CONTRIBUTION OF FLUORIDE IN WATER AND FOOD TO THE PREVALENCE OF FLUOROSIS IN AREAS OF TAMIL NADU IN SOUTH INDIA

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SUMMARY: Fluoride contents of water and food, collected from the subjects of five selected areas of Tamil Nadu in South India, were determined. Surveys were conducted to ascertain dental fluorosis prevalences among children of the areas, and dental and skeletal fluorosis prevalences in the adult populations. Dean's "Community Fluorosis Index" (CFI) for dental fluorosis was calculated, from the children's survey, and was found to be correlated with the prevalence and severity of fluorosis in the areas. A direct correlation was also confirmed between the mean fluoride level in drinking water and the percentage incidence of dental fluorosis. The dominant role of fluoride from drinking water, when compared with that from food, was established.

Key words: Dental fluorosis; Fluorotic areas; Food fluoride; Skeletal fluorosis; Tamil Nadu, India; Water fluoride.

Introduction

The well defined clinical entity, fluorosis, characterized by dental mottling as well as skeletal and non-skeletal disorders, is a problem in many parts of India. The aims of this study were to assess the extent of the fluorosis problem in Tamil Nadu, South India, and to determine the contributions of fluoride in drinking water and in food. The study also clarified the correlation between dental fluorosis prevalence and the prevalence and severity of other forms of fluorosis.

Materials and Methods

Surveys for fluorosis were conducted among the primary and middle school students in the villages of two control areas and five endemic areas of Tamil Nadu in South India, using a random sampling technique.[1] Community Fluorosis Indices (CFI) of the areas were calculated.[2] A door-to-door survey for fluorosis was also conducted among adults in the same villages, with the help of experienced clinical examiners. A comparative study on the role of fluoride from water and from food in causing fluorosis was made.

1) *Selection of control areas (fluorosis of any kind largely absent):*

Control area 1 (C1) consisted of 12 villages of Thiruchuli block of Kamarajar district. Control area 2 (C2) contained 9 villages of Athoor block of Dindigul Anna district.

2) *Selection of fluorotic areas:*

Fluorotic area 1 (F1), where dental fluorosis is prevalent and fluoride in drinking water is less than 1 ppm (0.34-0.91 ppm), consisted of 10 villages of Athoor block of Dindigul Anna district. Fluorotic area 2 (F2), where dental fluorosis is prevalent and drinking water fluoride is between 1 and 3 ppm,

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consisted of 10 villages of Nilakkotai block of Dindigul Anna District. Fluorotic area 3 (F3), where dental and skeletal fluorosis were prevalent and fluoride in drinking water varied from 3.8 to 8.0 ppm, consisted of four villages of Ayodhyapatnam block of Salem district.

3) *Analysis of drinking water and food samples:*

The fluoride content of drinking water and food collected from the areas studied, were determined using a fluoride ion selective electrode. Drinking water samples from all available sources of control and fluorotic areas (mostly bore wells) were collected in high density polyethylene bottles, and fluoride concentrations determined using an expandable ion analyser EA-920, the fluoride ion selective electrode 9409 and the reference electrode (all Orion USA make).[3] The fluoride levels of all the water samples collected from the areas of study were estimated during summer (March to May) and non summer (June to February) months. The exact quantity of water and food each subject consumed in a day was ascertained, and representative samples collected, separately, in high density polyethylene containers. That is, the solid and liquid parts of the diet were analysed separately to determine the fluoride level. The chief staple food grains grown in all the five areas were also collected and analysed for fluoride content.[4]

Results and Discussion

1) *Magnitude of the fluorosis problem:*

The percentage incidence of dental and skeletal fluorosis among children and adults of the five areas are shown in Tables 1 and 2. The Community Fluorosis Indices (CFI) of the areas are presented in Table 3. The percentage incidence of fluorosis and the corresponding CFI values were significantly correlated in all three fluorotic areas. Fluorotic area 3 (Salem) recorded significantly high CFI values among both children (3.56) and adults (3.72). The magnitude of the problem of fluorosis is in the order: fluorotic area 3 > fluorotic area 2 > fluorotic area 1 and is slightly greater in adults than in children in all the fluorotic areas. Fluoride being a cumulative toxin, the toxicity increases with the period of ingestion.

2) *Water fluoride levels and fluoride toxicity:*

The range and mean values of fluoride for each of the five areas are shown in Table 4. The fluoride concentrations of all the drinking water sources are significantly higher in summer months. There is little dilution of fluoride in ground water during summer, and significant dilution during the rainy season.

