

Brief communication (Original)

Prevalence and manifestations of water-born fluorosis among schoolchildren in Kaiwara village of India: a preliminary study

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Background: Fluorosis is an endemic condition with prevalence in 19 states and union territories in India. It is an urgent task to survey the fluorosis-related problems in these regions.

Objective: To study the clinical manifestations of water-born fluorosis among schoolchildren in Kaiwara village of India.

Methods: A cross-sectional study was conducted in all schoolchildren between 1st and 7th standard studying in Kaiwara village, Karnataka State, India. Parameters studied included fluoride ingestion through drinking water, fluoride excretion through urine, clinical features of fluorosis. These included dental staining, genu valgum, goiter, and conjunctival xerosis. Fluoride in water and urine samples was estimated using an ion meter.

Results: Of the 416 schoolchildren studied, 24.0% children had dental fluorosis, 11.4% children had genu valgum, 20.9% had goiter, and 10.3% had xerosis of the conjunctiva. One hundred children passed high levels of fluoride in urine, while 90% of water samples consumed by the local residents contained high levels of fluoride.

Conclusion: It was proved that water-born fluorosis is endemic in Kaiwara village. The endemic prevalence of the syndrome of fluorosis among school children was characterized by dental mottling, genu valgum, endemic goiter, and xerosis of the conjunctiva.

Keywords: Dental and skeletal fluorosis, fluoride, genu-valgum, goiter, xerosis.

Fluorosis is a systemic disorder caused by excessive ingestion of fluoride. Globally, fluorosis is water-born in 25 countries. India lies in a geographical fluoride belt, which extends from Turkey to China and Japan through Iraq, Iran, and Afghanistan. Of the 85 million tons of fluoride estimated in the earth's crust, nearly 12 million tons are in India. Consequently, fluorosis is an endemic condition prevalent in 19 Indian states and union territories [1].

Thus, 66 million people in India are at risk of developing fluorosis, including six million children

below the age of 14 years. Approximately 25 million people are already affected by fluorosis. Belgaum, Raichur, Bijapur, Gulbarga, Chitradurga, Tumkur, Chikmagalur, Mandya, Bangalore-rural, Mysore, Mangalore, Shimoga, and Kolar are the endemic districts for fluorosis in Karnataka state, India [2].

Fluorides are compounds of fluorine. Fluorine is the 13th most abundant element in the earth crust. As surface water passes through the fluoride rich rocks, it carries fluoride with it. Hence, most fluoride is found in ground water and not in surface water [3]. There has been a shift from the use of surface water to ground water for drinking purposes (bore wells) in this region over the past 10 to 15 years as a protective measure against water borne infections. The prevalence of fluoride-related problems is now one of these results.

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Materials and methods

A cross-sectional study was conducted in 416 primary schoolchildren (male: 218, female: 198) in Kaiwara village, Chintamani Taluk, Chickballapur District between July and December 2008 (see **Fig. 1**). Their age ranged from six to thirteen years (from 1st standard to 7th School standard). Children with severe caries and local debris on their teeth, and with orthopaedic deformities of the lower limb were excluded from this study.

We obtained the prior permission from the Community Development and Health Project Officer and the Principals of the three schools studied. One hundred urine samples were collected randomly from randomly selected study children. Drinking water samples were collected from the four tanks and six bore wells, which were used as sources of drinking water by the people of Kaiwara. This study was approved by the Ethics Committee of MS Ramaiah Medical College.

Parameters studied

We collected the following data: fluoride levels in drinking water and urine samples. Clinico-epidemiological features of fluorosis, source of drinking water, detection of dental fluorosis using the Deans index [4], detection of genu valgum, goiter, and xerosis of conjunctiva using WHO criteria [5]. These parameters were documented in a pre-designed structured protocol. Urinary and drinking water fluoride levels were estimated by using the Orion

Ionplus Fluoride Electrode (ORION, Beverly, USA).

Statistical analysis

Descriptive statistics were used to describe the prevalence of Dental Fluorosis, Genu Valgum, Goiter and Conjunctival xerosis.

Results

Table 1 shows sex distribution of dental fluorosis, genu valgum, goiter, and conjunctival xerosis. Dental fluorosis affected 27.5% male children and 20.2% female children. Twenty-four percent of all children were affected by dental fluorosis. Approximately 11% of children suffered from genu valgum, being equal in both sexes. Goiter was detected in 22.5% male children and 19.2% female children. Interestingly, 20.9% of children had Goiter, even though they consuming iodized salt. Conjunctival xerosis was detected in 11.5% male, 9.1% female children, and in all, 11.0% of children. This may be due to malabsorption of fat-soluble vitamin A due to fluoride exposure.

One hundred urine samples were collected randomly from the 416 children. A proper age and sex distribution was maintained using proportional probability sampling. The majority of people in the study area belonged to a lower socioeconomic class. We noted that the level of urine fluoride ranged from minimum of 0.33 ppm to maximum of 8.8 ppm with the mean value of 1.78 ± 1.202 ppm. Fluoride concentration of bore well water measured at Kaiwara is summarized in **Table 2**.

