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Epidemiology of Fluorosis in Dharwad District, Karnataka

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INTRODUCTION

Fluorine is present in small amounts in most foods and all tissues of the body, particularly in bones and teeth. It has been established that the ingestion of fluorine significantly reduces the incidence of dental caries. This finding has lead to the fluoridation of communal water supplies in many countries. But in some places, the drinking water sources naturally contain higher amounts of fluorine leading to mottling of enamel and skeletal deformities. The chronic intoxication of fluorine is referred to as endemic fluorosis.

The disease was identified in Dharwad district of Karnataka during 1971 from a cluster of villages in Kalkeri mandal of Mundargi taluk. Of the 48 villages included in the taluk 40 villages are found to be endemic(Anon,1989). Though the disease has been prevalent since quarter of a century no efforts have been made to investigate the epidemiology of the disease in this area. Hence, the present investigation was undertaken to study the epidemiology of the disease Fluorosis in selected villages of Mundargi taluk(Dharwad district).

MATERIAL AND METHODS

Study Area: The study was conducted in Mundargi taluk where, the incidence of fluorosis was reported endemic. The area is occupied by biotite gneiss (migmatite) traversed by dolerite dykes with emphibolites as restites. Horneblende and biotite of the country rock contain a high amount of fluoride (Someshekhar and Gowdreddy, 1972).

Selection of Sample: A pilot survey of the taluk was undertaken in collaboration with health department to know the severity of the disease. Finally six villages were purposively selected for the study. The villages were in Kalkeri mandal and located within 15 km from taluka headquarters. Ten percent of the households were randomly selected from each village and all members in the household were surveyed making a total of 532 subjects of all ages.

Information on socio economic factors, food habits, nutritional status and period of stay in the village was collected using a pretested questionnaire. Clinical features of both dental and skeletal fluorosis was assessed using a checklist prepared focussing on various aspects of manifestation of fluorosis. Further, in order to quantify the data on progress and severity of the disease an attempt was made to score each of the fluorotic symptoms.

Composite diets of individuals, for three consecutive days were collected from a subsample, homogenised, dried, powdered, and analysed for protein, calcium, magnesium (AOAC, 1990) and fluoride (Wadhwani, 1952)

The data were analysed using appropriate statistical tools.

RESULTS AND DISCUSSION

Environmental Factors: The taluk of Mundargi on an average receives annual rainfall of about 600 mm. The maximum temperature during April or May is 40± 1° C. Low rainfall accompanied with high temperature makes sorghum and wheat as staple food crops of the region. Red gram, bengalgram, moth bean, cowpea, groundnut, sesame, niger and chillies are also grown. Major sources of water for drinking and irrigation are deep wells, hand pumps and at few spots river water. The high temperature leads to excess consumption of water thus augmenting the intake of fluoride. Description of the study area is shown in table 1.

Demographic profile of the respondents indicated that the age ranged from 1 month to 80 years, with 224 children and 308 adults. Out of 532 study subjects, 280 were males and 252 were females. Majority of the adults involved in agriculture were either land owners or labourers. Children went for animal grazing or went to school. The general economic condition of the population was poor with little accessibility to vegetables, milk, milk products or animal foods, due to low purchasing power and lack of market. The fluoride

Table 1: Basic information of villages selected for the study (1990-91 census)

S. No.	*Name of the village*	*Total area in hectares*	*Total population*	*Total No.of households*	*Source of drinking water*	*Source of irrigation*	*Staple food*
1.	Kalkeri	1665.08	3568	515	W,Hp,R	Bore well & open well	Sorghum, wheat
2.	Virupapur	322.16	945	162	W,Hp	Bore well & open well	Sorghum, wheat
3.	Mustikoppa	766.95	374	62	W	Bore well & open well	Sorghum, wheat
4.	Thippapur	294.86	-	37	W,Hp	Bore well & open well	Sorghum, wheat
5.	Virupapur Tanda	-	-	112	W,Hp	Bore well & open well	Sorghum, wheat
6.	Beednal Tanda	1574.89	-	115	W,Hp	Bore well & open well	Sorghum, wheat
7.	Hesarur	1090.27	1473	269	W,R	Bore well & open well	Sorghum, wheat

W- Well water R- Tungabhadra river water Hp- Hand pump water

content of well water in fluorotic villages ranged from 4.00 ppm in Beednal Tanda to 10.50 ppm in Kalkeri village, while hand pump water contained higher level of fluoride ranging from 6.00 ppm (Beednal Tanda and Virupapur) to 13.50 ppm (Kalkeri) (Table 2). The intake of water per day was one litre in children. Adults engaged in hard manual labour in hot weather of about 40±1° C consumed four liters of water per day. The fluoride intake accordingly ranged from 10.50 ppm in children to 42.0 ppm in adults of Kalkeri village. Among the people of Virupapur, Mustikop, Thippapur and Virupapur Tanda the fluoride intake through water ranged from 6.00 to 24.0 ppm per day. The intake exceeded the safe limits of 1.5 ppm far in excess leading to dental and skeletal fluorosis. This was reflected in the clinical symptoms observed among the population.

