

Dietary Factors Affecting the Fluoride Toxicity in the Fluoridated Area of Rural Punjab

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ABSTRACT In India, millions of people are crippled by fluorosis. Though water with a high content of fluoride is the main cause of fluorosis, it is not the only source for the malady which afflicts the teeth, organs and systems. Food and cosmetics also contribute to fluorosis, besides of course drugs. This study was conducted on 200 subjects in the rural Southwestern area of Punjab. Information was drawn with regard to the demographic profile, dietary pattern, incidence of dental and skeletal fluorosis. The results showed that majority of the respondents were illiterate, involved in manual labour and agriculture and belonged to a very low socio-economic group. The prevalence of dental as well as skeletal fluorosis was higher in men as compared to women. Significant differences were found in the average daily food intake (except roots and tubers) between subjects free from fluorosis and suffering from severe fluorosis (Grade III) ($P < 0.01$). The diets of the people suffering from fluorosis were found grossly deficient in energy, protein, calcium and ascorbic acid and varied significantly from the persons free from fluorosis ($P < 0.01$).

INTRODUCTION

Endemic fluorosis continues to be a challenging national problem. Punjab is among the 15 identified endemic states. About 25 million of Indian scattered in these states are affected by fluorosis (Rao, 1988). Nearly 80 per cent of the population of India live in villages and fluorosis affected the farmers and cultivators, thus affecting their efficiency. It is known that fluoride finds its way to the human body largely through drinking water, hence causing fluoride toxicity affecting the bones and teeth. The fluoride content of drinking water, varies from 0.5 to 25 ppm in different parts of the country (Teotia et al., 1987). This amount of fluoride is quite high compared to normal permitted level of 1 ppm (WHO). Though water with a high content of fluoride is the main cause of fluorosis, it is not the only source for the malady which afflicts the teeth, bones and systems. Therefore, the present study was undertaken to know the influence of nutritional factors on fluoride toxicity in the rural area of South-western district of Punjab.

MATERIAL AND METHODS

The study was conducted on 200 subjects comprising equal number of male and female adults in rural areas of Faridkot District. Two villages from each block namely, Kaoni, Dhodha, Rupana and Thandewal were selected. Dietary information was collected by using 24 Hour Recall Method. The average daily per capita intake of nutrients were compared with the Recommended Dietary Allowances of ICMR (1988). Clinical examination of dental fluorosis was carried out by using Siddique's (1955) classification of dental mottling which was further substantiated by Jolly and Singh (1969). The prevalence of skeletal fluorosis was studied by radiographic examination with the help of physician from the Guru Gobind Singh Hospital, Faridkot. The skeletal changes were classified according to the standard classification (Roholm, 1937). The results were statistically analysed using Analysis of Variance and Critical Differences.

RESULTS

The general information about the respondents viz. age, education, occupation, income, size of family and source of drinking water are in table 1. The data indicated that 78 per cent men and 57 per cent of women were illiterate. Majority of the men were involved in heavy manual labour work and were belonging to the low-socio-economic group. The majority of the respondents (67.5 per cent) were using their own hand pump water for drinking and cooking purposes; whereas only 32.5 per cent were using public water supply source.

The percentage distribution of the respondents according to their incidence of dental and skeletal fluorosis is presented in table 2. It appears that 13% of men and 37% of women respondents were free from fluorosis. Grade I dental fluorosis

Table 1 : General information regarding the respondents

S.No.	Particulars	Men (n = 100)	Women (n = 100)
1	Age (in years)		
	21-40	43	61
	41-60	40	33
	61-80	17	6
2.	Education		
	Illiterate	78	57
	Matric	14	35
	Graduation	8	8
3.	Occupation		
	Labour	50	-
	Agriculture	40	-
	Service	10	12
	Housewives	-	88
4.	Per capita Per Month Income		
	100-200	65	47
	201-400	24	42
	Above 400	11	11
5.	Size of Family (Members)	Number	(%)
	2-4	59	(29.5)
	5-7	141	(70.5)
6.	Type of Family		
	Joint	38	(19)
	Nuclear	162	(81)
7.	Drinking Water Supply Source		
	Handpump	135	(67.5)
	Public water supply	65	(32.5)

was present in 15% of men and 14% of women, Grade II afflicted 56% of men and 45% of women ; whereas 16% of men and only 4% of women were found to be suffering from Grade III fluorosis. Skeletal fluorosis was present in 26% men and 4% of women.

