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PREVALENCE OF FLUOROSIS AMONG SCHOOL CHILDREN AND CATTLE POPULATION OF HIRAKUD TOWN IN ORISSA

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ABSTRACT
An epidemiological study was conducted on the prevalence of fluorosis in Hirakud town ,an industrial town of Western Orissa and the results were compared with two sub-urban and non-industrial towns located some 80 km away from Hirakud as control sites. Results revealed around 14-22% increase in teeth mottling (soiling) and aberration among school children in Hirakud over the control sites and 20-25% more in cattle population. Analysis of hospital records for out-patients although do not reveal any admission for treatment of fluorosis ,may be because of absence of specialists ,the admission rate with complain on teeth and bone related diseases has decline in Hirakud in comparison to the data of 2001-2002.Chi-square test indicates an association between prevalence of fluoride in environment and prevalence of fluorosis. Thus , the fluorosis has not affected the children as only teeth abrasions have been observed which might be due to other factors like health and hygiene. In Hirakud, the level of fluoride in water is within permissible limit, which may be a cause for no detectable dental or skeletal fluorosis among children excepting at the level of mild mottling or abrasion of teeth.It may be desirable to corroborate these findings with hematological studies

INTRODUCTION

Chronic fluoride intoxication, or fluorosis is a worldwide health problem and is endemic in those areas where the fluoride content in drinking water is relatively high. Its primary manifestations in human and mammals are mottling of teeth and osteosclerosis of the skeleton. The effect of fluoride on humans has been extensively studied and fluoride related health and environmental concerns have reached an alarming proportions in many regions of the world (WHO 1970, 1984, Shupe 1980; Desai *et al.,* 1988; Choubisa 1999)). The occurrence and development of endemic fluorosis has its roots to the high fluoride content in air, soil and water of which water is perhaps the major contributor. The significance of fluoride in water has always been a subject of debate. Whereas an intake of fluoride in controlled quantities (less than 1 ppm) is known to be beneficial for human health in preventing dental caries, high fluoride concentration in water causes dental and skeletal fluorosis. The recent implications of involvement of fluoride as a carcinogen and mutagen have added yet another dimension to the unresolved role of fluoride in human health (Mahoney *et al*., 1991; Hamilton, 1992; Yiamouiannis, 1993)

The fluoride concentration in ground water is largely governed by presence of Ca, Mg, Na, SiO_2, PO_4, pH and alkalinity. Nanyaro *et al.,* (1984) have attributed high fluoride content in waters of Northern Tanzania to their exceptionally low Ca and Mg concentrations. Citing Eriksson (1981), Nanyaro *et al.,* (1984) explained this relationship on the basis of low solubility of Ca and Mg fluorides. Maina and Gaciri (1984) have found in a study of 47 bore wells, that low Ca and negligible Mg concentrations corresponded to relatively high fluoride values. Chandra *et al.,* (1981) and Teotia *et al.,* (1981) have reported that water with low hardness i.e. low Ca and Mg contents and high alkalinity present the highest risk of fluorosis. Ca and Mg were found to be low as they are largely precipitated as carbonates. Only limited incorporation of F is permitted in the $CaCO_3$ structure, such that there is always a net balance of F in solution.

Fluoride concentration may increase in the environment due to certain natural and human factors and thus pose a threat to human health.

1. Industrial sources of fluoride pollution- aluminium industries and phosphate fertilizer factories are the biggest sources of industrial fluoride in the environment. The production of hydrogen fluoride and chlorofluorocarbon (CFC) used in the petroleum and refrigeration industries also add to fluoride contamination in the environment. The manufacture of steel, bricks and tiles and the combustion of coal may emit fluorides.

2. Geological sources- Deep wells, minerals. Springs and hot water geysers which may be used for tapping

geothermal energy may release a large amount of fluoride into the atmosphere. The weathering of fluoride-bearing rocks, particularly fluoropatites also releases fluoride into the ecosystem.

