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Research Article

SKELETAL AND DENTAL FLUOROSIS MAPPING IN AN ENDEMIC VILLAGE OF KORBA DISTRICT IN CHHATTISGARH STATE, INDIA

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ABSTRACT

Context: Endemic fluorosis due to high fluoride concentration in groundwater is a major public health problem in certain pockets of Chhattisgarh, India. The risk of fluorosis was highest in that area which shows more fluoride content in drinking water.

Objectives: To find out the prevalence of the skeletal and dental fluorosis among the population and to assess its relation to the drinking water fluoride level.

Methods and Material: A descriptive, cross-sectional study with a clinical examination by door to door visit and follow-up visits undertaken in Phulsar village and Korbi Hamlet, of Korba district, of Chhattisgarh state in the Oct 2013. Drinking water sources of individuals were mapped residing in paras (clusters) and quantitative assessment of fluoride concentration of drinking water was done in that area.

Settings and Design: Cross sectional community based design by census method.

Results: A total of 97% houses and 88% population of the village was covered and clinically examined for skeletal and dental fluorosis. The survey covered 1087 (85%) individuals in which 534 were female and 553 were male. Dental fluorosis and genu varum are the commonest type of fluorosis among surveyed inhabitants followed by genu vulgum and kyphosis. 2.72% inhabitants are having multiple deformities. Highest prevalence of skeletal fluorosis in children's (6.3%) and adults (26.6%) are at maximum fluoride level in drinking water sources of 2.5 ppm and 3.5 ppm, respectively. The prevalence of skeletal fluorosis was more common above 45 years among both sexes while lower in the children less than 12 years of age. High prevalence of fluorosis was recorded in all surveyed hamlets, which had also the highest fluoride level (>3.00 ppm.) in the drinking water source.

Conclusions: This study reaffirms the relationship of fluorosis with high fluoride levels content in drinking water. Dental fluorosis can be easily recognized, the skeletal involvement is not clinically obvious until the advanced stage of crippling is reached. Change in water source from deep tube well and a hand pump to piped water supply with health education to the community is necessary in order to reduce the problem.

Keywords: Skeletal Fluorosis, Dental Fluorosis, F Level (Fluoride) Water, Genu Varum, Genu Vulgum Prevalence Rate.

INTRODUCTION

Skeletal fluorosis is a bone disease caused by excessive consumption of fluoride. In progressive cases, skeletal fluorosis causes pain and damage to bones and joints. Fluoride in water and eatables is mostly of geological origin. A continuous level of fluoride more than 1.5 ppm per liter and above in drinking water is considered hazardous for the health of bone and teeth[1,2]. Although there are a large number of studies available, the data are such that it is difficult to determine a clear exposure response relationship. India lies geographically in a fluoride belt, which extends from Turkey up to China and Japan through Iraq, Iran and Afghanistan[3]. In India, the disease is endemic in about 275 districts of 20 states

and UTs, with 66 million individuals, at risk. Out of these, 6 million are children below the age of 14 years[4] .In the state of Chhattisgarh, 14 districts have endemic pockets[5] .Clinically the disease manifests in skeletal and dental forms. Dental fluorosis is predominantly seen in children when the exposure is between one to four years of age and mostly occurs in children below 12 years of age[6] .Skeletal fluorosis clinically manifests in the form of various deformities viz. Genu varum, genu valgum and kyphosis[7-9] .The disease severity depends on numerous factors like age, nutritional status and response of the individual to exposure[10] .Children, adolescent and adults are considered to be the main victims of fluorosis by some researchers[6,11].

A centrally sponsored scheme entitled 'National Programme for Prevention and Control of Fluorosis' has been prepared for the Eleventh Five Year Plan with a budget provision to check fluorosis in 19 states. Present survey was carried out as part of disease mapping exercise with aim to assess the burden of fluorosis, identify types of deformity and to assess the fluoride concentration in prime drinking water sources with the aim of initiating suitable interventions.