Table 2: Flouride content of drinking water in different villages of study area

S. No.	*Name of the village*	*Source*	*Flouride (ppm)*
Fluorotic Villages			
1.	Kalkeri	Well	10.50
	Hand pump	13.50	
	River	0.80	
2.	Virupapur	Well	6.00
	Hand pump	6.00	
	River	0.80	
3.	Mustikop	Well	6.00
	Hand pump	6.50	
	River	0.80	
4.	Thippapur	Well	6.00
	Hand pump	8.00	
5.	Virupapur Tanda	Well	6.00
	Hand pump	8.50	
6.	Beednal Tanda	Well	4.00
	Hand pump	6.00	
Nonfluorotic Village			
7.	Hesarur	River	0.80

Food Habits: The foods grown in endemic fluorosis areas tend to absorb higher fluoride from the soil and water (Batra et al., 1995). The common beverage consumed in the endemic villages was black tea with negligible amount of milk which favours fluoride absorption. The people are habituated to boil tea leaves in water thus increasing the leached fluoride in the infusions. The population, due to their poor economic condition were used to consumption of sorghum in the form of roti with either chilli chutney or sorghum gruel and chilli powder. Sorghum containing higher amount of molybdenum favours the absorption and retention in the later stages (Stookey and Muhler, 1962). In addition, the people of endemic area were involved in various vices like chewing of tobacco, smearing snuff on the teeth which adds to the intake of fluoride as tobacco and snuff are reported to contain high fluoride.

Nutritional Status: Susceptibility of Indians to fluorosis was claimed to be due to poor nutritional status (Siddiqui, 1955). The dietary deficiencies of energy, calcium (Moudgil et al., 1986), calcium and vitamin C (Siddiqui, 1955) were claimed to be the reasons for early on set of fluorosis. The protein intake in the present study

ranged from 47.68 g/day in Kalkeri village to 52.08 g/day in Virupapur village (Table 3). The adequacy was 80 per cent in Kalkeri village and 87 per cent in Virupapur village. The average calcium intake of all the fluorotic villages was 237 mg per day as against a recommendation of 400 mg per day. The adequacy was only 59 per cent. In addition to high fluoride intake of 11.14 mg per day, through food, the lowered calcium intake accelerated the fluoride absorption.

Protein quality in terms of essential amino acid content plays an important role in the utilisation of protein. In the diets of children and adults of fluorotic villages, lysine was the first limiting amino acid with amino acid score of 0.47 and 0.45, respectively (Table 4). The amino acid score for lysine was 0.76 in children of 1-3 years who did not show any clinical symptoms of fluorosis. The amino acid score of 0.36 and 0.37 were noticed in the diets of males (13-15 years) and females (16-18 years) respectively where, the symptoms of both dental and skeletal fluorosis began to appear. The lowered amino acid score had an additional impact on the development of fluorosis among children.

Table 3: Nutrients and fluoride intake through the diets

S. No.	*Village*	*Sample No.*	*Protein (g/day)*	*Calcium (mg/day)*	*Fluoride (mg/day)*
1.	Kalkeri	1	57.80	198.80	6.12
		2	44.64	230.88	6.80
		3	41.44	230.88	6.48
		4	52.52	213.76	7.20
		5	42.04	205.24	7.00
		Mean	47.68	215.92	6.72
2.	Virupapur	1	50.76	213.44	10.60
		2	53.40	239.40	9.20
		Mean	52.08	226.60	9.92
3.	Mustikop	1	45.52	282.16	9.60
4.	Thippapur	1	43.76	221.56	13.20
5.	Beednal Tanda	1	49.04	239.44	12.00
6.	Virupapur Tanda	1	43.76	238.00	15.40
	Overall Mean		46.97	237.28	11.14

Tabel 4: Amino acid scores of lysine in the diets

S. No.	*Age group (years)*	*Sex*	*Score*
1.	1- 3	-	0.76
2.	4-6	-	0.49
3.	7-9	-	0.50
4.	10-12	M	0.43
5.	10-12	F	0.45
6.	13-15	M	0.36
7.	13-15	F	0.46
8.	16-18	M	0.44
9.	16-18	F	0.37
	Mean		0.47

Prevalence of fluorosis: The clinical picture in endemic villages revealed dental, skeletal and combination of dental and skeletal fluorosis. The prevelence of dental fluorosis alone was 25 per cent, skeletal fluorosis 5.45 per cent, while combined symptoms of fluorosis was 31.20 per cent (Table 5). The prevalence was significantly higher in males (65.00%) compared to females (57.94%). The severity of the disease as indicated by the fluorotic score was also higher in males (9.04) compared to females (5.85).