Impact of fluorine or human health

Excess fluorine in water, if taken constantly causes serious damage to the teeth and bones of the human body, which shows symptoms of disintegration and decay and the diseases are called dental fluorosis and skeletal fluorosis respectively. Many studies have found fluoroisis to be invariably associated with high concentration of fluoride in drinking water (Desai *et al.,* 1988, Samal & Naik, 1988 & Dwarakanath and Subburam, 1991). Fluoride readily accumulates in the bones, teeth and other calcified tissues of the human body. It has also been found in the kidney and in urinary tract stones, in hardened arteries and in the aorta where it can cause cardiovascular problems. The kidney is certainly one of the organs easily damaged by excessive fluorine intake (Hodge and Smith, 1965). Dental mottling is the earliest sign and symptom of dental fluorosis and was first noticed by Eager (1901). Hodge and Smith (1965) related the various concentrations of fluorine to a range of health symptoms in humans (Table1). Osteosclerosis is caused by calcium deficiency resulting from the action of fluoride. Fluorine makes an insoluble complex with calcium. Teeth appear to be the most susceptible organs to fluorine poisoning and concentrations higher than 2ppm of fluorine initiate tooth mottling (Smith *et al.,* 1931). Prolonged exposure to fluorine over a period of time manifests itself as skeletal fluorosis , the commonest symptoms of which are persistent backache. The disease affects the vertebral column, the pelvic girdle and ribs. Maximum changes are detected in the vertebral column particularly in the cervical and lumber regions. Fusion of the vertebral bones may also occur resulting in neurological symptoms and severe neck stiffness. These may have crippling effects on the human body.

However, the teeth and bones are not the only human body organs affected by fluorosis. Large doses or a persistent intake of small amounts over a number of years can affect soft tissues and be manifested as gastrointestinal, neuromuscular, respiratory and cardiovascular problems and also allergic skin lesions. Woldbott and Cecilioni (1969) reported complaints of respiratory and gastrointestinal tract problem in residents living in the vicinity of a fertilizer plant in Canada and called it neighborhood fluorosis.

Fluoride poisoning is also related to genetic disorder in children called Down's syndrome (mongolism). It is a congenital condition associated with certain physical and mutual abnormalities. Women who give birth to children in the high fluoride regions of Rajasthan have significantly more children with Down's syndrome than those in low fluoride regions (Mathur, 1983)

Table 1: The impact of increasing concentrations of fluorine on the human body

Concentration of Fluorine (ppm)	Impact on human Health
1	Reduction in dental caries
2 or more	Mottled enamel
5 or more	Some sign of osteosclerosis
8 or more	10% osteosclerosis
20 or more	Crippling effects
50 or more	Thyroid changes
100 or more	Growth retardation

Impact of Fluorine on Domestic Animals

The prevalence and severity of fluoride toxicity in animals varies from place to place, even in areas having identical fluoride concentration in drinking waters. Besides the amount of fluoride in the water and the durations of exposure, age, healthy, stress factors and the biological response of individuals (Shupe, 1980) and other factors such as the local environment (temperature and humidity), other dissolved salts in drinking water and the involvement of fluoridated food chains may increase the prevalence and severity of fluoride toxicity. Chronic fluoride toxicity in the form of osteodental fluorosis was observed in cattle, buffaloes, sheep and goats (Choubisa, 1999) from 21 villages of Bansura, Dungarpur and Udaipur districts of South Rajasthan where the mean fluoride concentration in drinking water varied from 1.5 to 4.0 ppm. The prevalence of dental fluorosis in calves (< 1 year age) was greater than that in adult cattle and buffaloes. In the older groups of buffaloes, their teeth were brownish black instead of creamy yellow as found in calves and cattle. The overall prevalence of skeletal fluorosis was with the highest prevalence in cattle and buffaloes at a fluoride concentration of 3.2 ppm. Thyroid dysfunctions have also been reported in fluorotic animals (Hillman *et al.,* 1979; Suttie, 1980).

Hirakud , the first industrial town of Orissa state ,has one Aluminium Smelter Plant operating since last 45 years with present capacity of 1.00 lakh ton per annum.Fluoride is the major pollutant generated from such plants contributing to air ,water and soil pollution.The plant is considered to be the best plant in the private sector from environmental management point of view. The present investigation was carried out to assess the impact of fluoride available in the environmental segments of Hirakud on school children and cattle population with respect fluorosis and to compare the result with data from control sites of Deogarhand Kuchinda.

MATERIALS AND METHODS

The survey, undertaken during Nov.2005- January 2006, of the prevalence of Fluorosis in cows, buffaloes, sheep and goats (200 from Hirakud and 400 from control sites of Deogarh and Kuchinda) were done house to house in the early morning and late evening when animals are generally available and in herds in the fields in the day time. Only native livestock living in the areas from birth and were grazed outside at least for 4 hours a day were considered. For dental Fluorosis, the teeth of immature and mature animals were examined carefully and for skeletal fluorosis / osteofluorosis, stunted growth, low milk production, poor bodly condition, lameness were examined. Reluctant to move of stiffness, skeletal deformities, a snapping sound from the feet during walking and intermittent diarrhoea were looked for fluorotic animals and also examined by palpation for evidence of generalized swelling of thyroid gland.

School children (100 from Hirakud & 200 from Control sites) in the age group of 5-15 years were examined for only teeth mottling and lameness or skeletal abnormalities. The control sites were in non-industrial areas of Deogarh and Kuchinda. The hospital records of last five years were examined from Hirakud as well as Kuchinda and Deogarh to find out the extent of out door patients admitted for bone and teeth ailments.