Table 2 : Percentage distribution of respondents according to the prevalence of dental and skeletal fluorosis

Incidence of dental mottling	Men	Women
Normal	13	37
Grade I (Mild fluorosis)	15	14
Grade II (Moderate fluorosis)	56	45
Grade III (Severe fluorosis)	16	4
Incidence of skeletal fluorosis	Men	Women
Skeletal fluorosis	16	4

The average daily food intake of the respondents is presented in table 3. The average daily intake of all the food group was maximum in the subjects (both men and women) free from fluorosis and minimum in the subjects suffering from grade III fluorosis. Significant differences were found in the average daily food intake (except roots and tubers) between subjects free from

fluorosis and suffering from severe fluorosis (Grade III) ($P < 0.01$). Even significant differences were observed in the intake of cereals, pulses, milk and milk products and fats and oils between subjects free from fluorosis and mild fluorosis (Grade I) ($P < 0.01$).

Table 4 shows the average daily nutrient intake of the subjects. The energy intake of the men subjects *i.e.* free from fluorosis and suffering from grade I, grade II and grade III fluorosis was inadequate when compared with recommended allowances of ICMR (1988). In case of women subjects the energy intake was adequate in the subjects free from fluorosis and having grade I fluorosis, whereas energy intake was found inadequate in subjects suffering from grade II and grade III fluorosis. Protein and calcium intake was high in men and women subjects free from fluorosis and having grade I fluorosis when compared to the recommended allowances of ICMR (1988). The intake of protein and calcium was found inadequate in men and women subjects suffering from grade I and grade III fluorosis. The calcium and phosphorus ratio was normal in the subjects (men and women) free from fluorosis and having grade I fluorosis, whereas it was not normal in the subjects suffering from grade II and grade III fluorosis. The ascorbic acid intake was adequate in men and women subjects free from fluorosis but was inadequate in the subject suffering from grade I, grade II and grade III fluorosis, when compared with recommended allowances of ICMR (1988). The differences in the intake of all these nutrients were highly significant between the subjects free from fluorosis and suffering from grade III fluorosis both in case of men and women ($P < 0.01$).

DISCUSSION

In the present study majority of the respondents were illiterate, involved in labour and agriculture as occupation and belonged to a very low socio-economic group. The drinking water source of the respondents was hand pumps; inspite of the availability of public water works.

The prevalence of dental fluorosis was higher in men (87%) as compared to women (59%). Likewise skeletal fluorosis was more in men (16%) as compared to women (4%). The respondents

Table 3 : Average daily food intake of the respondents according to their grades of fluorosis (Average intake $\pm$ S.D., g)