The water fluoride levels in control areas 1 and 2 (mean values 0.65 and 0.53 mg/L, respectively, in non-summer months) are below the tolerance limit of 1 ppm, which explains the virtual absence of fluorosis in these areas. The water fluoride level of fluorotic area 1 (mean value 0.70 mg/L non-summer) is within the tolerance limit but dental fluorosis is present in 30% of children and 40% of adults. A similar observation was made by Jolly *et al* in Punjab.[5] A direct relationship between the levels of fluoride in drinking water and the magnitude and severity of the fluorosis problem is evident. The mean fluoride levels of drinking water sources in the three fluorotic areas in non-summer months are 0.70, 1.83 and 5.64 mg/L, respectively.

TABLE 1. Incidence of dental fluorosis and skeletal fluorosis among children aged 8-15 years

Area	No. of children surveyed	No. of children with		Percent incidence	
		Dental fluorosis	Skeletal fluorosis	Dental fluorosis	Skeletal fluorosis
Control area 1	210	0.0	0.0	0.0	0.0
Control area 2	208	4.0	0.0	1.9	0.0
Fluorosis area 1	206	62.0	0.0	30.1	0.0
Fluorosis area 2	205	119.0	0.0	58.0	0.0
Fluorosis area 3	210	187.0	0.0	89.0	0.0

TABLE 2. Incidence of dental fluorosis and skeletal fluorosis among adults

Area	No. of adults surveyed	No. of adults with		Percent incidence	
		Dental fluorosis	Skeletal fluorosis	Dental fluorosis	Skeletal fluorosis
Control area 1	155	0.0	0.0	0.0	0.0
Control area 2	153	3.0	0.0	2.0	0.0
Fluorosis area 1	154	61.0	0.0	39.6	0.0
Fluorosis area 2	156	100.0	0.0	64.1	0.0
Fluorosis area 3	157	146.0	53.0	93.0	33.8

TABLE 3. Community Fluorosis Index

Area	No. of subjects surveyed		No. of subjects with dental fluorosis		Community Fluorosis Index	
	Children	Adults	Children	Adults	Children	Adults
Control area 1	210	155	0.0	0.0	0.00	0.00
Control area 2	208	153	4.0	3.0	0.01	0.02
Fluorosis area 1	206	154	62.0	61.0	0.63	0.83
Fluorosis area 2	205	156	119.0	100.0	1.71	1.85
Fluorosis area 3	210	157	187.0	146.0	3.56	3.72

TABLE 4. Mean fluoride values (mg/L) in drinking water sources

Area	Fluoride levels (mg/L)			
	In non-summer months *		In summer months **	
	Range	Mean	Range	Mean
Control area 1	0.38-0.86	0.65	0.46-1.00	0.78
Control area 2	0.32-0.68	0.53	0.38-0.82	0.63
Fluorosis area 1	0.34-0.91	0.70	0.41-1.10	0.84
Fluorosis area 2	1.20-2.90	1.83	1.40-3.50	2.20
Fluorosis area 3	3.80-8.00	5.64	4.60-9.60	6.78

* June - February (temperatures 25°C - 29°C) ** March - May (temperatures 29°C - 33°C)

3) *Total fluoride intake and fluoride toxicity:*

Fluoride intakes from water and food, and total fluoride intake, per day for individuals living in control and fluorotic areas, were computed separately[6] for children (Figure 1), adult males and adult females, but were similar for each category. They are nearly the same for the two control areas. In the low water fluoride areas (controls and fluorotic area 1) the fluoride contribution through food is higher - in agreement with the findings of Lakadawala and Punekar.[7] Water fluoride is the main contributor to total fluoride intake in fluorotic areas 2 and 3 - in agreement with similar studies in Hisar town, Haryana State.[8,9]

From analysis of fluoride in food grains the mean fluoride levels were computed and are shown in Figure 2. There was no correlation between fluoride levels of food grains grown in the areas and total fluoride.[6] Individuals may or may not consume grains grown in their area. On the other hand people depend, for cooking and drinking, on local water sources only. Therefore the contribution of water fluoride remains high throughout the year, with higher intake in summer due to the higher concentration of the fluoride and to the higher quantity of water consumed.