Age: Mottled tooth enamel is restricted to the age group as fluorine gets deposited in teeth during the period of calcification of the permanent teeth. Dental fluorosis was not present upto the age of six years (Table 6).

Symptoms of only dental fluorosis were found in the age group of 6 to 13 years and skeletal fluorosis appeared earliest at the age of 15 years.

Table 5: Prevalence of fluorosis among males and females

S. No.	*Sex*	*Prevalence of fluorosis*			*No symptoms*	*Total*	*Fluorotic score*
		Dental	*Skeletal*	*Both dental and skeletal*			
1.	Male	81 (28.93)	7 (2.50)	94 (33.57)	98 (35.00)	280 (100.00)	9.04
2.	Female	52 (20.63)	22 (8.73)	72 (28.57)	106 (42.06)	252 (100.00)	5.85
	Total	133 (25.00)	29 (5.45)	166 (31.20)	204 (38.25)	532 (100.00)	

$\chi^2 = 13.55$

Table 6: Prevalance of fluorosis according to age

S. No.	*Age*	*Dental*	*Skeletal*	*Combined*	*No symptoms*	*Total*	*Fluorotic score*
1.	1-6	-	-	-	58 (100.00)	58 (100.00)	0.0
2.	7-9	14 (32.56)	-	-	29 (67.44)	43 (100.00)	2.02
3.	10-12	21 (43.75)	-	-	27 (56.25)	48 (100.00)	2.31
4.	13-15	19 (45.24)	-	1 (2.38)	22 (45.83)	42 (100.00)	3.17
5.	16-18	20 (60.61)	1 (3.03)	3 (9.09)	9 (27.27)	33 (100.00)	6.04
6.	19-24	13 (32.50)	2 (5.00)	11 (27.50)	14 (35.00)	40 (100.00)	6.62
7.	25-30	20 (26.32)	9 (11.84)	19 (25.00)	28 (36.84)	76 (100.00)	2.03
8.	31-40	10 (17.54)	7 (12.28)	28 (49.12)	12 (21.05)	57 (100.00)	12.74
9.	41-50	8 (13.11)	7 (11.48)	45 (73.77)	1 (1.64)	61 (100.00)	71.80
10.	51-60	8 (17.39)	2 (4.35)	34 (73.91)	2 (4.35)	46 (100.00)	14.32
11.	61-70	-	1 (5.26)	16 (84.24)	2 (10.53)	19 (100.00)	16.17
12.	71-80	-	-	9 (100.00)	-	9 (100.00)	18.15
	Total	133	29	166	204	532	

χ^2–= 162.2* r = +0.35^{NS}

Figures in parenthesis indicate percentages

*Significant at 5% level of significance

Further, the prevalence of fluorosis increased with increase in age reaching 100 per cent after the age of 61 years. Tamboli et al. (1980) also reported 100 per cent prevalence of skeletal in the age group of 65 years and above. The mean fluorotic score also increased from 2.02 at seven years to 18.15 at 80 years of age. Fluorotic score had positive correlation with age (r=0.35 ^{NS}).

Period of Stay: Period of stay in endemic fluorosis area had significant influence on the incidence of fluorosis.The fluoride may get accumulated in the bones and teeth with time. As period of stay increased, the percentage of people suffering from both dental and skeletal fluorosis increased reaching 100 per cent with 71 years of stay (Table 7). A minimum of six years of stay was required for the symptoms of dental fluorosis to manifest and 11-20 years for skeletal fluorosis. The period of stay had significant influence on the prevalence of fluorosis (χ^2 = 147.83). A significant positive correlation was obtained between period of stay and mean fluorotic score. The severity in terms of fluorotic score was 0.96 at 6-10 years of exposure but it increased to 8.43 at 71-80 years of stay.

