Original Article

Magnitude of fluorosis and various interventions to reduce fluorosis in Gujarat, India

Sangita V. Patel, Kedar Gautambhai Mehta[1], Prakash V. Kotecha

Department of Preventive and Social Medicine, Medical College Baroda,
[1]Department of Community Medicine (PSM), GMERS Medical College Gotri, Vadodara, Gujarat, India

Abstract

Background: Gujarat is one of the endemic states for the prevalence of fluorosis due to high fluoride levels in water of many villages in the state.

Aim and Objectives: To determine the prevalence of dental fluorosis and skeletal fluorosis in Vadodara district, Gujarat, India, and to document various interventions conducted by Government to reduce the prevalence of fluorosis in Gujarat.

Materials and Methods: A cross sectional survey was carried out in 11 villages (6 with high fluoride level and 5 with normal fluoride level) by house to house visits. Various interventions like capacity building of faculties, diagnostic, treatment and counseling for fluorosis and alternate water supply facilities were provided.

Results: The prevalence of dental fluorosis and skeletal fluorosis was 59.31% and 18.65% in high fluoride areas, while it was 39.21% and 12.54% in normal fluoride areas, respectively. After estimation of this problem, and other research studies carried in Gujarat, the Government of Gujarat provided a fluorine meter to measure the fluoride level in water and urine in all government medical colleges of the state. Capacity building of faculties from various departments was done regarding the epidemiology, diagnosis, treatment, and counseling of fluorosis patients. Early diagnosis and treatment were provided to all fluorosis patients visiting tertiary care hospitals. Alternate drinking water supply was also provided by the government.

Conclusion: Both dental and skeletal fluorosis was high in Gujarat and field level diagnostic facilities are inadequate. A coordinated training program helped to identify the problem and suggest remedial measures. An integrated and comprehensive approach is required to reduce the problem of fluorosis in Gujarat.

Keywords: Capacity building, counseling, dental fluorosis, prevalence, skeletal fluorosis

Address for correspondence:
Dr. Kedar Gautambhai Mehta,
Department of Community Medicine (PSM), 1st Floor, College Building,
GMERS Medical College, Gotri, Vadodara, Gujarat, India.
E-mail: kedar_mehta20@yahoo.co.in

Submitted: 22-Sep-2020, **Revised:** 30-Nov-2020, **Accepted:** 14-Dec-2020,
Published: 30-Dec-2020

Access this article online	
Quick Response Code:	Website: www.environmentmed.org
	DOI: 10.4103/ed.ed_29_20

INTRODUCTION

Fluorosis is one of the major public health problems in India. It has been reported in India since 1937.[1] The state is considered to be endemic when the fluoride level in drinking water is more than 1.5 mg/L. In India, nearly 150 districts of 15 states are endemic for fluorosis.

How to cite this article: Patel SV, Mehta KG, Kotecha PV. Magnitude of fluorosis and various interventions to reduce fluorosis in Gujarat, India. Environ Dis 2020;5:107-11.

Moreover, Gujarat falls in Category III (having 50%–100% of the districts affected by fluorosis).[1] Many factors are contributing to high fluoride content in water. First, less rainfall and poor dilution are leading to increased salinity in the water of many districts. Second, almost 47% of the area is having rocky formations. Third, there has been an excessive withdrawal of groundwater for domestic, industrial, agricultural uses. Finally, it has the longest coastline with ingress of seawater all along.[2]

Fluorine is one of the essential micronutrients for normal mineralization of bone, teeth, and dental enamel. It is considered as a double-edged sword. Less intake of fluorine is associated with occurrence of tooth decay and dental caries. High doses (>1.5 mg/L) of fluoride lead to dental fluorosis, and very high doses of >3 mg/L of fluoride cause skeletal fluorosis. When water contains more than 10 mg/L of fluoride, it leads to crippling skeletal fluorosis.[3] Hence, the severity of fluorosis depends on various factors such as fluoride level in drinking water, daily intake, continuity, and duration of exposure.

Till date, fluorosis has no treatment. However, it is preventable, provided that it is detected at an early stage. Calcium-rich foods like milk and milk products such as curd and buttermilk in the diet are some of the important strategies to prevent fluorosis. Other preventive measures include intake of Vitamin C-rich foods such as amla, guava, and citrus fruits. Avoiding high fluoride-containing water for drinking purposes and avoiding high fluoride-containing food items such as betel nuts, black rock salt (Sanchar powder), certain toothpaste, mouth rinses, and drugs is also recommended.[2]

Many districts of Gujarat such as Ahmedabad, Amreli, Banaskantha, Mehsana, Patan, Sabarkantha, and Vadodara are affected by high fluoride concentration in drinking water. One study conducted in different villages of Patan district of North Gujarat estimated the burden of dental and skeletal fluorosis to be 30% and 8%–10%, respectively.[4]

Earlier, in 2012, we had published a research article titled, "Prevalence of dental fluorosis and dental caries in association with high levels of drinking water fluoride content in a district of Gujarat, India."[5] After this publication and because of research work done by other researchers in Gujarat,[6-9] the Government of Gujarat took up some important measures to reduce the problem of fluorosis.