Several subjects surveyed in fluorotic area 3 complained of gastrointestinal discomforts which conformed to the signs and symptoms of non-skeletal effects from fluorosis reported by Susheela and her co-workers.[10]

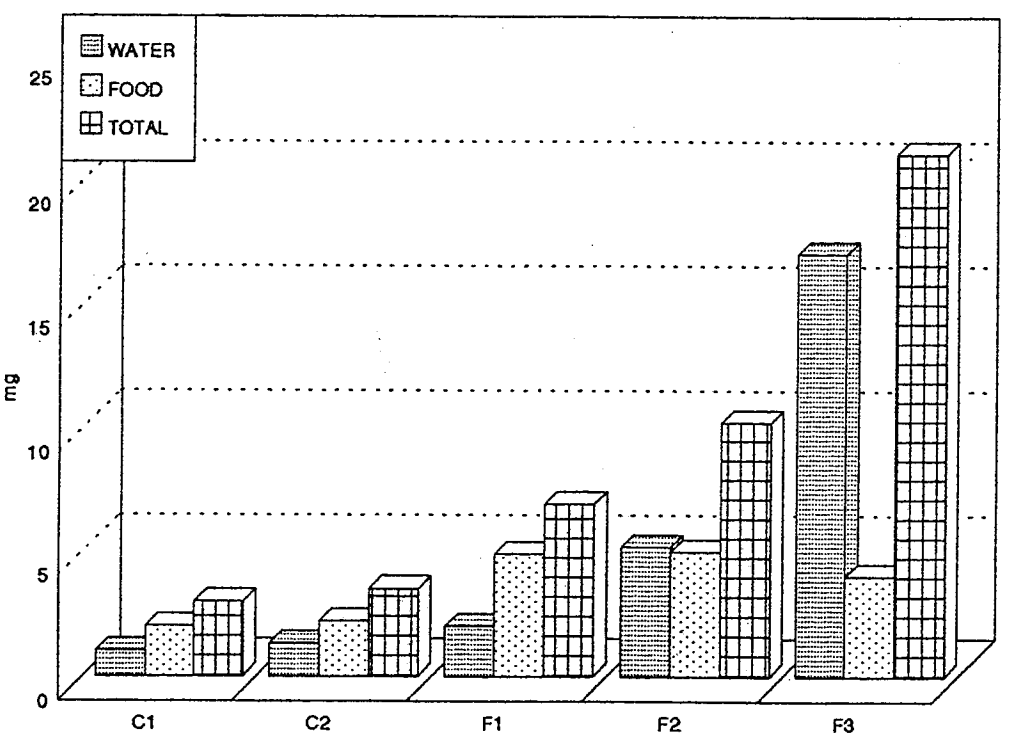

Figure 1. Fluoride through water, food, and total intake/day: mean values for children

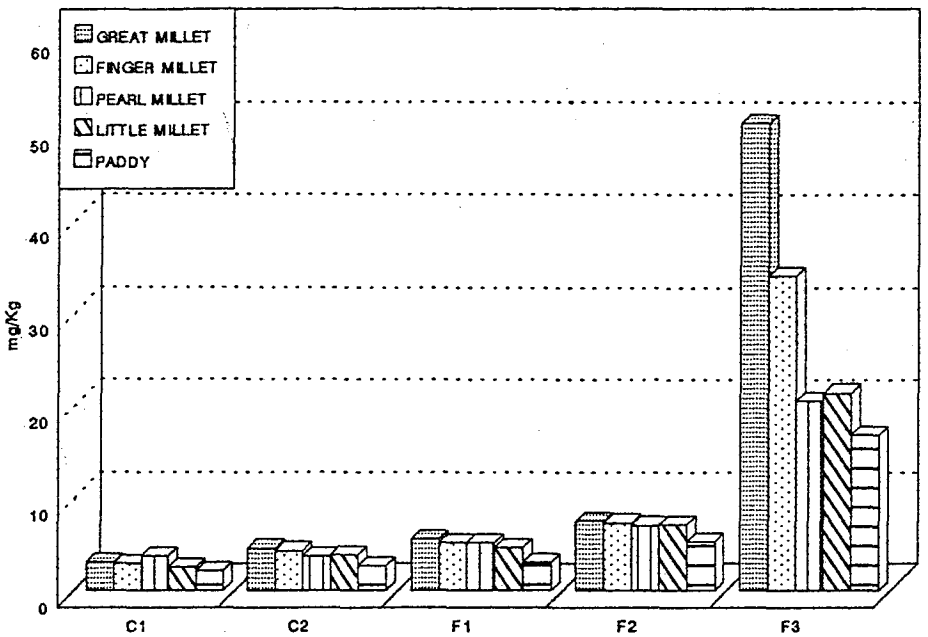

Figure 2. Mean fluoride levels in chief staple food grains

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