Occupation: The people who were presently bedridden with past history of heavy work were grouped seperately as the appearance of fluorotic symptoms was cumulative. Prevalence of both dental and skeletal fluorosis was lower(12.78%) among sedentary workers (Table 8). Prevalence of fluorosis was 50.0 per cent among heavy workers and 75.0 per cent among those bedridden with past history of heavy work. On an average, 42.48 per cent of sedentary workers, 66.67 per cent of moderate workers, 81.09 per cent of heavy workers and 87.5 per cent of bedridden showed one or the other fluorotic symptoms. Prevalence of fluorosis differed significantly among people with different occupations. The people involved in sedentary work had the lowest score (4.49) while, those bedridden had highest score (14.37).

Table 7: Prevalance of fluorosis according to period of stay

S. No.	*Age*	*Dental*	*Skeletal*	*Combined*	*No symptoms*	*Total*	*Fluorotic score*
1.	< 6 years	-	-	-	75 (100.00)	75 (100.00)	0.0
2.	7-10	21 (28.77)	-	-	52 (71.23)	73 (100.00)	0.96
3.	11-20	64 (46.38)	5 (3.62)	13 (9.42)	56 (40.58)	138 (100.00)	4.35
4.	21-30	26 (33.33)	11 (14.10)	27 (34.62)	14 (17.95)	78 (100.00)	9.72
5.	31-40	11 (21-57)	5 (9.80)	29 (56.86)	6 (11.77)	51 (100.00)	13.12
6.	41-50	3 (6.00)	5 (10.00)	42 (84.00)	-	50 (100.00)	18.79
7.	51-60	8 (17.39)	3 (6.52)	35 (76.09)	-	46 (100.00)	16.85
8.	61-70	-	-	12 (92.31)	1 (7.69)	13 (100.00)	25.63
9.	71-80	-	-	8 (100.00)	-	8 (100.00)	18.43
	Total	133	29	166	204	532	

$\chi^2 = 147.83^*$ $r = +0.93^{NS}$
Figures in parenthesis indicate percentages
* Significant at 5% level of significance
Figures in parenthesis indicate percentages
*Significant at 5% level of significance

Table 8: Prevalance of fluorosis according to occupation

S. No.	*Occupation*	*Dental*	*Skeletal*	*Combined*	*No symptoms*	*Total*	*Fluorotic score*
1.	Sedentary workers	68 (25.56)	11 (4.14)	34 (12.78)	153 (57.52)	266 (100.00)	4.49
2.	Moderate workers	7 (58.33)	-	1 (8.33)	4 (33.33)	12 (100.00)	8.99
3.	Heavy workers	56 (23.33)	18 (7.56)	119 (50.00)	45 (18.91)	238 (100.00)	12.13
4.	Bedridden with past history of heavy work	2 (12.50)	-	12 (75.00)	2 (12.50)	16 (100.00)	14.37
	Total	133	29	166	204	532	

$\chi^2 = 45.66^*$ $r = +0.98^{NS}$
Figures in parenthesis indicate percentage
* Significant at 5% level of significance

Hence, it can be concluded from the present study, that Mundargi taluk of Dharwad district containing high fluoride in its drinking water is an endemic taluk. The people consume lower amounts of protective foods and high of fluorogenic foods. Age, sex, period of stay, occupation are some of the factors influencing prevalence of fluorosis.

KEY WORDS Fluorosis. Prevalence. Fluoride. Food habits.

ABSTRACT Epidemiology of fluorosis in selected endemic villages of Dharwad district was studied during 1994-95. The sample size was 532 of which 224 were children and 308 adults. Life style of subjects involved hard manual labour and of poor economic condition. The villages had maximum temperature of 40±1° C with

dry climate. Fluoride in drinking water of fluorotic villages was as high as 4.00 ppm to 13.5 ppm. Diet consisted of sorghum, chillies and black tea which augment fluoride intake. The protein intake ranged from 47.68 g per day to 52.08 g per day, calcium adequacy was only 59 per cent. The adult intake of fluoride was to a maximum extent of 11.14 mg per day through food and 42.00 ppm through water. Lysine was the first limiting amino acid in both children and adults. The amino acid score was 0.36 in diet of males (13-15 years) and 0.37 in the diets of females (16-18 years). Prevalence of dental fluorosis was 56.20 percent and skeletal fluorosis was 36.65 per cent. Of those affected by fluorosis 34.20 per cent were males and 27.44 percent were females. Dental fluorosis appeared after the age ofsix years and skeletal after 15 years. A minimum period of six years stay was predisposing for dental fluorosis to manifest and eleven years for skeletal fluorosis The fluorotic score was positively related to the quantum of work done. The score ranged from 4.49 in sedentary workers to 12.13 in heavy workers.

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