This study has been conducted with objectives to determine (a) the prevalence of dental fluorosis and skeletal fluorosis in Vadodara district, Gujarat, India, and (b) various interventions to reduce the prevalence of fluorosis in Gujarat. The interventions include facilities for early diagnosis (including infrastructure, instruments, and medical faculties), proper treatment, and counseling of fluorosis patients in Vadodara, Gujarat.

MATERIALS AND METHODS

Prevalence of dental fluorosis and skeletal fluorosis

Villages of Vadodara district were divided into two categories, namely high fluoride and normal fluoride levels in drinking water as reported by the Gujarat Water Supply and Sewerage Board (GWSSB). Out of 2,500 villages, 11 villages having high fluoride in drinking water and 11 villages having normal fluoride in drinking water were randomly selected for water sampling. Water samples were collected from all the water sources from all these selected villages. The analysis of the fluoride level was made by spectrophotometric method. The results of these 22 villages were compared with GWSSB reports. Eleven out of 22 villages showed similar findings and were selected for further study, in which 6 out of 11 villages showed high fluoride level and 5 out of 11 villages showed normal fluoride level.

The data collection for this study was made by house-to-house visit twice in these 11 selected villages. Those houses which could not be studied in the second visit also were excluded from the study. The prevalence of dental fluorosis was measured with the following grading system: questionable (Grade 1), very mild fluorosis (Grade 2), mild fluorosis (Grade 3), moderate fluorosis (Grade 4), and severe fluorosis (Grade 5). The prevalence of skeletal fluorosis was done clinically based on the rigidity and pain of the back, neck region, and shoulder joints as recommended in the guidelines by the Government of India.[2] When joint rigidity was found to be positive in any of the three joint tests, the patient was labeled as a case of skeletal fluorosis.[5,10] It was not feasible to do any X-ray in the community.

Diagnostic facilities

The Department of Health and Family Welfare, Government of Gujarat, in the year 2010 provided a fluorine meter for measurement of fluoride in water and urine. Gujarat has been a pioneer in India to provide such a facility in all six government medical colleges of the state.

Intervention

Due to water scarcity in many parts of the state, the Government of Gujarat also took initiative to provide alternate water source, especially from the Narmada River, for drinking purpose. For this, the construction of huge

canals across the state was undertaken. This not only served the purpose of adequate drinking water supply to the people but also helped in prevention and control of fluorosis in Gujarat.

Capacity building

Capacity building of faculty members of all six medical colleges of Gujarat state was done. A special 2-day training was given to the faculties of the Department of Preventive and Social Medicine (PSM), Medicine, Surgery, Orthopedics, Biochemistry, and Dentistry. The training was provided by national-level faculties using standardized PowerPoint presentation prepared based on the Government of India guidelines.[1,2]

The major areas covered during this training included topics such as epidemiology of fluorosis and tests for differentiating skeletal fluorosis from other bone disorders through history taking. Data related to residence, water supply, and diet were charted. Recognition of common clinical features in skeletal, gastrointestinal, and dental features was taught using appropriate pictures and case studies. Following that, diagnosis using fluoride levels in urine, blood, and water was recommended. Based on area of skeletal change, radiographs of the forearm or spine were examined for increase in bone mass, bone density, or loss of bone translucency or ligament calcification.

Proper treatment with Vitamin C and antioxidants was recommended counseling regarding avoiding consumption of fluoride-containing food, change of water source, and avoiding use of fluoridated toothpaste for prevention and control of fluorosis.

Patient care and counseling

Early diagnosis and proper treatment is one of the important pillars in fluorosis mitigation. Hence, after appropriate training of all faculty members in Gujarat state, all measures were taken for early diagnosis, proper treatment including dental treatment for dental fluorosis, and rehabilitation for severe cases of skeletal fluorosis. Proper counseling was done to the patients and their family members by the PSM Department who were specially trained in counseling practices.

RESULTS

Of the total population under study (n = 8,036), 6,093 persons were studied. The prevalence of dental fluorosis in high fluoride areas was (1,685/2,841) 59.3%, while in normal fluoride areas, its prevalence was (1,275/3,252) 39.2%. The difference was statistically significant (95% confidence interval: 17.59%–22.57%). The overall prevalence of skeletal fluorosis was 15.6%, with the prevalence of skeletal fluorosis as 18.65% in high fluoride areas and 12.54% in normal fluoride areas. The prevalence of fluorosis was seen higher in the age group of 12–24 years, with a mean age of 22.5 years. These findings were published in the *Indian Journal of Medical Research* and *Indian Practitioner Journal* in 2012.

