Original Research Paper

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An assessment of prevalence of dental and skeletal fluorosis in the Tehsil Bawal of district Rewari , Haryana

Biology

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ABSTRACT

Water is a major source of fluoride ions in the areas where skeletal and dental fluorosis are endemic. High concentration of fluoride in groundwater has adverse effects on the human population, livestock and crops of a particular region. Geochemical study of groundwater of Bawal Tehsil was used to demarcate the regions having high fluoride concentrations. The findings of present study show that, that the severity of dental and skeletal fluorosis was related to fluoride concentration in drinking water; and showed a positive correlation with it. In the study area, it was detected that 74.43% villagers interrogated were suffering from dental fluorosis.

Introduction

Endemic fluorosis remains a challenging and extensively studied national health problem in India. In 1991, 13 of India's 32 states and territories were reported to have high concentrations of fluoride in water (Jadhav and Bogawar, 2014) but the number of states having fluoride concentration has risen to 17 by 1999.

If fluoride is consumed in more than 4.0 ppm, it can promote the dental fluorosis in children. If it is consumed more than 10.0 ppm can promote dental fluorosis, skeletal fluorosis and crippling skeletal fluorosis, possibly cancer (WHO, 2004).

Dental fluorosis is an accumulation of fluoride in teeth and is caused by ingestion of fluoride during the period of tooth development, i.e. prior to tooth eruption. The fluoride becomes incorporated into the crystal lattice structure of the enamel and causes hypo mineralization which increases the porosity of the enamel.

Another disease known as Skeletal fluorosis is characterized by increased bone mass and density, accompanied by a range in skeletal and joint symptoms. In early stages, the Symptoms include pain and stiffness in the backbone, hip region, and joints, accompanied by increased bone density (osteosclerosis). The stiffness increases steadily until the entire spine becomes one continuous column of bone, a condition known as "poker back". As this condition progresses, various ligaments of the spine can also become calcified. In its most advanced stages, fluorosis produces neurological defects, muscle wasting, paralysis, crippling deformities of the spine and major joints, and compression of the spinal cord.

Skeletal fluorosis affects both children and adults. It does not easily manifest itself until the disease attains anadvanced stage. Fluoride is mainly deposited in the joints of the neck, knee, pelvic, and shoulder bones, and once intakes place, it makes movement or walking difficult. The symptoms of skeletal fluorosis are similar to those of spondylitis or arthritis.

Water is a major source of fluoride ions in the areas where skeletal and dental fluorosis are endemic (Mwaniki, 1990; Dequenker and Declerck, 1993 and Trivedi et al., 1993). However, endemic fluorosis can also be caused by consuming fluoride repeatedly by consuming contaiminated food (Zan-dao et al., 1979).

Review of literature

Several studies have proven that lifelong impact and accumulation of fluoride not only causes human skeletal and teeth damages but also changes DNA structure and increases risk of cancer (Veressinina et al., 2001). Certain experiments were carried out in Japan (Tohyama, 1996) and Taiwan (Yang et al., 2000) that linked various types of cancers with fluoride consumption.

Objectives

Therefore, In view of this, the present study is an attempt to assess fluoride contamination in drinking water and its impact on plants and population in the affected area of Bawal tehsil in Rewari district of Haryana with following objectives.

1. To study the prevalence of skeletal fluorosis among human beings and domestic animals residing in fluoride endemic regions.

2. To study the prevalence of dental fluorosis among human beings and domestic animals residing in fluoride endemic regions.

Study area

Rewari district comprises of 2 divisions (Rewari and Kosli), three Tehsils (Rewari, Bawal and Kosli) and one subtehsil (Dharuhera Rewari). Rewari also comprises of one Municipal council, one Municipal committee, Two market committees (Rewari and Kosli) and five development Blocks namely Bawal ,Jautusana , Khol, Nahar and Rewari.

The number of villages are 398 as against 348 gram panchayats, it is about 85 kms far from the nation capital. The district is splitted into two parts namely South East and North West .The North West is attacehd to Rohtak parliamentary consituency while South East part is included into Gurgaon parliamentary constituency. There are 3 assembly constituencies – Rewari, Bawal and Kosli.

Sample

High concentration of fluoride in groundwater has adverse effects on the human population, livestock and crops of a particular region. Geochemical study of groundwater of Bawal Tehsil was used to demarcate the regions having high fluoride concentrations. Based on the geochemical study of groundwater samples, epidemiological survey of villages lying in fluorosis belt was conducted. In the survey, following aspects were considered to study the impact of high fluoride content:-

1. On Human Health- A questionnaire based survey was conducted based on the zonal distribution of Tehsil, age and sex of the residents.