Water samples (pond, well and tube well) vegetation (paddy, grass and non-deciduous leaf) and soil from crop field, grass land and forest were analyzed to correlate their fluoride content with extent of dental fluorosis among children and cattle.

RESULTS

The study was undertaken during Nov.2005-Jan.,2006 in Hirakud Industrial Township and was compared with two control non-industrial sites, Deogarh and Kuchinda township of Western Orissa. The objective of the study was to assess the prevalence of any symptoms relating to fluorosis among school children (5 to 15 years) and of outside-grazed cattle. The survey revealed non-occurrence of symptoms other than teeth mottling (soiling) and eroded teeth among children and cattle for which these two parameters were collected through sample survey. Hospital records were also collected to find out the trend of patients being treated as outdoor-patients with complains of teeth & bone related problems during the last five years.

Analysis of data(Table 2) reveals a relatively higher percent of children (48) from Hirakud township having teeth mottling and erosion in comparision to the control sites of Deogarh (34) and Kuchinda (26). In all these sites (both industrial and control), either piped water supply or well water was the source of drinking water and all the children used Colgate/Close-up/Pepsodent as tooth paste. There was also no apparent difference in the food habit as rice was the main food during day time and in the night 20-60% of children ate roti with 60% in Hirakud(Fig.1)

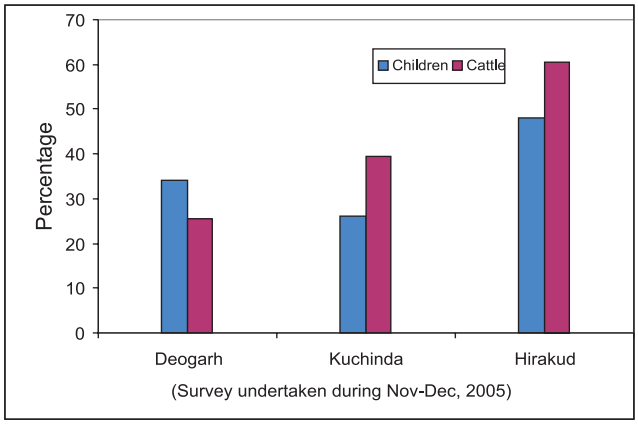

Figure 1: Per cent of school children & outside grazed cattle showing mottling, erosion and breakage.

Similarly, occurrence of teeth mottling, erosion and breakage among cattles (Table 3) was also highest in Hirakud (60.5%) followed by Kuchinda (39.5%) and Deogarh (25.5%).

Table 2: Comparative description of samples with teeth erosion & mottling among children in relation to variables

	Deogarh	Kuchinda	Hirakud
No. of children	100	100	100
Male	65	55	56
Female	35	45	44
Drinking water sources			
Piped water supply	33	27	48
Well	52	11	14
Tubewell	15	62	38
Others	0	0	0
Type of tooth paste used			
Colgate	33	27	48
Close - up	52	11	14
Pepsodent	15	62	38
Others	0	0	0
Type of food			
Lunch Rice	100	100	100
Roti	0	0	0
Dinner Rice	80	65	40
Roti	20	35	60
No. of cases of teeth mottling			
Male	25	15	28
Female	9	11	20
Total	34	26	48
% of mottling cases	34	26	48

Table 3: Comparative description in the tread of cattle with teeth breakage/mottling

	Deogarh	Kuchinda	Hirakud
No. of house surveyed	43	18	29
No. of Cattle	200	200	200
Type			
Cow	165	109	200
Goat	24	50	0
Buffalo	11	26	0
Sheep	0	15	0
No of cases with teeth abnormalities			
Cow	42	44	121
Goat	5	16	0
Buffalo	4	10	0
Sheep	9	0	
Total	51	79	121
% out of total cattle surveyed	25.5	39.5	60.5

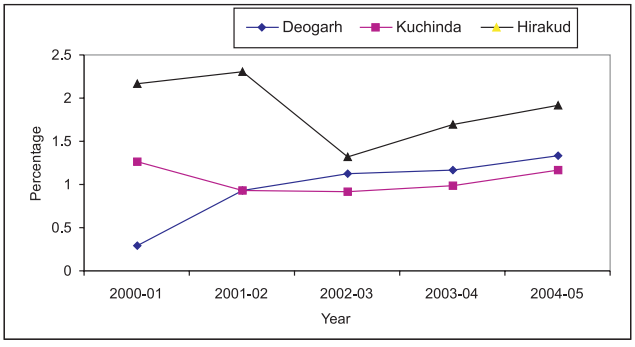

Figure 2: Comparative description in the trend of per cent of the outdoor patients treated for complains in teeth& bone related problems

Table 4: Chi square test on association of relatively high fluoride contaminated site and fluorosis

Availability of fluoride in the environment in relatively high amount	No. of children showing teeth mottling & erosion		Total	χ^2	$p < 0.05$
	Yes	No.			
Yes (Hirakund)	48	52	100	9.38	3.84
No (Deogarh & Kuchinda)	60	140	200		
	No. of children showing teeth mottling & erosion				
Yes (Hirakund)	121	79	200	42.96	3.84
No (Deogarh & Kuchinda)	130	270	400		

In both the cases, Null hypothesis is rejected indicating a strong association between fluoride availability in the environment and teeth mottling, erosion & breakage among school children & cattle.