Along with this research project, nearly 25–30 faculty members from each medical college were trained in the diagnosis of fluorosis and its prevention and control measures. Moreover, with the availability of the instrument for fluoride estimation in all government medical colleges of the state, drinking water and urine samples were collected from the fluorosis patients visiting the health-care facility. This, in turn, helped in the diagnosis of fluorosis at an early stage. All fluorosis patients visiting the Medicine/Surgery/Orthopedics Outpatient Department in Government Hospital were referred to the Biochemistry Department for fluoride estimation in their urine and drinking water they used. Patients were then referred to the PSM Department for counseling on fluorosis and important preventive measures such as intake of calcium and Vitamin C and avoiding water/food substances having high fluoride content. On an average, 10 patients per month were counseled in Government Medical College, Vadodara. Some patients with mild-to-moderate stains on their teeth were treated with microabrasion technique by sanding off the outer layer of the enamel in the dentistry department.

DISCUSSION

As per the Indian Standards, the fluoride level up to 1 mg/L in drinking water is considered acceptable. However, in India, the problem of high fluoride in drinking water is noticed. Many states of the country including Gujarat continue to remain highly endemic for fluorosis. As per a review study, 18.2% of population showed the symptoms of back pain, joint stiffness, and reduced range of motion, of which 71% of cases showed radiological changes. In such areas, the fluoride level in drinking water was found to be 0.5–4.0 ppm. Furthermore, 35.3% dental fluorosis was seen in the same population.[4] Our study reports a prevalence of around 60% in the villages of Vadodara district having high fluoride content in water. The prevalence of dental fluorosis and skeletal fluorosis was found to be 38.9% and 15%, respectively, in our study which is comparable with a study conducted by Shah *et al*. The results in our study do not tell about the period of fluoride ingestion in the studied population. Dental fluorosis develops only when one is exposed to high fluoride level during childhood when dentition develops. Once fluorosis develops, it is permanent.

Determination of the prevalence of fluorosis is important baseline information indicating the current situation of the problem of fluorosis in Gujarat. Hence, after this baseline survey, instrument for fluorine estimation in water and urine was provided by the Government of Gujarat to all medical colleges. The purpose of provision of this instrument was estimation of fluoride in urine and drinking water on a regular basis to diagnose the cases of fluorosis early. During this period, the government also provided alternate water source by providing water of the Narmada River in many parts of the state serving dual purpose of addressing the problem of water scarcity and fluorosis. The Narmada River water is still not reaching some tribal areas in the state. If safe water supply is not available, then it is difficult to control the problem of fluorosis. This point came to light during the counseling of fluorosis patients. However, provision of alternate water supply alone would not solve the problem of fluorosis. Early diagnosis, prompt treatment, and proper counseling of patients for various preventive and control measures are equally important. Hence, capacity building was also done in medical colleges.

Dietary modifications like avoiding the food items rich in fluoride such as black rock salt, hajmola (digestive herbal pills), chickpea, black tea, daal mooth, certain churnas (digestive herbal powders), betel nuts, and areca nuts and promotion of intake of certain nutrients such as Vitamin C, calcium, and antioxidants in the diet were measures suggested to prevent fluorosis. Advice was given to avoid fluoride toothpaste. All fluorosis patients visiting the health-care facility were counseled about these measures. The treatment of fluorosis depends on the severity of the disease. Some dental procedures such as microabrasion, tooth whitening, crowns, composite bonding, and porcelain veneers have been found to be effective in removing stains of moderate-to-severe fluorosis.[11]

Hence, an integrated approach including alternate safe water supply, early diagnosis and treatment, and dietary modifications with essential nutrients and antioxidants will be helpful for control of fluorosis.

One interesting study by Gupta *et al*. has documented reversal of dental and clinical fluorosis in children by administration of calcium, Vitamin D3, and ascorbic acid supplement well below the toxic dosage.[12] In our study, when we did follow up with all villages, after supply of water supply by the Government of Gujarat, although some improvement was observed clinically, we were unable to provide any information on such finding about reversal of fluorosis. Hence, this question about reversal of fluorosis still remains unanswered.