2. On Livestock- A questionnaire was designed and conducted with owners of cattle, they were asked about source of drinking water the use for cattle and amount of water consumed on daily basis. Similarly fodder composition and mineral supplements were also analyzed and recorded. Fodder samples irrigated with groundwater source were collected for fluoride estimation.

Results

(a) Prevalence of dental fluorosis according to age and sex :

In the study area, it was detected that 74.43% villagers interrogated were suffering from dental fluorosis (Table 1). Its higher prevalence observed in females (80.40%) as compared to males where the prevalence percentage was 73.99. Among males the highest

occurrence of dental fluorosis was recorded in the older age group (> 40 years), (80.33%) and in females it was highest in middle aged woman (85.48%). Dental fluorosis was more prevalent in those children who had spent their first decade of life in fluorosis endemic areas. In the 17-28 years age group, it was more common in females (82.67%) as compared to males (71.08%). This might be due to the migration of a large number of females to the study area from other endemic regions of the state or other states. In the 29-40 years age group, prevalence of dental fluorosis in males and females was 74.51% and 85.48% respectively. Prevalence of dental fluorosis was found to increase proportionally with age, body size and weight. In the residents of > 40 years of age, 79.92% prevalence of dental fluorosis was recorded. The increased physical activity and the source of food consumed may lead to a higher water intake and thus a higher prevalence in older age groups (Nanda, 1972) was observed.

Table 2: Prevalence of severity of dental fluorosis according to sex

S. No.	Age group (years)	No. of Subjects	Normal		Questionable		Grade I		Grade II		Grade III		Grade IV	
			n	%	n	%	n	%	n	%	n	%	n	%
1.	Children Group (4-16)	133	32	24.06	26	19.55	17	12.78	19	14.29	21	15.79	18	13.53
2.	Youth Group (17-28)	148	36	24.32	28	18.92	19	12.84	24	16.22	19	12.84	22	14.86
3.	Middle Group (29-40)	113	23	20.35	30	26.55	22	19.47	13	11.50	15	13.27	10	8.85
4.	Older Age (> 40)	119	26	21.85	18	15.13	23	19.33	20	16.81	19	15.97	13	10.92
	Total	513	117	22.81	102	19.88	81	15.79	76	14.81	74	14.42	63	12.28

Community Fluorosis Index (CFI) was calculated to identify the zones where dental fluorosis has been of public health significance. CFI value of only zone II (0.52) was in the borderline. All other zones had CFI values between 0.67-1.98 indicating 'slight' to 'medium' range in public health significance.

In the present study, a highly positive correlation was found between fluoride concentration in water and CFI scores of different zones. Prevalence of skeletal fluorosis was mainly observed in zone I with 26%, 32% and 47% prevalence of skeletal fluorosis of Grade – I, Grade – II and Grade III respectively.

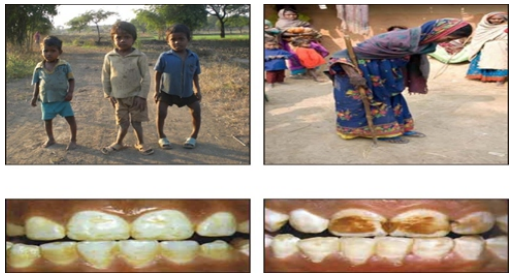

Fig. 1: Prevalence of skeletal and dental fluorosis in the study area

Table 3: Block wise distribution of severity of dental and skeletal fluorosis

Zone wise distribution of Tehsil	Number of subjects	F- (mean in Drinking Water)	Severity of dental fluorosis							Skeletal fluorosis		
			Q	I	II	III	IV	CFI	ODF (%)	I	II	III
Zone I	53	1.95	15	19	21	16	11	17	73.23	26	32	47
Zone II	67	2.15	37	21	14	18	14	21	81.57	21	28	36
Zone III	58	2.25	28	26	19	22	16	14	56.27	19	24	27
Zone IV	61	1.67	24	20	16	26	19	19	61.35	22	23	19
Zone V	56	1.79	34	27	11	15	13	10	59.25	17	19	23
Total	295	1.60	138	113	81	97	73	81	72.67	105	126	152

(d) Prevalence of skeletal fluorosis according to age and sex :

The prevalence of skeletal fluorosis according to age and sex is revealed in Table 1. Skeletal fluorosis was the least in 4-16 years age group (11.28%). In 17-28 years age group, it was 14.19%. In 29-40 years age group, it was 21.24% and in > 40 years, it was 26.05%. In all the age groups, it was more common in females as compared to males. In females higher prevalence may be due to other deficiencies also as the interactions between nutrition, environment, dose and duration of fluoride exposure are the key factors in governing the clinical picture of fluorosis (Krishnamachari, 1982).