MATERIALS AND METHODS

The list of villages in Korba district along with a fluoride level obtained from the State Programme Officer. Phulsar village and neighbouring para of Korbi village was selected randomly for the survey. A cross-sectional survey of the village was undertaken during Oct 2013. Initially, a village map, as per Para (locality) was prepared with the help of key informants. Local announcement was made regarding the purpose and period of the survey, technique to be used and its significance, to get better cooperation and coverage of the village population. The school children were also examined after taking appropriate consent of the school administration. House to house survey of the whole village was undertaken by a team on the first day and second day simultaneously to cover the entire population. A follow-up visit was made in the evening of the second day to cover the houses which were found locked and persons who were found absent on the first day of the survey. During the house to house visits, all available house members were clinically examined. The information was filled in the pre-designed proforma. Field case definitions were used for labeling the cases of dental fluorosis, genu valgum, genu varum and kyphosis. Parawise /house wise drinking water were identified and mapped. The listing, labelling and collection of water samples were done on the final day of the survey. Samples were collected in bottles, which were properly washed with detergents and rinsed with water. Water samples were drawn from most commonly used water sources from each para and private individual hand pumps and wells. These water samples were sent to a Public Health Engineering (PHE) laboratory in district Korba for estimation of water fluoride levels. After analysis of water samples, a mapping of the fluoride content in the different drinking water sources along with the affected households was taken in each hamlet of the surveyed village was done. The data were retrieved and analyzed, whenever necessary an appropriate statistical test was applied.

RESULTS

The Phulsar village is located in a Podiupera block of Korba district .It has population of 709 and the para of Khajurpara (Korbi) had population of 378. The survey covers mainly five paras, of which, one paras is 0.5 to 1km away from the main locality. Among the surveyed population, 534 were females, and 553 were male. During the house to house survey, a total of 198 (97 % of the total) houses and 958 (88% of the total) populations of the village were covered. Five houses were found locked and remaining was temporarily out of the villages on the date of surveys. The village is split into paras while the socioeconomic status of the village is heterogeneous. Though the subject, of the survey area had variety of occupation, they have been separated into six groups, viz., Agriculture, Business, housewife, Labor, Service and Student based on the type of work done by them. Information about income of individual members could not be recorded in detail. 28% of the occupants were engaged in agriculture while 4%were agriculture labourer. 34.2% of the total population was students. The village along with neighboring para had mainly 26 water sources. There was no sanitary well in the surveyed village and neighboring paras. Wells and tube wells are the only water sources which they utilized for drinking water and for other purpose like washing and also for cattle use. All the inhabitants were relying solely on hand pump only. Hand pump near to school contains high level of fluoride and the same is utilized by school students. The majority of villagers were also changing the sources of drinking water as per their convenience and need. Dental fluorosis and genu varum are the most common form of fluorosis in surveying paras. 45 (17%) persons are suffering from multiple fluorosis deformities that are ranged from mild to crippling stage.

Table 1 show para-wise prevalence of fluorosis and water fluoride concentration of prime drinking water sources in each para. The overall prevalence of fluorosis was 27.66% among the surveyed population. The highest number of dental fluorosis cases was found in Ghatpara (16.3%) followed by Khajurpara (16.2%). The prevalence of genu varum was more in Khajurpara (11.4%) followed by Phulsar mainpara (10.6%) as compared to other paras. Genu Vulgum and kyphosis prevalence was more in pulsar mainpara, Ghatpara and Khajurpara (Korbi). Multiple fluorosis deformities are seen in all paras but more prevalent in Phulsar main para and Khajurpara (Korbi). Probably, these differences are similarly associated with the fluoride concentration in water, duration of exposure and individual habits of the persons. There is a definite relationship of an increase in the prevalence of fluorosis with the rise of fluoride in drinking water. Both sexes are equally affected in these areas. Ghatpara had the highest prevalence of fluorosis even it contains low fluoride in the prime drinking water source. Primary school children in both the hamlets had fluorosis prevalence in more than 50% and the fluoride concentration in drinking water sources of these schools is >3ppm. A reason could be changing drinking water sources of the population, especially school going children. Fluoride level of prime drinking water sources of the surveyed para ranged from 0.16 ppm to 3.45 ppm. The surface water had a low fluoride level in comparison to the tube wells of the