Nowadays, the availability of filters like reverse osmosis (RO) plants will definitely help in removal of dissolved solids as well as microbes and reduction of fluoride level in water. However, it has certain disadvantages such as issues of affordability due to high cost and adverse health effects of demineralized water. Due to the use of demineralized RO water, the risk of cardiovascular morbidities and mortality[13] and Vitamin B12 deficiencies has increased.[14]

There were many challenges faced in the implementation of this project. First, the sample collection from patients was not feasible in many instances. This is because, when the patient visits the health-care facility, he may not carry sample of the drinking water. Hence, the patient is requested to carry the drinking water sample during the follow-up visit which he may or may not do. Second, the instrument for fluoride estimation in the water/urine sample requires timely refilling and replacement of cartridges which is not done on a regular basis in medical colleges due to administrative issues related to the cost and maintenance of the instrument. Third, there was a high staff turnover ratio because of transfer, retirement, or resignation. Hence, once again, the newly recruited staff required detailed training of the entire process.

There are some limitations to this study. We are able to present the findings from one medical college only, although facilities for fluorosis diagnosis have been provided to all six medical colleges of the state. This facility was available only at a tertiary care hospital, and it was not available at primary health centers, community health centers, and district hospitals, which cause difficulty in accessibility to the patients.

CONCLUSION AND RECOMMENDATIONS

Fluorosis remains one of the important public health problems in Gujarat, with an overall prevalence of approximately about 60% in high water fluoride-level areas.

An integrated approach is needed to combat the problem of fluorosis. Intersectoral coordination between Civil Engineering Department, Food and Nutrition Department, and Health Department is necessary. Only water supply will not solve problem of fluorosis; instead, a multisectoral approach including water supply, patient care and counseling, and dietary modifications is necessary.

Acknowledgment

The authors would like to acknowledge Dr. Vikas Desai,

Ex-Director Health and Family Welfare Department, Government of Gujarat, for her inputs and support for various facilities and interventions for prevention and control of fluorosis in the entire state of Gujarat. We are thankful to the Indian Institute of Science, Bangalore, for giving opportunity to attend a workshop on "naturally occurring pollutants affecting water quality in India and neighboring regions" and present the various interventions carried out to control fluorosis in Gujarat.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Susheela AK. Fluorosis: Indian Scenario: A Treatise on Fluorosis. New Delhi: Fluorosis Research and Rural Development Foundation; 2001.
2. Government of India. Prevention and Control of Fluorosis in India. New Delhi: Rajiv Gandhi National Water Drinking Mission; 1993.
3. World Health Organization. Fluorides and Human Health. Monogr Ser 59. Geneva: World Health Organization Publ WHO; 1970.
4. Sharma S, Ramani J, Bhalodia J, Thakkar K. Fluoride and fluorosis in context to Gujarat state of India: A review. Res J Pharm Biol Chem Sci 2012;3:85-94.
5. Kotecha PV, Patel SV, Bhalani KD, Shah D, Shah VS, Mehta KG. Prevalence of dental fluorosis & dental caries in association with high levels of drinking water fluoride content in a district of Gujarat, India. Indian J Med Res 2012;135:873-7.
6. Vikas D. Mehsana Fluoride Area Health Baseline Survey. Gujarat, India: Fluoride; 1994.
7. Sunderrajan K. Groundwater Quality in India Distribution, Social Burden and Mitigation Options. International Water Management Institute, Vallabh Vidya Nagar, Anand, Gujarat, India: INREM Foundation; 2010.
8. Shah T, Indu R. Fluorosis in Gujarat: A Disaster Ahead. International Water Management Institute, Vallabh Vidya Nagar, Anand, Gujarat, India: INREM Foundation; 2004.
9. INREM Foundation. Health Impacts of Poor Water Quality along Coastal Areas of Gujarat. International Water Management Institute, Vallabh Vidya Nagar, Anand, Gujarat, India: INREM Foundation; 2010.
10. Kotecha PV, Patel SV, Shah D, Bhalani KD, Shah VS, Mehta KG. A cross sectional study to assess the prevalence of skeletal Flurosis and the relationship for Dental Fluorosis and Skeletal Fluorosis in Baroda district villages. Indian Pract 2012;65:85-90.
11. Ramalho KM, Eduardo Cde P, Rocha RG, Aranha AC. A minimally invasive procedure for esthetic achievement: Enamel microabrasion of fluorosis stains. Gen Dent 2010;58:e225-9.
12. Gupta SK, Gupta RC, Seth AK, Gupta A. Reversal of fluorosis in children. Acta Paediatr Jpn 1996;38:513-9.
13. Kozisek F. Health risks from drinking demineralised water. World Health Organ 2005:152-4.
14. Gupta ES, Sheth SP, Ganjiwale JD. Association of Vitamin B12 deficiency and use of reverse osmosis processed water for drinking: A cross-sectional study from Western India. J Clin Diagn Res 2016;10:OC37-40.