(e) Prevalence of non-skeletal manifestations according to age and sex:

The data in Table 4 reveals facts of prevalence of non-skeletal manifestations amongst residents of Bawal Tehsil on the basis of age and sex. Residents of all age and sex had Gastro-intestinal complaints like loss of appetite, abdominal pain and nausea. However, it was found to increase equivalently with age. In > 40 years of age, 38.66%, 33.61% and 17.65% residents interrogated had problems of loss by appetite, abdominal pain, and nausea respectively. Neuro-muscular problems like paralysis were also observed in > 40 years of age only.

Table 4: Distribution of non-skeletal manifestations according to age and sex

S. No.	Age group (years)	No. of subjecs	Loss of Appetite		Abdominal Pain		Nausea		Insomnia		Polyuria		Polydipsia		Paralysis		Fatigue	
			n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1.	Children Group	133	10	7.51	16	12.03	15	11.28	5	3.76	8	6.02	13	9.77	-	-	6	4.51
	M	78	6	7.69	9	11.54	6	7.69	2	2.56	3	3.85	8	10.26	-	-	4	5.13
	F	43	4	9.30	7	16.28	9	20.93	3	6.98	5	11.63	5	11.63	-	-	2	4.65
2.	Youth Group	148	20	13.51	22	14.86	18	12.16	9	6.08	11	7.43	16	10.81	-	-	7	4.73
	M	83	12	14.46	15	18.07	8	9.64	5	6.02	6	7.23	7	8.43	-	-	3	3.61
	F	53	08	15.09	7	13.21	10	18.87	4	7.55	5	9.43	9	16.98	-	-	4	7.55
3.	Middle Age Group	113	25	22.12	31	27.43	34	30.09	7	6.19	8	7.08	18	15.93	-	-	9	7.96
	M	51	13	25.49	17	33.33	16	31.37	4	7.84	6	11.76	11	21.57	-	-	3	5.88
	F	62	12	19.35	14	22.58	18	29.03	3	4.84	2	3.23	7	11.29	-	-	6	9.68
4.	Older age	119	46	38.66	40	33.61	21	17.65	14	11.76	13	10.92	15	12.61	4	3.36	11	9.24
	M	61	31	50.82	19	31.15	15	24.59	5	8.20	7	11.48	5	8.20	1	1.64	4	6.56
	F	43	15	34.88	21	48.84	6	13.95	9	20.93	6	13.95	10	23.26	3	6.98	7	16.28
	Total	474	101	21.31	73	15.40	88	3.16	35	7.38	40	8.44	62	13.08	4	0.84	33	6.96
	M	273	62	22.71	60	21.98	45	2.20	16	5.86	22	8.06	31	11.36	1	0.37	14	5.13
	F	201	39	19.40	49	24.38	43	43.78	19	9.45	18	8.96	31	15.42	3	1.49	19	9.45

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Discussion

The onset of fluorosis and the severity of symptoms are governed by chronic fluoride ingested and the duration of exposure (Viswanadham and Murthy, 1977). Water is a major source of fluoride ions in the areas where skeletal and dental fluorosis and endemic.

In the study area, dental and skeletal fluorosis were observed in 4 age groups viz. Children (4-16 years), Youth (17-28 years), Middle age (29-40 years) and Older age (>40 years). In the study area, prevalence of dental and skeletal fluorosis was found to increase with rise in age. Dental fluorosis was not reported in children upto 3 years of age. The reason behind this is that as formation of teeth starts in the embryonic life the deciduous teeth generally remain unaffected from environment.

In the study area, it was recorded that in the 4-16 years age group; prevalence of dental fluorosis was 74.43%. In males, it was 71.89% while in females it was 78.18%. Saravanan *et al.,* (2008) examined the prevalence of dental fluorosis among school children (5-12 years) in rural area of Childambaram Taluk, Cuddalore District, Tamil Nadu. It was found that prevalence of dental fluorosis was 79.92% in the study area and the gender difference was not statistically significant. On the other hand, a lower prevalence of 16.80% was recorded in rural school children of Alappuzha district of Kerala (Gopalakrishanan *et al.,* 1999).