surveyed water sources. Apart from these, the relationship of fluoride intoxication to the ingestion of fluoride is dependent upon meteorological factors, e.g., high temperature, consumption of dirty water laden with suspended impurities and dietary habits of peoples, which were not ruled out in this survey.

The prevalence of dental fluorosis was seen more in female (11.9%) in comparison to male (9.5%). Skeletal fluorosis is more in male in comparison to female. As showed in above table dental fluorosis (38.8%) and genu varum (38.8%) was the commonest type of fluorosis among surveyed inhabitants followed by genu varum and kyphosis. 17 (2.7%) inhabitants having multiple deformities Nearly 80% of the skeletal fluorosis individuals are suggestive symptoms like pain in cervical region/joints, restriction in joint movement, chronic backache, tingling and numbness, inability to squat and ugly gait and posture.

As showed in table 2, the prevalence of dental fluorosis was more among 6-12 years (28.7%) followed by 13 to 19 years (22.7%) while the prevalence is lower in age group above 45 years of age groups. The prevalence of skeletal fluorosis was more common above 45 years among both sexes while lower in the children (6-12). The prevalence of the fluorosis is more in the students' i.e. 35.3%, while agriculture labor group 26.7%. No cases of fluorosis observed in the age group less than six years of age. In comparison, the prevalence of dental fluorosis is more among school going children than in the community members as showed in Table 3. The hand pump near school is having F levels more than 3 ppm in surveyed hamlets and Khajurpara. The students are exposed to high fluoride level in school as well as in the house. The majority of the sources having fluoride level ranging from 2.1 to 5.0 ppm come under category III (High risk sources). The difference in the prevalence rate among the children and the adults consuming water with different concentration of fluoride was statistically significant.

Table 1: Prevalence of fluorosis as per hamlets (para) (Oct 2013)

Sr No	Hamlets	Population	Fluorosis cases	Prevalence percentage	Exposure to Mean Water Fluoride levels(ppm)	Min-max (ppm)	Standard Deviation
1	Pulsar Main	426 (44.5)	106	24.9	3.0	0.3-3.4	0.4
2	Ghatpara	98 (10.2)	28	28.6	0.8	0.2-3.4	0.9
3	Katajharwa Para	39 (4.1)	7	17.9	2.3	0.7-3.4	1.3
4	Khurkhuri Chapara	61 (6.4)	20	32.8	2.7	0.9-3.4	1.1
5	Khajurpara (Korbi)	334 (34.9)	104	31.0	3.0	-0.1-3.4	0.4
Total		958 (100.0)	265	27.6	2.7	-01-3.4	0.9

(Figures in parentheses indicate percentage)

Table 2: Agewise prevalence percentage of type of fluorosis deformity among surveyed population

Age Groups	Fluorosis mapping									
	DF*	DF* & Genu Varum	DF* & Genu Vulgum	DF*& Kyphosis	Genu Varum	Genu Varum & Kyphosis	Genu Vulgum	Genu vulgum & Kyphosis	Kyphosis	Total
6-12 Years	52 (28.7)	4 (2.1)	7 (3.7)	0 (0.0)	4 (2.1)	0 (0.0)	3 (1.6)	0 (0.0)	0 (0.0)	70 (38.4)
13-19th Years	40 (22.7)	2 (1.1)	1 (0.5)	0 (0.0)	9 (5.1)	1 (0.5)	3 (1.7)	1 (0.5)	1 (0.5)	58 (32.9)
20-45 Years	11 (3.1)	7 (2.0)	0 (0.0)	0 (0.0)	52 (15.0)	2 (0.5)	3 (0.8)	0 (0.0)	1 (0.2)	76 (22.0)
45 to 65 Years	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	31 (22.4)	15 (10.8)	0 (0.0)	0 (0.0)	2 (1.4)	49 (35.5)
>65 Years	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (22.5)	4 (12.9)	1 (3.2)	0 (0.0)	0 (0.0)	12 (38.7)
Total	103 (10.7)	13 (1.3)	8 (0.8)	1 (0.1)	103 (10.7)	22 (2.2)	10 (1.0)	1 (0.1)	4 (0.4)	265 (27.6)