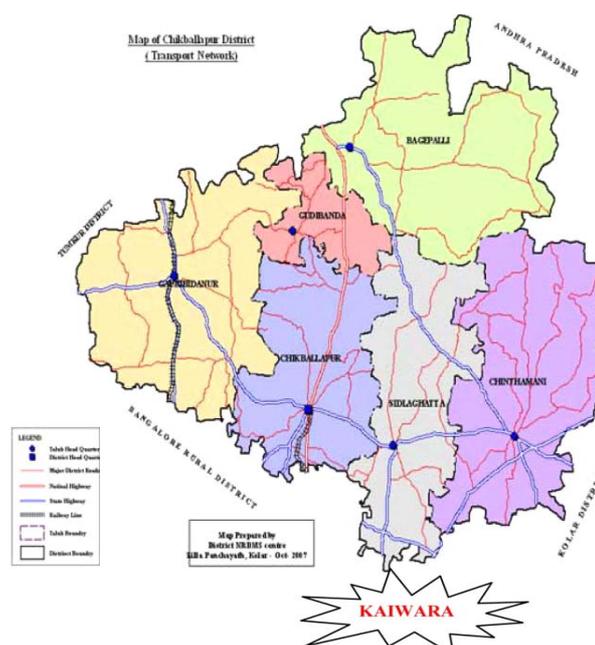


Fig.1 Regional location of Kaiwara village, Chickballapur District, Karnataka, India.

Table 1. Sex distribution of dental fluorosis, genu valgum, goiter, and conjunctival xerosis.

Sex	Dental fluorosis		Genu valgum		Goiter		Conjunctival xerosis	
	Present (%)	Absent (%)	Present (%)	Absent (%)	Present (%)	Absent (%)	Present (%)	Absent (%)
Male	60 (27.5)	158 (72.5)	25 (11.5)	193 (88.5)	49 (88.5)	169 (77.5)	25 (11.5)	193 (88.5)
Female	40 (20.2)	158 (79.8)	22 (88.9)	176 (88.9)	38 (19.2)	160 (80.8)	18 (9.1)	180 (90.9)
Total	100 (24.0)	316 (11.3)	47 (88.7)	316 (76.0)	87 (20.9)	329 (79.1)	43 (10.3)	373 (88.7)

Table 2. Fluoride concentration of bore well water in Kaiwara village.

Sample number	Sources of water	Test
1	Chamundeswari Hill tank	2.26 ppm
2	Narasimiahswamy Temple tank	1.46 ppm
3	Vivekananda tank	2.44 ppm
4	Chickaballapur tank	2.08 ppm
5	Bimaligeshwara Temple bore well	1.0 ppm
6	Hollugumanahalli bore well	1.92 ppm
7	Petaganahalli bore well	2.52 ppm
8	Bannahalli bore well	2.06 ppm
9	Kaiwara Ashram bore well	2.68 ppm
10	Kaiwara Gosala bore well	2.40 ppm

The upper safe limit for urine fluoride is 0.1 ppm [6]. All children studied had values higher than this safe level. All water samples were tested at the Public Health Institute, Bangalore. It was reported that nine out of 10 sources of water contained an excess of fluoride and were unfit for human consumption [6].

Discussion

Recently, Saravanan et al. [1] studied the prevalence of dental fluorosis among primary school children in Cuddalore district of Tamilnadu, India. The prevalence of dental fluorosis was 31.4%. Jolly SS et al. [7] examined 46,000 children belonging to 358 villages aged 5-17 years in Punjab for dental fluorosis. According to their report, in 210 villages (maximum fluoride concentration: 1.4 ppm), the incidence of dental mottling was 0-10%. In 96 villages (maximum fluoride concentration: 2.3 ppm), the incidence of dental mottling was 10-30%. In 52 villages (max fluoride concentration >2.3 ppm), the incidence of mottling was >30%. Excessive ingestion of fluoride during early childhood may damage the tooth formation by fluoro-appetite deposition in the enamel, dental mottling, and discoloration. Teeth affected by

fluorosis have visible discoloration, ranging from white spots to brown and black stains as well as brittleness leading to breakage.

There is a report by the National Institute of Nutrition of India [8] of young children in Kachariadih village of Nawada district in Bihar state, India, where the fluoride level in water ranged from 3.5 ppm to 14.5 ppm. The prevalence of genu valgum was 14%. These bone deformities occurred at an early age up to nine years, and were more predominant in one to five year old children. It was suggested that the clinical and radiological changes of bone in young children might have also been due to secondary vitamin-D deficiency [8].

Excessive exposure to fluoride causes a syndrome of osteo-sclerosis, osteo-malacia, and ligamentous calcification, called skeletal fluorosis, affecting both the axial and appendicular skeletons. The syndrome is characterized by ankylosis of the spine and knee deformities such as genu valgum, genu verum, and genu recurvatum, of which genu valgum is the most common. Human kidneys concentrate fluoride as much as 50-folds from plasma to urine. This can lead to renal rickets due to proximal tubular damage with

resultant renal loss of calcium phosphorus, which is essential for normal development and functions of bone and joints. Fluoride's potential to impair thyroid function is perhaps best illustrated by the fact that at one time fluoride was used as a thyroid-suppressive medication for patients with hyperthyroidism. It was utilized because it was found to be effective at reducing the activity of the thyroid gland - even at doses as low as two mg/day [9]. According to Susheela AK et al. [10], fluoride damages micro-villi in the upper gastrointestinal tract leading to mucosal damage, malabsorption and related gastrointestinal dysfunction.

In conclusion, water-born fluorosis was endemic in Kaiwara village. The endemic prevalence of the syndrome of fluorosis among school children was characterized by dental mottling, genu valgum, endemic goiter, and xerosis of the conjunctiva. All schoolchildren examined in Kaiwara village passed high levels of fluoride in urine and 90% of water samples consumed by the local people are contaminated with fluoride. The high prevalence of these disorders compromised the psycho-physical growth and development of children. The second phase of this study will be conducted under admission to the pediatrics ward of MS Ramaiah Medical Teaching Hospital; a representative cohort of these children will be subject to metabolic investigations.

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