There was a 2.88% decrease in the prevalence of the inability to stretch the arm to touch the back of the head after taking water from the community filter [Table 1].

The prevalence of dental fluorosis among those participants consuming water from community filter (fluoride level 0.96 mg/L) was still found to be 16.34%., earlier they were using water from the school tube well (containing fluoride level of 4.16 mg/L) There was a slight decrease in prevalence (1.92%) of dental fluorosis compared to the baseline survey [Table 1] 2.88% of the population now drinking safe water were still using fluoride-containing toothpaste, however after repeated motivation there was decrease in this number. 41.34% of population now drinking safe water also taking black lemon tea containing high fluoride but there is decrease of intake of 4.81% compared to the baseline survey. 69.23% of population now drinking safe water is taking plenty of green leafy vegetables and fruits containing antioxidants. There is an increase in intake of green leafy vegetables and fruits (6.74%) compared to the baseline survey; 21.15% of the population now drinking safe water taking adequate amount of fish followed by less frequent amount of egg and meat and there is increase in intake by 1.92% compared to the baseline survey [Table 1].

Discussion

The overall prevalence of dental fluorosis among study participants was found to be 18.26%. One study in southern Rajasthan has reported the overall prevalence of dental fluorosis to be 45.7%.[8] A similar study in Gudag and Bagalkot districts of Karnataka found the prevalence of dental fluorosis to be 35%.[9] Yellowish-brown discoloration of teeth with horizontal streaks was the most common symptom of dental fluorosis, followed by blackening/pitting/chipping of teeth. Bharati, *et al*., reported browning of teeth in 64.29% and pitting of teeth in 32.4% subjects.[9] Similar positive correlation between fluoride concentration and DFI (Dental Fluorosis Index) score, was also found in studies by Ruan, *et al*.,[10] Mann, *et al*.,[11] Acharya S,[12] and Kumar J.[13,14] Prevalence of manifestations of skeletal fluorosis was found to be 18.26-43.26%. Other studies have reported the prevalence of skeletal fluorosis was found to be 17% to 22% (8,9) The most common sign among skeletal fluorosis were being pain and stiffness of the joints (43.26%) and inability to touch the chin with chest (40.38%). Narayana, *et al*., reported joint pain, neck stiffness among 50-70% of cases.[15] Shashi, *et al*., in their study in three endemic areas of Punjab state observed back pain (73%) and neck pain (34%) as skeletal fluorosis symptoms.[16]

Studies have suggested that, if nutritional intervention focusing on adequate intake of calcium, iron, vitamin C and E and other antioxidants is practiced simultaneously along with safe drinking water, features of adverse health effects get reduced faster.[7] In this study after repeated motivation during visits, it was found that there was 6.74% increase in intake of fruits and green leafy vegetables containing antioxidants and 1.92% increase in intake of fish followed by egg and meat. These nutritional interventions along with provision of safe water may have a role in the change of disease outcome.

In the present study tobacco consumption (in any form) was observed among 39.42% of subjects. Kubakaddi, *et al.,* observed that 40% of the tobacco chewers were suffering from dental and skeletal fluorosis.[17] It was evident from previous studies that withdrawal of source(s) identified for fluoride, leads to reduction of fluoride in body fluids and results in disappearance of health problems emanating from non-skeletal fluorosis within a short period.[7] The present study also showed 3.85-5.77% decrease of various non-skeletal manifestations following drinking of safe water from a community filter.

Table 1: Distribution of participants taking water from community filter according to disease manifestations and degree of change on follow-up examination (*n*=104)