DF*- Dental fluorosis
(Figures in parentheses indicate prevalence percentage)

Table 3: Prevalence among the students in the surveyed hamlets

Fluorosis mapping	Community	Student	Total
Dental Fluorosis	19(3.0)	84(25.6)	103(10.7)
Dental Fluorosis & Genu Varum	7(1.1)	6(1.8)	13(1.3)
Dental Fluorosis & Genu Vulgum	1(0.1)	7(2.1)	8(0.8)
Dental Fluorosis & Kyphosis	1(0.1)	0(0.0)	1(0.1)
Genu Varum	90(14.2)	13(3.9)	103(10.7)
Genu Varum & Kyphosis	22(3.4)	0(0.0)	22(2.3)
Genu Vulgum	5(0.7)	5(1.5)	10(1.0)
Genu vulgum & Kyphosis	0(0.0)	1(0.3)	1(0.1)
Kyphosis	4(0.6)	0(0.0)	4(0.4)
Total	149(23.6)	116(35.3)	265(27.6)

(Chi Squar test $\chi 2 = 155.86$, df =9, P<0.000)

(Figures in parentheses indicate prevalence percentage)

DISCUSSION

General skeletal fluorosis directly affects the economy of villagers as it causes illness and debilitation. Skeletal fluorosis results in impairment, disability and subsequently makes the affected subject handicap. In the early clinical stage of skeletal fluorosis, symptoms include pain in the bones and joints. During this phase, changes in the pelvis and spinal column can be detected on x-rays. The bone has both a more prominent and more blurred structure. In the second clinical stage, pain in the bones become constant and some of the ligaments start to calcify. Osteoporosis may occur in the long bones, and early symptoms of osteosclerosis are present. In advanced skeletal fluorosis, also called crippling skeletal fluorosis, the extremities become weak and movement of the joints is difficult. Vertebrae partially fuse together, crippling the patient. The study results show the overall prevalence (Skeletal and dental) of fluorosis was 27.6% with a fluoride level of prime drinking water ranging from 0.1 to 3.4 ppm. The relationship between a level of fluoride in drinking water and the prevalence of fluorosis has been found to vary from place to place[12-14]. In the present survey, the resident of Khurkhuri Chapara, constituting about 6.4% of the surveyed population, showed higher prevalence (32.8%) of fluorosis, which relates well with high fluoride levels (>3ppm) of their prime drinking water source. But as shown in Table 1, the prevalence of fluorosis is not found to be related to water fluoride concentrations in all the paras. This may be explained by the habit of frequently changing the drinking water sources by the villagers between the paras. It may also be due to the difference in occupation that may affect the amount of drinking water consumption by inhabitants of different paras. Moreover, the possible contribution of other factors related to the host like nutrition, concomitant worm infestation, etc. cannot be ruled out the possibility[10]. A detailed follow-up investigation is needed to explore the role of specific factors. The prevalence of skeletal fluorosis was about 14.5% in the present survey. Males reported higher prevalence (15.9%) as compared to female (13.2%). The findings are consistent with the other observers in Andhra Pradesh [7], Karnataka [11, 15] and southern China[16]. Prevalence also increased with increasing age as reported by other authors[7,11,17] .This may be due to the cumulative effect of long-term exposure to higher fluoride levels. In the present survey, genu varum (38.5 %) genu valgum and kyphosis (12.0%) were the commonest skeletal deformities, similarly reported by other authors[7,11] .The prevalence of both dental and skeletal fluorosis was higher in males. Multiple deformities are also pointed out in a younger age group. The incidence and severity of fluorosis varied greatly among different occupational groups. In the present study, the prevalence of skeletal fluorosis (16-36%) is high in all occupations. While some researchers had reported a high incidence of skeletal fluorosis in farmers and hard workers only[10,18].This could be due to high exposure of F level and other nutritional factors. Farmers and labor habitually carry a heavy load on head and are engaged in activities like digging and ploughing with elementary type of plough. All these put of stress on the bone, and this also explains the preponderances of skeletal deformities in this group. A person involved in light manual labor for service, housewife and the other group showed a lower incidence of a bone lesion.

