



Original Article

Effect of Withdrawal of Fluoride Sources, Promoting Safe Water and Nutritive Diet on Health in a Community Suffering from Fluorosis

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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. As per WHO guide line and the Bureau of Indian Standard (BIS), the permissible upper limit of fluoride is 1.5 mg/L. Studies showed that withdrawal of sources identified for excess fluoride often leads to reduction of fluoride in the body fluids and results in the disappearance of non-skeletal fluorosis within a short duration of 10-15 days. **Objective:** To determine the effect of safe drinking water and other measures including dietary measures on school children having clinical manifestations of dental fluorosis and on adult participants having various clinical manifestations of fluorosis with a past history of taking unsafe water containing high amount of fluoride. **Materials and Methods** A longitudinal intervention study was conducted from December 2014 to May 2015 in a village selected randomly from a fluoride endemic Block of Malda District of West Bengal. 50 families having 142 family members in the selected village and 66 children studying in primary school having history of taking unsafe water containing high level of fluoride was selected for the study. The occurrence of various dental, skeletal and non-skeletal

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manifestations of fluorosis and their food habits, addictions and use of fluoride toothpaste was assessed. The effect of taking water with fluoride concentration below permissible limit from a supplied community filter was studied. The prevalence of dental fluorosis also studied among the school children. The data obtained was compared with the collected data from the baseline survey. **Results::** 34.84% of school children had signs of dental fluorosis and there is 3.3% decrease from the baseline level after intake of safe water from the filter. The prevalence of signs and symptoms of Dental, Skeletal and Non-skeletal fluorosis were 7.04%, 14.08% - 26.76% and 7.04%-44.36% respectively. Withdrawal of source(s) identified for fluoride by providing community filters supplying safe water along with nutritional interventions lead to 0.29% decrease of manifestation of dental fluorosis, 2.11% decrease of manifestations of skeletal fluorosis and 1.41% to 18.31% decrease in manifestations of non-skeletal fluorosis within four months. Following repeated motivation of participants during visit there was also 2.11% decrease in the usage of fluoride containing toothpaste and consumption of black lemon tea and 1.41% decrease in tobacco consumption which is known sources of fluoride ingestion in our body. **Conclusion:** Withdrawal of source(s) identified for fluoride by supplying community filter, dietary restriction and other nutritional interventions lead to decrease of manifestations of all types of fluorosis within four months.

Key words: Fluorosis, Intervention, Safe water, Diet, Health Impact

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 Twenty out of 35 States and Union Territories of India were identified as endemic for fluorosis² and about 66 million people 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 affects the permanent teeth of children with clearly visible discoloration on the teeth of children after 8 years of age. Dental fluorosis is a good indicator of exposure to excessive amounts of fluoride. Fluoride leaches from the geological crust contaminating drinking water. WHO guideline value and the permissible upper limit of fluoride as per Bureau of Indian Standard (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 cells in the body and results in health complaints that overlap with several other disorders. The extent of morbidity 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.

In the states of Assam, Jammu & Kashmir, Kerala, Chhattisgarh and West Bengal 10-40% of districts are affected.³ In West Bengal fluoride was first detected at Bhubanandapur in Nalhati I block of Birbhum district in 1996. During last habitation survey conducted by Public Health Engineering Department (PHED), Government of West Bengal in the year 2003, fluoride was found in 663 habitations in West Bengal spread over 45 blocks in 9 districts. Subsequently by rapid assessment survey (2005), 729 sources were found contaminated with fluoride above 1.5 mg/L in 43 Blocks of seven Districts of West Bengal with affected population of approx. 2.26 lakhs with fluoride level varying from 1.1-4.47 mg/L.⁴

The study was conducted in Malda, one of the fluorosis affected districts, with the following objectives:

- To determine the effect of safe drinking water and other measures including dietary measures on school children having clinical manifestations of dental

fluorosis with a past history of taking unsafe water containing high amount of fluoride.

- To assess the effect of safe drinking water and other measures including dietary measures on adult participants having various clinical manifestations of fluorosis with a past history of taking unsafe water containing high amount of fluoride.

Methodology

A longitudinal intervention study was conducted from December 2014 to May 2015 in Nalagola village of Malda District of West Bengal to assess the occurrence of various dental, skeletal and non-skeletal manifestations of fluorosis and the effect of taking safe water on these manifestations.