Disease manifestations	Prevalence on baseline survey october 2010 No. (%)	Prevalence on follow-up survey june 2011 No. (%)	Prevalence on follow-up survey july 2011 No. (%)	Prevalence on follow-up survey august 2011 No. (%)	Prevalence on follow-up survey december 2011 No. (%)	Percentage change october 2010-december 2011 (%)
Dental fluorosis	19 (18.26)	18 (17.30)	18 (17.30)	17 (16.34)	17 (16.34)	–1.92
Earlier issues	20 (19.23)	20 (19.23)	20 (19.23)	20 (19.23)	20 (19.23)	No change
Abortion/Stillbirths	6 (5.76)	6 (5.76)	6 (5.76)	6 (5.76)	6 (5.6)	No change
Skeletal fluorosis						
a) Touch the chin with the chest (inability)	42 (40.38)	39 (37.5)	39 (37.5)	38 (36.53)	33 (31.73)	–8.65
b) Bend to touch the toes (inability)	38 (36.53)	35 (33.65)	35 (33.65)	34 (32.69)	34 (32.69)	–3.84
c) Stretches arm to touch the back of the head (inability)	19 (18.26)	18 (17.30)	17 (16.34)	17 (16.34)	16 (15.38)	–2.88
d) Pain and stiffness of the joints	45 (43.26)	28 (26.92)	28 (26.92)	28 (26.92)	26 (25)	–18.26
Non-skeletal fluorosis						
a) Pain in the stomach	40 (38.46)	36 (34.61)	35 (33.65)	34 (32.69)	34 (32.69)	–5.77
b) Bloating or flatulence	13 (12.49)	9 (8.65)	8 (7.69)	8 (7.69)	7 (6.73)	–5.76
c) Loss of appetite	31 (29.80)	27 (25.96)	26 (25)	26 (25)	25 (24.04)	–5.76
d) Constipation followed by diarrhea	22 (21.15)	20 (19.23)	19 (18.26)	19 (18.26)	18 (17.30)	–3.85
e) Polyurea/Polydypsia	33 (31.73)	30 (28.84)	30 (28.84)	28 (26.92)	28 (26.92)	–4.81
f) Fatigue/Depression	28 (26.92)	25 (24.04)	25 (24.04)	24 (23.07)	24 (23.07)	–3.85
g) Muscle weakness	28 (26.92)	26 (25)	25 (24.04)	25 (24.04)	24 (23.07)	–3.85
Fluoride toothpaste (Using)	6 (5.76)	4 (3.84)	4 (3.84)	3 (2.88)	3 (2.88)	–2.88
Consumption of food						
a) Supari	6 (5.76)	2 (1.92)	2 (1.92)	1 (0.96)	1 (0.96)	–4.80
b) Tobacco	41 (39.42)	38 (36.53)	37 (35.57)	37 (35.57)	36 (34.61)	–4.81
c) Black lemon tea	48 (46.15)	45 (43.26)	44 (42.30)	44 (42.30)	43 (41.34)	–4.81
d) Black rock salt	Nil (0)	Nil (0)	Nil (0)	Nil (0)	Nil (0)	No change
e) Adequate intake of fruits and vegetables	65 (62.49)	68 (65.38)	68 (65.38)	69 (66.34)	72 (69.23)	+6.74
f) Adequate intake of fish	20 (19.23)	20 (19.23)	22 (21.15)	22 (21.15)	22 (21.15)	+1.92

Although the description of the disease was done long back by eminent physicians like Dr. S. S. Jolly, Dr. Amarjeet Sing and Dr. C. G. Pandit,[18] indicating a disease entity that originated in India in early 1930, not much has been done till date regarding its mitigation measures. However, to address the problem of fluorosis in the country, the National Programme for Prevention and Control of Fluorosis was launched in 2008-09 with an objective to collect, assess and use the baseline survey data of the Department of Drinking Water Supply for fluoride mapping along with comprehensive management and capacity building.[19,20] Increased provision of alternate safe water source by treatment of surface water, rain water harvesting, ground water recharge along with community participation, awareness generation and nutrition intervention can solve the problem of fluorosis to a great extent on a long-term basis. The families taking water from the community filter were satisfied about the water regarding its taste, palatability, its capability of increasing appetite, decreasing gastrointestinal problems like flatulence and bloating, acidity and heartburn, etc. So the filter water was acceptable to them.

The use of filter water was also found to be cost-effective for them as the cost of medicines and doctor's visit reduced considerably after taking safe water from the community filter.

Conclusion and Recommendations

It is evident from this study that flourosis is a definite public health problem in the selected block of Purulia district with increased prevalence of dental, skeletal and non-skeletal fluorosis among the study population. Withdrawal of source(s) identified for fluoride by (a) supplying safe water from community filter for drinking and cooking purposes (b) dietary restriction of black salt, black lemon tea, supari and tobacco which contain high amount of fluoride (c) nutritional interventions like intake of plenty of fruits and green vegetables containing high level of antioxidants and milk containing calcium (d) avoiding use of fluoride-containing toothpaste, could lead to decrease of manifestation of the various types of flouorosis, specially non-skeletal fluorosis within six months. More extensive studies involving a large group of the population may be needed in future to measure the impact.

National and State Government should play a vital role in ensuring drinking water security at the household and community level by supplying domestic filters at affordable costs at the household level and by installation of community filter specially in "No safe source" (NSS) villages on a priority basis. For long-term measures treatment of surface water, rain water harvesting, ground water recharge, etc should be implemented. Increased availability and accessibility of safe water, community participation, awareness generation through appropriate IEC measures and nutrition intervention all are necessary to combat the problem of fluorosis on a sustainable basis in future.

