COMMUNITY PERCEPTION IN ADAPTATION OF TECHNICAL AND TRADITIONAL FLUORIDE MITIGATION PRACTICES

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ABSTRACT
India is among the 23 nations around the globe where health problems occur due to excess ingestion of fluoride (>1.5 mg/l) by drinking water. In Rajasthan, 24 out of 32 districts are fluorotic and 15 million of the populations are at risk. An exploratory qualitative study was carried out to describe perception of the community regarding fluoride and related health problems in central. 746 habitations among 1160 habitation studied were found to have >1.5 mg/l fluoride. Fluoride concentration varies from 0.2 to 12.2 mg/l. in the area A detailed fluorosis study was done in 50 habitations with >5.0 mg/l fluoride. 7424 individuals were examined. The overall prevalence of dental and skeletal fluorosis was found to be 5,053/7,424 (68.06%) and 529/3,885 (13.62%), respectively.

***Keywords**: Fluoride, Dental fluorosis, Skeletal Fluorosis, CFI, Defluoridation.*

1 INTRODUCTION

Fluorideconcentration is an important aspect of hydro-geochemistry because of its impact on human health. India has 14.1% of total fluoride deposits on the earth's crust. It is not surprising, therefore, that the fluorosis is endemic in 17 states of India (UNICEF 1999). Research has shown that fluoride concentrations between 0 and 0.5 mg/l favor dental caries development, whereas concentrations between 1.5 and 5 mg/l can result in dental fluorosis. However, fluoride contents of between 0.5 and 1.5 mg/l have a beneficial effect, reducing caries development (WHO 1996). Thus, the fluoride concentration in drinking water is a like two-edged knife, both its higher and lower concentration is not safe (Husain et al. 2002, 2004a). The Bureau of Indian Standards (BIS) prescribed a limit between 1.0 and 1.5 mg/l, whereas USPHS (1962) has set a range of allowable concentrations for fluoride in drinking water for a region depending on its climatic conditions because the amount of water consumed and consequently the amount of fluoride ingested being influenced primarily by the air temperature. Accordingly, the maximum allowable concentration for fluoride in drinking water in Indian conditions comes to 1.4 mg/l, while as per Indian standard it is 1.5 mg/l.

High groundwater fluoride concentrations associated with igneous and metamorphic rocks such as granites and gneisses have been reported from India, Pakistan, West Africa, Thailand, China, Sri Lanka, and Southern Africa (WHO 2006). The dissolution of fluorite, apatite, and topaz from local bedrocks leads to high fluoride concentration in groundwater. It is estimated that around 200 million people, from among 25 nations the world over, are under the dreadful fate of fluorosis. India and China, the two most populous countries of the world, are the worst affected. In Indian continent, the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks and about 62 million

people are at risk of developing fluorosis from drinking high fluoride water. The problems are most pronounced in Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, and Uttar Pradesh (Hussain 2001; Hussain et al. 2000, 2003, 2004a, b, 2005a, b, 2007; Godfrey et al. 2006; Sharma et al. 2007; Khaiwal and Garg 2007).

In Rajasthan, availability of safe and potable water is still low for a majority of rural population residing in 18 districts, where the main source of drinking water is the groundwater in the form of open wells, tube wells, hand pumps, etc., having fluoride content as compared to water from surface source. Certain edibles, e.g., tea, betal, tobacco, etc. also contain sufficient amount of fluoride which is absorbed in the body through gastrointestinal tract, further aggravating the problem. It is estimated that an average adult may ingest 8–10 mg fluoride daily from drinking water (Hussain et al. 2002, 2004a; Whitford 1997). A bibliographic survey has shown that however a lot of studies are available showing fluoride concentration in some areas, there is still a lack of studies on the effect of high fluoride concentration on the local consumers, i.e., fluorosis. In various studies, it was found that the effect of fluoride not only depends on the climatic condition but also on the dietary habits. The person not taking balanced diet has higher risk of fluorosis than that person taking balanced diet. It was also found that the high calcium dose in food also reduce the risk of fluorosis.

Therefore, it was planned to study the depth fluorosis in the rural area of Central Rajasthan which have high fluoride concentration in groundwater. The selected part for this study is situated in central part of the state where groundwater is a major source of drinking water. Review on the literature showed that no studies have been undertaken in the study area with regard to fluoride and fluorosis problem yet. So the objective of this study was to investigate the quality of drinking water (underground water) with special reference to the concentration of fluoride in most rural habitations of Central Rajasthan, India and to study the cases of fluorosis in the villages having more than 5.0 mg/l fluoride. Beside these the acceptance of defluoridation techniques in community is also studied.