Food stuffs (g)		Mean intake of total respondents (men = 200, women = 100)	Subjects free from fluorosis (men = 50, women = 37)	Grade I fluorosis (men = 15, women = 14)	Grade II fluorosis (men = 56, women = 45)	Grade III fluorosis (men = 20, women = 16)	C.D. between A and B	C.D. between B and C	C.D. between C and D	C.D. between D and A
Cereals	Men	260 $\pm$ 100	383 $\pm$ 13	271 $\pm$ 49	263 $\pm$ 89	139 $\pm$ 20	80.09 **	62.04 **	62.04 **	80.09 **
	Women	206 $\pm$ 69	265 $\pm$ 47	214 $\pm$ 41	145 $\pm$ 16	97 $\pm$ 15	30.41 **	28.98 **	47.65 **	20.48 **
Pulses	Men	41 $\pm$ 12	67 $\pm$ 10	40 $\pm$ 12	28 $\pm$ 9	32 $\pm$ 5	9.95 **	7.70 **	5.81	10.48 **
	Women	34 $\pm$ 15	52 $\pm$ 3	37 $\pm$ 5	28 $\pm$ 8	25 $\pm$ 8	5.12 **	4.88 **	6.06	3.45 **
Green leafy Vegetables	Men	47 $\pm$ 17	48 $\pm$ 8	35 $\pm$ 10	35 $\pm$ 5	26 $\pm$ 4	17.33	13.21	13.24	17.15 **
	Women	45 $\pm$ 17	42 $\pm$ 9	35 $\pm$ 12	34 $\pm$ 6	24 $\pm$ 6	11.59	10.95	18.23	7.03 **
Roots and tubers	Men	45 $\pm$ 32	56 $\pm$ 21	52 $\pm$ 21	53 $\pm$ 21	47 $\pm$ 31	19.50	15.10	15.10	19.50
	Women	41 $\pm$ 20	39 $\pm$ 17	35 $\pm$ 22	38 $\pm$ 26	32 $\pm$ 10	13.39	12.75	20.79	9.01
Other vegetables	Men	142 $\pm$ 60	214 $\pm$ 41	184 $\pm$ 76	134 $\pm$ 74	34 $\pm$ 13	51.08	39.56 *	52.98 **	67.76 **
	Women	136 $\pm$ 56	165 $\pm$ 32	132 $\pm$ 56	114 $\pm$ 41	35 $\pm$ 9	29.09 *	27.74	60.48 **	26.00 **
Milk and milk products	Men	628 $\pm$ 421	1031 $\pm$ 121	971 $\pm$ 124	149 $\pm$ 8	145 $\pm$ 12	54.48 **	42.21 **	31.82	54.48 **
	Women	422 $\pm$ 386	1008 $\pm$ 234	835 $\pm$ 66	157 $\pm$ 4	125 $\pm$ 13	12.90 **	12.30 **	20.24 **	8.71 **
Fats and oils	Men	37 $\pm$ 8	48 $\pm$ 10	38 $\pm$ 9	30 $\pm$ 6	26 $\pm$ 7	8.07 *	6.16 *	6.16	10.71 **
	Women	33 $\pm$ 13	40 $\pm$ 4	36 $\pm$ 4	25 $\pm$ 5	20 $\pm$ 3	3.28 *	4.17 **	5.15	2.93 **
Sugar and Jaggery	Men	54 $\pm$ 19	73 $\pm$ 18	68 $\pm$ 15	40 $\pm$ 8	41 $\pm$ 5	2.22	22.83 **	17.21	29.48 **
	Women	51 $\pm$ 19	71 $\pm$ 15	64 $\pm$ 7	37 $\pm$ 4	40 $\pm$ 6	17.21	8.50 **	10.52	6.01 **

C.D. - Critical difference P < 0.05 *Significant at 5% level, P < 0.01 **Significant at 1% level

Table 4 : Average daily nutrients intake of the respondents according to their grades of fluorosis (Average intake $\pm$ S.D.)

Nutrient		Mean intake of total respondents (men = 200, women = 100)	Free from fluorosis (men = 50, women = 37)	Grade I fluorosis (men = 15, women = 14)	Grade II fluorosis (men = 56, women = 45)	Grade III fluorosis (men = 20, women = 16)	Recommended allowances ¹	C.D. between A and B	C.D. between B and C	C.D. between C and D	C.D. between D and A
Energy (Kcal)	Men	2036 $\pm$ 590	2766 $\pm$ 380	2699 $\pm$ 551	1877 $\pm$ 393	1445 $\pm$ 352	3200	415.21	428.8 **	428.8 **	553.6 **
	Women	1957 $\pm$ 529	2450 $\pm$ 412	2182 $\pm$ 483	1599 $\pm$ 271	1314 $\pm$ 216	2100	463.41	587.6 **	726.1	414.90 **
Protein (g)	Men	63 $\pm$ 23	90 $\pm$ 18	89 $\pm$ 18	44 $\pm$ 15	40 $\pm$ 17	60 g	12.45	12.80 **	9.65	16.52 **
	Women	62 $\pm$ 22	77 $\pm$ 14	75 $\pm$ 35	43 $\pm$ 14	35 $\pm$ 3	50 g	13.21	16.71 **	20.69	11.80 **
Calcium (mg)	Men	2133 $\pm$ 933	2143 $\pm$ 629	1938 $\pm$ 597	372 $\pm$ 10	304 $\pm$ 64	400 mg	441.0 $\pm$ 14	453.3 **	340.29	585.2 **
	Women	1350 $\pm$ 767	1943 $\pm$ 747	1699 $\pm$ 1311	327 $\pm$ 66	280 $\pm$ 113	400 mg	524	662.79 **	820.95	468.6 *
Phosphorus (mg)	Men	1198 $\pm$ 828	2286 $\pm$ 916	2034 $\pm$ 716	858 $\pm$ 425	848 $\pm$ 256	-	185.1 **	143.43 **	108.11	185.19 **
	Women	987 $\pm$ 597	1382 $\pm$ 450	1392 $\pm$ 356	605 $\pm$ 206	506 $\pm$ 312	-	382	484.07 **	599	342.2 **
Ascorbic acid (mg)	Men	32 $\pm$ 18	44 $\pm$ 12	25 $\pm$ 18	23 $\pm$ 11	16 $\pm$ 8	40 mg	12.09 **	7.04	7.04	12.09 **
	Women	27 $\pm$ 14	50 $\pm$ 44	35 $\pm$ 19	24 $\pm$ 11	11 $\pm$ 3	40 mg	19.44	18.52	30.44	17.37 **