References

1. Fawell J, Bailey K, Chilton J, Dahi E, Fewtrell L, Magara Y. Human health effects: Fluoride in drinking water WHO drinking-water quality series. London: IWA Publishers; 2006. p. 29-35.
2. W.H.O. Chemical aspects. W.H.O. Guidelines for drinking-water quality volume 1 In, W.H.O. 3rd ed. Geneva: W.H.O; 2004. p. 184-6.
3. Susheela AK. Prevention and control of fluorosis: Dental fluorosis-symptoms.1st ed. New Delhi: National Technology Mission on Drinking Water; 1991. p. 7-9.
4. RGNDWM. Prevention and control of fluorosis- health aspects volume-I: Oral cavity, teeth and dental fluorosis. New Delhi: Rajiv Gandhi National Drinking Water Mission, Ministry of Rural development, New Delhi; 1994. p. 53-7.
5. Susheela AK. Prevention and control of fluorosis: Skeletal fluorosis-symptoms. 1st ed. New Delhi: National Technology Mission on Drinking Water; 1991. p. 4-6.
6. RGNDWM. Prevention and control of fluorosis-health aspects volume-I: Effects of fluoride on the bones, the skeletal system and skeletal fluorosis. New Delhi: Rajiv Gandhi National Drinking Water Mission, Ministry of Rural development, New Delhi; 1994. p. 40-9.
7. Susheela AK. Fluorosis: An easily preventable disease through practice and intervention. New Delhi: Fluorosis Research and Rural Development Foundation; 2005. p. 10.
8. Choubisa SL. Some observations onendemic fluorosis in domestic animals in Southern Rajasthan India. Vet Res Commun 1999;23:457-65.
9. Bharati P, Kubakaddi A, Rao M, Naik RK. Clinical symptoms of dental and skeletal fluorosis in Gadag and Bagalkot Districts of Karnataka. J Hum Ecol 2005;18:105-7.
10. Ruan JP, Yang ZQ, Wang ZL, Astrom AN, Bardsen A, Bjorvatn K. Dental fluorosis and dental caries in permanent teeth: Rural school children in high fluoride areas in the Shaanxi province, China. Acta Odontol Scand 2005;63:258-65.
11. Mann J, Tibi M, Sgan-Cohen HD. Fluorosis and caries prevalence in a community drinking above optimal fluoridated water. Community Dent Oral Epidemiol 1987;15:293-5.
12. Acharya S. Dental caries, its surface susceptibility and dental fluorosis in South India. Int Dent Journal 2005;55:359-64.
13. Kumar J, Swango P, Haley V, Green E. Intra-oral distribution of dental fluorosis in Newburgh and Kingston, New York. J Dent Res 2000;79:1508-13.
14. Suryakantha AH. Social Science; Community medicine with recent advances. 1sted. New Delhi: Jaypee Brothers Medical Publishers (p) ltd; 2009. p. 659-60.
15. Narayana AS, Khandare AL, Krishnamurthy MV. Mitigation of fluorosis in Nalgonda district villages: 4th International workshop on fluorosis prevention and defluoridation of water;2004.Available from: http://www.de-fluoride.net/4th proceedings/98-106.pdf [Last cited on 2011 December].
16. Shashi A, Kumar M, Bhardwaj M. Incidence of skeletal deformities in endemic fluorosis. Trop Doct 2008;38:231-3.
17. Kubakaddi A, Bharati P, Kasturba B. Effect of fluoride rich food adjuncts and prevalence of fluorosis. J Hum Ecol 2005;17:43-5.
18. Joly SS, Sing BM, Mathur OC, Malhotra KC. Epidemiological, clinical and biochemical study of endemic dental and skeletal fluorosis in Punjab. Brit Med J 1968;4:427-9.
19. National Oral Health Survey and Fluoride mapping-2002-03(India). New Delhi: Dental Council of India;2004.
20. National Programme for Prevention and Control of Fluorosis, Annual Report (2010-11). M/o Health and FW, Govt of India, p. 156,158.

How to cite this article: Majumdar KK, Sundarraj SN. Health impact of supplying safe drinking water on patients having various clinical manifestations of fluorosis in an endemic village of West Bengal. J Fam Med Primary Care 2013;2:74-8.

Source of Support: Nil. **Conflict of Interest:** None declared.