2 METHODOLOGY

The fluoride concentration in water was determined electrochemically, using fluoride ion selective electrode [13]. For collection of data pertaining to evidence, prevalence and severity of dental and skeletal fluorosis a house-to-house survey was conducted in 58 habitations having fluoride concentration above 5.0 mg/l. For the survey a questionnaire was designed consisting information regarding age, sex, and dietary habits of individuals. For dental fluorosis, teeth of individual sand nutritional habits of different age groups and sex were carefully examined in proper daylight. The characteristic of different grades of dental fluorosis are grouped as described by Dean [14] in table 1.

Table 1 Dean's (1942) classification for dental fluorosis

Normal	The enamel presents translucent, semi-vitriform type of structure.The surface is smooth, glossy and usually pale creamy white color.
Questionable	Seen in area of relatively high endemicity, occasional cases are borderlineand one would hesitate to classify them as apparently normal or very mild.
Very Mild	Small, opaque paper-white area seen, scattering irregularly over the labial andbuccal tooth surfaces.
Mild	The white opaque areas involve at least half of the tooth surface andfaint brown stains are sometimes apparent
Moderately Severe	Generally all tooth surfaces are involved and minute pitting is often present on thelabial and buccal surfaces. Brown stains are frequently a disfiguring complication.
	The severe hypeoplasic affect the form of the teeth and stains are wide spread, andvary in intensity from deep brown to black.

For the evidence of skeletal fluorosis, only adult individuals (>21) were considered. The grading proposed by Teotia [15] for clinical skeleton fluorosis was considered and used in the present study.

Grade I Generalized bone and joint pain.

Grade II Generalized bone and joint pain, stiffnessand rigidity of dorsolumberspine and restricted movements atspine and joints.

Grade III Symptoms of grade II with deformitiesof spine and limbs knockknees, crippled or bedridden state,kyphosis, invalidism, genu-varum andgenu-valgum.

Using Dean's classification Fluoride Index was calculated by the following formula:

$$\text{Community Fluorosis Index (CFI)} = \frac{\sum (\text{Scores} \times \text{no. in each score group})}{\text{Number of cases examined}} \quad (1)$$

The scores represent to a particular value givento the various degree of fluorosis. It is 0 for normal,0.5 for trace, 1.0 for very mild, 2.0 for mild,3.0 for moderate, and 4.0 for severe.

3 MAIN RESULTS

Fluoride distribution in central Rajasthan is shown in table 2. Fluoride is recorded as high as 21.2 in the area. 63.2% habitations have groundwater with excessive fluoride to 1.5 mg/l standard limit. Maximum habitations have fluoride concentration in the range of 1.5 to 3.0 mg/l.

Table: 2 Fluoride Distributions in Study Area

No. of Habitation studied	Fluoride Concentration		No. of Habitation with Fluoride Concentration					Fluoride below MPL		Fluoride Above MPL	
	Min	Max	<1.0	1.0-1.5	1.5-3.0	3.0-5.0	>5.0	No.	%	No.	%
1160	0.2	21.2	158	256	447	249	50	414	35.7%	746	64.3%

The fluoride concentration in study area rangesfrom 0.2 to 12.2 mg/l. The maximum concentration of fluoride was recorded from villageJadisara village of Nagaur block in Nagaur District. 158 villages (13.6%) fall in category I. In thesevillages, fluoride concentration is below 1.0 mg/l which is maximum desirable limit as per standardsfor drinking water recommended by BISin IS: 10,500, 1991.Therefore, there is no possibilityof fluorosis in these villages. A total of256 villages (22.1%) have fluorideconcentration between 1.0 and 1.5 mg/l (categoryII); 1.5 mg/l is the maximum permissible limit ofstandard for drinking water (BIS, 10500, 1991).In 447 villages (38.5%), the fluoride is between1.5 and 3.0 mg/l (category III). The concentrationis above the maximum permissible limit. In 249villages (21.5%) the range of fluoride concentrationin ground water is 3.0 to 5.0 mg/l. Only 50villages (4.3%) fall in category V, where fluorideconcentration is above 5.0 mg/l.As per the desirable and maximum permissiblelimit for fluoride in drinking water determinedbyWorld Health Organization (1996) or byBureau of Indian Standards (1991), groundwaterat 746(64.3%) habitations were found unfitfor drinking purposes. Moreover, dental andskeletal fluorosis is at alarming stage in local residentof these areas.Brouwer et al.(1988) stated that F^- is attracted by positivelycharged calcium ions,

due to its strong electronegativecharges, in teeth and bones and, therefore,excessive intake of fluoride causes pathologicalchanges in teeth and bones.