In the 17-28 years age group (Youth group), it was higher in females (82.67%) than in males (71.08%). This might be due to migration of females to fluorosis endemic villages to these highly affected areas after marriage. Similarly, in 29-40 years (Adult group), prevalence percent of females (85.48%) was higher than in males (74.51%). The dental fluorosis was found to increase with age as in >40 years age group (old age), dental fluorosis was the highest (in males, 80.33% and in females, 74.14%). This increase in dental fluorosis was found to rise with age. This trend is consistent with the findings of Dental Council of India in rural Tamil Nadu (DCI, 2004).

The level or severity of dental fluorosis measured by Dean Index (1942) was applied in the study area. In the age group of 4-16 years (children group), questionable dental fluorosis (19.55%) and grade III (15.79%) were prevalent. The severity of dental fluorosis increased with age and in older age group (>40 years), Grade IV dental fluorosis was most prevalent (19.92%). The increase in the severity of dental fluorosis is attributed to increase in the time of exposure to fluorotic water. The results obtained were in accordance with the findings of Jain (2006), and Saini (2009) in their individual studies.

In skeletal fluorosis, high fluoride concentration manifests as an increase in the bone density leading to thickness of long bones and calcification of ligaments. The symptoms include mild rheumatic/ arthritic pain in the joints and muscles to serve pain in cervical spine region along with stiffness and rigidity of the joints. The disease may be present at sub-clinical, clinical or acute levels of manifestation (Teotia and Teotia, 1988). Crippling skeletal fluorosis can occur when the water supply contains more than 10 mg/L of fluoride (WHO, 1970 and Boyle and Chagnon, 1995).

In the present study, skeletal fluorosis cases were observed only in the zones of high average fluoride in groundwater viz. Zone I (4.45 mg/L) and Zone II(3.96 mg/L). All the 3 grades of skeletal fluorosis were prevalent in zone I while no skeletal deformity relating skeletal fluorosis was found in the villages of low fluoride concentration zones (1.5 mg/L) in the groundwater. Thus, a direct dose-response relationship was evident in both dental and skeletal fluorosis.

In a similar study conducted in high fluoride villages of Sonbhadra district, highest fluoride concentration recorded was 6.7 mg/L from a dug well. In fluoride affected villages, deformation of ligaments, bending of spinal column and aging problem ware observed among the residents (Janardhana Raju, N. *et. al.,* 2009).

Conclusion

The findings of present study show that, that the severity of dental and skeletal fluorosis was related to fluoride concentration in drinking water; and showed a positive correlation with it. Case of Grade IV dental fluorosis, Grade III skeletal fluorosis and Community Fluorosis Index (CFI = 2.1), zone II (1.7), zone IV (1.9) were most prevalent in zone I of tehsil where fluoride concentration in groundwater was in the range of 0.48 mg/L to 4.45 mg/L. CFI was beyond the border line and was 'medium' from view point of public health significance in zone III (1.4) and zone V(1.3). In these zones, fluoride concentration in groundwater was beyond the permissible limit (1.5 mg/L). Similarly, positive correlations between CFI scores and fluoride concentration in water of rural areas of Davangere, India were noted by findings of other researchers (Chandra Shekar and Anuradha, 2004).

Skeletal fluorosis was not observed in age group of 4-16 years but progressively increased to 14.19% in 17-28 years group, 21.24% in middle age group and 26.05% in the older age (>40 years age). Skeletal fluorosis was generally higher in males as compared to females except in the age group of >40 years (37.93%). However, in other studies there was no significant gender difference (Choubisa, 2001). The results coincide with the findings of Watanabe *et al.,* (2000). This could be due to more strenuous work performed by males and consequently greater requirement of drinking water. Thus, mg F/ day requirement could be higher in males as compared to females.

In the study area, prevalence of non-skeletal manifestations among the residents was also observed. Gastrointestinal problems viz. loss of appetite, abdominal pain and nausea were found to increase with age and prevalence percentage was 34.88%, 48.84% and 13.95% respectively at >40 years (old age) group. Neurological problems including paralysis were also higher (6.98%) in old age group while no case of paralysis was noticed till 40 years age group in any gender.

It was inferred from the studies that gastro-intestinal problems, memory loss, neuromuscular problems, cardio-vascular problems etc. were not prominent in a particular age group but varied considerably amongst different age groups.

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