A longitudinal intervention study was conducted from December 2014 to May 2015 in Nalagola village of Malda District of West Bengal to assess the occurrence of various dental, skeletal and non-skeletal manifestations of fluorosis and the effect of taking safe water on these manifestations. Two Blocks of Malda District were endemic for fluorosis, of which Bamangola Block was selected randomly for the study. In the selected Block the village Nalagola where there was no safe source of drinking water was selected randomly and a community filter was installed as an intervention measure. Fluoride content of the tube well in that area varied from 1.43-2.02mg/L(PHED report Govt. of West Bengal 2008). Fifty families having 142 family members taking water solely from a particular Nalagola primary school tube well with Fluoride level 1.82 mg/L was selected as study population. A community filter was installed in March 2015 at Nalagola Primary School. The selected families and the school children started using community filter water with Fluoride level below permissible limit of 0.167mg/L for drinking and cooking purposes. The water samples were tested by Indian Institute of Engineering Science and Technology (IEST), Shibpur.

The selected families along with 66 children studying in Nalagola Primary School 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 electro coagulation which is a

standardized method of removing fluoride from water designed by IEST, Shibpur supported by UNICEF and accredited by PHED, Govt. of West Bengal.

Ethical clearance was done prior to the initiation of the study. After taking consent from Headmaster of the school, 66 students of class I to class IV (6 to 10 years of age) were screened for dental fluorosis. The history of exposure to water containing fluoride level above permissible limit was verified with their residential address. The students having dental fluorosis were re-examined in the follow up visit to determine the changes in manifestations of dental fluorosis four months after consumption of safe drinking water from the supplied community filter. The data obtained was compared with the collected data of the baseline survey at first visit.

After taking informed consent, the family members were interviewed for their food habit, addiction and use of fluoride containing toothpaste for baseline data using a check list. They were also clinically examined for presence of dental, skeletal and non-skeletal fluorosis. Dental fluorosis, skeletal fluorosis and non-skeletal fluorosis was assessed by case definitions and diagnostic criteria developed by Fluorosis Research & Rural Development Foundation, New Delhi.^{2,5,6,7}

The family members were then motivated to use only filter water for their drinking and cooking purposes and were monitored continuously by the fieldworkers. The family members were subsequently re-examined in the months of May 2015 to determine the changes in clinical manifestations. The data obtained was compared with the baseline survey data. During follow up visit enquiries were made regarding any difficulty in using the filter water. Data collected were analyzed by suitable statistical methods.

Results:

Prior to intervention 37.87% of school children had dental fluorosis which decreased to 34.84% after intervention and there was 3% decrease from the baseline level (Table I).

Table I Distribution of school children according to change in the prevalence of dental fluorosis after intervention (n=66)

	Male (n=38)		Female (n=28)		Total (n=66)		% Decrease
	Baseline survey No (%)	Follow up survey No (%)	Baseline survey No (%)	Follow up survey No (%)	Baseline survey No (%)	Follow up survey No (%)	
Dental Fluorosis in school children	20 (52.63%)	19 (50%)	5 (17.85%)	4 (14.28%)	25 (37.87%)	23 (34.84%)	3.03

Among male students decrease was 2.63% and female students 3.57%. After intervention, 7.04% of population using drinking water from community filters still had dental fluorosis and there was 0.29% decrease from the baseline level (Table II). These changes occurred mostly among subjects who had early stages of fluorosis. No appreciable change was found among subjects having advanced stage of the disease. Population using drinking water from community filters (42.25%) and using fluoride containing toothpaste and 17.60% of population drinking water from community filters still drinking black lemon tea containing high fluoride, both had 2.11% decrease from the baseline level (Table II).

Table II Distribution of population taking water from community filter according to changes in disease manifestations after intervention (n= 142)

Disease Manifestations	Prevalence on baseline survey on December 2014 No (%)	Prevalence on follow up survey on April 2015 No (%)	% Change in Prevalence in follow up survey
Dental Fluorosis	11 (7.33)	10 (7.04)	- 0.29
Skeletal Fluorosis			

a) Touch the chin with the chest (inability)	21 (14.78)	21 (14.78)	No Change
b) Bend to touch the toes (inability)	41 (28.87)	38 (26.76)	- 2.11
c) Stretches arm to touch the back of the head (inability)	20 (14.08)	20 (14.08)	No change
NonSkeletal Fluorosis			
a) Pain in the stomach	77 (54.22)	63 (44.36)	-9.86
b) Bloating or flatulence	36 (25.35)	10 (7.04)	-18.31
c) Loss of appetite	32 (22.53)	18 (12.67)	-9.86
d) Constipation followed by diarrhoea	47 (33.09)	42(29.57)	-3.52
e) Polyuria/ Polydipsia	18 (12.67)	15(10.56)	-2.11
f) Fatigue/Depression	19 (13.38)	17 (11.97)	-1.41
g) Muscle weakness	40 (28.16)	38 (26.76)	-1.41
Fluoride Toothpaste (Using)	63 (44.36)	60 (42.25)	-2.11
Consumption of food			
a) Supari (betel nut)	28(19.71)	28(19.71)	No Change
b) Tobacco	40 (28.16)	38 (26.76)	-1.41
c) Black lemon tea	28 (19.71)	25 (17.60)	-2.11
d) Black rock salt	4 (2.81)	4 (2.81)	No Change
e) Adequate intake of Fruits & Green leafy Vegetables	90 (63.38)	90 (65%)	+ 1.62
f) Adequate intake of fish and animal protein	42(29.57)	47(33.09)	+ 3.52