The present findings are mainly attributed to exposure to water with higher fluoride levels. As this has been identified as a major factor by several others investigators also[7, 9, 11, 19, 20] .However, fluoride concentrations exceeding 2.5 ppm in the drinking water appeared to be critical for the manifestation of severe forms of skeletal fluorosis with deficiency of some nutritional factors to aggravate symptoms of fluorosis reported[19] .Skeletal fluorosis symptoms observed included pain in joints and knee, tingling and numbness of extremities, bending, stiffness of limbs, stiff vertebral column and unable to carry out the routine duties. A number of authors have also reported similar symptoms with varied severity and percentage at different settings and periods[21-23] .It can be summarized that the study reports higher prevalence of dental fluorosis in school children and young adults. The study results show the prevalence of dental fluorosis as 25.6%. Further studies, mostly been undertaken among the school children, reported higher prevalence[19, 24.25, 26].Further, in the present survey, the prevalence of dental fluorosis was higher in individual between 6 -19 years of age compared to higher age groups, which is not in line with the available scientific information which states that the dental fluorosis occurs when exposure is between 1 to 4 years of age, and those above eight years are not at risk[20,27].However, researchers from rural Tamil Nadu [4] and Haryana [28] have reported a higher prevalence in the early

age group, like the present survey. These findings have been attributed to greater body size, increase physical activity and difference in food consumption pattern in the older age group. Further a cumulative effect at earlier exposure may also contribute to the higher prevalence in higher age groups. Our findings do not say anything about the period of fluoride ingestion in the studied population. We also found a higher prevalence of dental fluorosis among males, which is similar to observations made in Uttar Pradesh, India[29].This contrasts with findings from Kerala where higher prevalence was reported among girls[30].Some authors have found no significant gender differences in dental fluorosis[31.32,33] .Higher physical activities among boys, a difference in food pattern and drinking water habits as well as higher mobility might have exposed them to water sources. This study attributed the findings to higher fluoride levels in prime drinking water sources. Several researchers[34]had reported skeletal fluorosis at F levels above 1- 3 ppm, respectively, while dental fluorosis have been reported with < 1.0 ppm fluoride in drinking water[29].From table 3, it is clear that severe skeletal fluorosis occurs where the drinking water contains more than 2.5 ppm and below this concentration dental fluorosis is found to be widespread in the surveyed village.

CONCLUSION

Fluorosis is an important public health problem in the surveyed village. The study relates the occurrence of fluorosis with high levels of fluoride in prime drinking water sources, mainly deep tube wells of paras. Skeletal fluorosis deformities range from mild to severe stage. An immediate change in the water supply to a common water source along with health education and better nutrition are the cost-effective intervention measures for the community is highly desirable. Possibility of other measures to decrease the water fluoride level of a tube well may also be explored i.e. installation of defluoridation plants. Those who are affected by skeletal fluorosis need conservative and surgical intervention after mapping of cases in surveyed village and initiate rehabilitation activities.

Limitation of study: In above study a blood and urine sample analysis, details of diet pattern's examination and x-ray of a person affected by skeletal fluorosis are not carried out.

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