1. Recommended dietary allowance of ICMR (1988) C.D. - Critical difference P < 0.05 significant at 5% level, P < 0.01 significant at 1% level

suffering from grade III dental fluorosis were also found to be suffering from skeletal fluorosis. Many factors like strenuous activity due to occupation; more intake of water, tea and alcohol in men subjects were found to be responsible for high prevalence of fluorosis as compared to the females.

In the present study it was observed that the respondents did not have any strong likes or dislikes for any particular food. They ate whatever they could afford because the income of the majority of the respondents was low and the amount of money available for food was strictly limited, thus resulting in the lower food intake and correspondingly the higher incidence of fluorosis. This continuous subsistence of the subjects on such diets also resulted in lack of many essential nutrients particularly protein, calcium and ascorbic acid and made them easy victims for this crippling disease. The findings of some other workers also indicated that inadequate intake of protein, calcium and ascorbic acid in the diets of the population suffering from fluorosis may aggravate the incidence of fluorosis (Krishna-machari, 1978; Tamboli et al., 1980; Maudgil et al., 1986 and Muratee, 1992).

Another finding of the study is that the diets of the subjects suffering from fluorosis were grossly deficient in energy. The results of the present study are in accordance with Tamboli et al. (1980) and Maudgil et al. (1986) who also reported that inadequate intake of energy may strike more the incidence of fluorosis.

Thus, it is concluded that there is need for

more attention to be paid regarding nutrition education to the people. The people in the fluoridated area should consume adequate amount of milk, curd, butter milk, *paneer* and green leafy vegetables to take care of protein and calcium requirements. Vitamin C rich foods such as orange, lemon, kinnow, guava, *Ber* and *Amla* should be consumed in large amounts to ensure the intake of vitamin C. These steps can spare the people from suffering dental and skeletal fluorosis.

REFERENCES

- ICMR: *Recommended Dietary Intakes of Indians*; Indian Council of Medical Research, New Delhi, India (1988).
- Jolly, S.S. and Singh, I.D.: An epidemiological study of endemic fluorosis in Punjab. *Ind. J. Med. Res.*, **51**: 1333-1346 (1969).
- Krishnamachari, K.A.V.R.: Studies on fluorosis. *Ind. J. Med. Res.*, **68**: 94-98 (1978).
- Maudgil, A., Srivastava, R.N., Vasudev, A., Bagga, A., Gupta, A.: Fluorosis with crippling skeletal deformities. *Ind. Paedit.*, **23**: 767-773 (1986).
- Muratee, S.: Fluorosis - Its prevention and control. *Nutrition*, **26**: 17-27 (1992).
- Rao, R.: Rasam to the rescue. *The Tribune* p. 6 (1988).
- Roholm, K.: *Fluorine Intoxication a Clinical Hygienic Study with a Review of the Literature and Some Experimental Investigations*. H.K. Lewis and Co. Ltd., London (1937).
- Siddique, A.H.: Fluorosis in Nalgonda district, Hyderabad-Deccan, *Brit. Med. J.*, **2**: 1408-1413 (1955).
- Tamboli, B.L., Mathur, G.M., Mathur, A.P., Lalla, S.K. and Goyal, O.P.: Prevalence of fluorosis in Pratapura and Surajpura village, district Ajmer (Rajasthan). *Ind. J. Med. Res.*, **71**: 57-67 (1980).
- Teotia, S.P.S., Teotia, M., Singh, D.P., Nath, M.: Deep bore drinking water as a practical approach for eradication of endemic fluorosis in India. *Ind. J. Med. Res.*, **85**: 699-705 (1987).