Table 3 represents the prevalence of fluorosis according to age and sex. It was observed that at the age below 30, there is a small difference in the dental fluorosis cases in male and females. However, at the age beyond 30, the dental fluorosis in males was found in higher percentage than in females.

Table 3: Prevalence of Dental and Skeletal Fluorosis

Age Group (in year)	No. of Individual Examined			Dental Fluorosis (%)			Skeletal Fluorosis (%)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
5-10	912	753	1665	640 (70.18%)	578 (76.76%)	1218 (73.15%)	-	-	-
11-20	998	876	1874	660 (66.13%)	674 (76.94%)	1334 (71.18%)	-	-	-
21-30	812	727	1539	574 (70.69%)	464 (63.82%)	1038 (67.45%)	102 (12.56%)	56 (7.70%)	158 (10.27%)
31-40	621	530	1151	412 (66.34%)	326 (61.51%)	738 (64.12%)	92 (14.81%)	50 (9.43%)	142 (12.34%)
41-50	423	340	763	283 (66.90%)	198 (58.24%)	481 (63.04%)	81 (19.15%)	48 (14.12%)	129 (16.91%)
>50	230	202	432	140 (60.87%)	104 (51.49%)	244 (56.48%)	64 (27.83%)	36 (17.82%)	100 (23.15%)
Total	**3996**	**3428**	**7424**	**2709 (67.79%)**	**2344 (68.38%)**	**5053 (68.06%)**	**339 (8.73%)**	**190 (4.89%)**	**529 (13.62%)**

This may be due to joining females from other villages after marriage. Several workers reported a variable prevalence in different and similar age groups, but their common findings about prevalence of dental fluorosis is (a) more in areas of high fluoride concentration, (b) decreased with increasing of age, and (c) higher in males as compared to females. In the present study, no significant correlation was found between the prevalence of dental fluorosis and age, which is alsoreported earlier (Choubisa and Sompura 1996; Raina and Kant 1995; Desai et al. 1988; Jolly et al. 1970). These findings indicate that the onset, prevalence, and severity of dental fluorosis do greatly vary from place to place despite the almost identical fluoride level in drinking waters. The variations also depend upon several other factors viz., dietary habits, nutritional status, average water intake, chemical constituents of drinking water, and climatic conditions.

Table 3 represents the prevalence of skeletal fluorosis in different age groups. The data show that male cases are greater than that of female. This is because of residency of males originally from the village and also high amount of fluoride-rich water intake since birth. While in females, most of them are from other villages and in the village after their marriage. It is also recorded that on increasing age, the incidence of skeletal fluorosis also increases. In the survey, 100 individuals (23.1%) above age 50 are skeletal fluorosis positive. While in case of age group 21–30, only 10.27% (158 individuals)are suffering from fluorosis.

4. PROBLEMS IN ADAPTATION OF FLUORIDE MITIGATION PRACTICES

Rajasthan Integrated Fluorosis Mitigation Program (RIFM) of Government of Rajasthan is running from year 2001. At present third phase is running. In first phase villages with fluoride concentration above 5.0 ppm were selected. In second phase villages with fluoride concentration above 3.0 ppm were targeted. In these villages Domestic Defluoridation Units based on Activated Alumina was used. This kit was distributed free to BPL's and on subsidized rate for other.

Awareness program were also launched but in feedback study it was found that very few families are aware for it. The major problem in this technique was found of the regeneration of Activated Alumina. A trained, skilled and technical person can perform this work and the regeneration centers opened by government in partnership with NGO have been closed due to very low scope. In second phase government also introduced the Hand pump attached defluoridation units based on activated alumina. These units are community based and a street / colony / part of village is benefited by this. The success rate of these units was found slightly more than the domestic household defluoridation units. Taking the whole experience in consideration only hand pump attached defluoridation units were installed in third phase.

Fig. 1 Some Observations of Dental Fluorosis

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