Population drinking water from community filters and taking plenty of green leafy vegetables and fruits containing antioxidants (63.38%) and 33.09% of population drinking water from community filters and taking fish regularly had 1.62% and 3.52% increase in intake respectively after intervention (Table II). Pain in the stomach (44.36%), constipation followed by diarrhea (29.57%), muscle weakness (26.76%), loss of appetite (12.67%), fatigue or depression (11.97%), polyurea/polydipsia (10.56%) and bloating or flatulence (7.04%) were common among non-skeletal fluorosis symptoms.

There was significant decrease in symptoms of non skeletal fluorosis following intake of safe drinking water within four months. Bloating or flatulence and pain in the stomach with loss of appetite decreased by 18.31% and 9.86% respectively. There

was also 3.52% decrease in constipation, diarrhea, 2.11% decrease polyuria/polydipsia and 1.41% decrease in symptom of fatigue or depression and muscle weakness. (Table II).

Most common sign of skeletal fluorosis - inability to bend to touch the toes decreased by 2.11% from the baseline survey. After intervention there was no change in signs of inability to touch the chin with chest (14.78%) and to stretch arm to touch the back of the head (14.08%) (Table II).

Discussion:

The overall prevalence of dental fluorosis among study participants was found to be 7.04%. Choubisa in his study in southern Rajasthan found that overall prevalence of dental fluorosis was 45.7%⁸. Pushpa Bharati et al in their study in Gudag & Bagalkot districts of Karnataka found prevalence of dental fluorosis to be 35%⁹. Similar positive correlation between fluoride concentration and DFI (Dental Fluorosis Index) score was also found in other studies.¹⁰⁻¹⁴

In the present study, the baseline prevalence of manifestations of skeletal fluorosis was found to be 14.08% - 28.87%. Pushpa Bharati et al in their study in Gudag & Bagalkot districts of Karnataka found prevalence of skeletal fluorosis 17% and both types 12.67%⁹. Choubisa in his study in southern Rajasthan found that overall prevalence of skeletal fluorosis was 22%⁸. Joint pain was found in 31.87% subjects in study done by Pushpabharati et al⁹. Narayana et al reported joint pain, neck stiffness in 50-70 % of cases¹⁵. Shashi et al in their study in 3 endemic areas of Punjab state observed back pain (73%) and neck pain (34%) as skeletal fluorosis symptoms¹⁶.

According to Susheela et al if nutritional intervention focusing on adequate intake of fresh green vegetables and fruits containing calcium, iron, vitamin C and E and other antioxidants is practiced simultaneously along with safe drinking water, features of adverse health effects get reduced faster⁷. In this study after repeated motivation during visit it was found that 63.38% of population drinking water from community filters was taking fruits and green leafy vegetables containing antioxidants with 1.62% increase in intake of fruits and green leafy vegetables and 3.52% increase in intake fish, egg and meat from baseline survey. 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 found in 28.16% of subjects. Kubakaddi et al observed that 40% of the tobacco chewers were suffering from dental & 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 of non skeletal fluorosis within a short period.⁷ The present study also showed 1.41% to 18.31% decrease of various non skeletal manifestations following drinking of safe water from community filter.

Five hundred and twenty-five 5- to 12-year-old school children studying in six primary schools of six villages in Chidambaram were surveyed. The overall dental fluorosis prevalence was found to be 31.4%. Dental fluorosis increased with age ($P < 0.001$), whereas gender difference was not statistically significant.¹⁸ In this study 34.84% of school children belonging to 9-11 yrs age group had signs of dental fluorosis. Of them 52.63% of them were boys and 17.85% were girls.

Although the description of disease was done long back in early 1930 by eminent Indian physicians¹⁹, not much has been done till date regarding its mitigation measures. However in order to address the problem of fluorosis in the country, 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 for fluoride mapping along with comprehensive management and capacity building.^{20,21} 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 nutritional intervention can solve the problem of fluorosis to a great extent on a long term basis.

Conclusion and recommendations:

It was evident from this study that fluorosis is a definite public health problem in the selected block of Malda district, both among school children and general population. Supply of safe water from community filter and advice to use this water strictly for drinking and cooking purposes are important measures for prevention of fluorosis.

Intake of black salt, black lemon tea, supari and tobacco containing high amount of fluoride and use of fluoride containing toothpaste should be restricted. Consumption of fruits, green vegetables containing high level of antioxidants and milk containing calcium could lead to decrease of manifestation of fluorosis specially non skeletal fluorosis. However more extensive studies involving large group of population may be needed in future to measure the impact

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