Hospital records revealed (Fig.2) that at Hirakud, the people admitted to hospitals as out door patient with complain of teeth & bone related problems has an over all decline from 2000-01 (2.17%) to 2004-05 (1.91 %). In control sites, the over all figures are less than Hirakud with 0.29 – 1.33% in Deogarh and 0.93 – 1.10 in Kuchinda during the last five years. However, in all the sites, the percent of people complaining bone & teeth related diseases are increasing.

Statistical analysis (Table 4) performed to find out the association between environmental contamination with fluoride (industrial area) and occurrence of fluoride related symptoms indicate a significant association between the two parameters.

DISCUSSION

Fluorosis is a result of abnormal deposition of fluoride in hard tissues. Fluorine has a marked affinity for teeth and bones. The first clinical indication of fluorosis in an area may be mottled teeth in cattle & children. Bone change includes osteosclerosis and osteophysis. The health problems due to fluoride contamination are far more widespread. In 1999, UNICEF reported that as many as 177 districts of India have been confirmed as fluoride affected areas. Susheela (1993) has reported that approximately 62 million peole in 15 state in India are affected by dental, skeletal and nonskeletal fluorosis.

The first case of endemic fluorosis in human was reported in 1937 from Prakasam district of Andhra Pradesh. In 1950, only four states, Andhra Pradesh. Tamil Nadu, Punjab & Uttar Pradesh, fluorosis was reported. By 2003, the number of states has increased to 17.

Chronic fluoride toxicity in the form of osteo-dental fluorosis was observed in cattle, buffaloes, sheep & goat from 21 villages of Banswara, Durgapur and Udaipur districts of Southern Rajasthan where fluoride content in drinking water varied from 1.5 – 4 ppm (Choubisa, 1999) with more prevalence in the calves of <1 year age. At fluorine content of 4 ppm in water, 100% calves, 65.6% buffaloes and 61.0% cattle were affected due to dental fluorosis to varying degree. Similarly the over all prevalence of skeletal fluorosis was 8.5% with highest prevalence of 29% in cattle and 37.5% in buffaloes at a fluoride concentration of 3.2 ppm (Choubisa, 1999).

Sinha (1997) in his study found fluorosis to be endemic in seven villages around Jaipur (Rajathan) where the fluorine content was more than 8 ppm. In those villages, 70% of the human population suffered from dental fluorosis and 48% from skeletal fluorosis, 10-13% of people had crippling effects. In areas where fluorine content reached 11-12 ppm, 74.5% of dental fluorosis, 54.5% skeletal fluorosis and 23.3% crippling effect were

observed among people, crippling effect become more pronounced among people beyond 45 years of age.

In Orissa, fluorosis has been reported from Karlakote, a village in the undivided Kalahandi district. The people of this village and surrounding villages are mainly affected from fluorosis due to high level of fluoride in ground water. However, no systematic study has been conducted at Karlakote and adjoining villages on fluoride level in environmental segments. Similarly a significant percent of people belonging to Sargaruan Gram Panchayat of Khurda district of Orissa have been severely affected by fluorosis because of high level of fluoride in water (1.4 – 8.2). These are the two areas in Orissa where people have been affected due to high level of naturally occurring fluoride in ground water.

However, contribution of fluoride pollution by industries in Orissa is expected at Angul and Hirakud due to Nalco Smelter Plant and Hindalco Smelter plant respectively. In Orissa, Angul Industrial environment has a high level of fluoride because of NALCO Smelter with a production capacity of 5.0 lakhs tons per year. However, no published data is available on the extent of human and animal fluorosis although news paper reports are available on people being affected because of industrial pollution.

Present study at Hirakud reveals that fluorosis has not affected children as only teeth abrasions have been observed which might be due to other factors like health and hygiene. In Hirakud, the level of fluoride in water is within permissible limit, which may be a cause for no detectable dental or skeletal flluorosis among children excepting at the level of mild mottling or abrasion of teeth. However, the sign of prominent teeth mottling among domestic cattle at Hirakud could be related to relatively more fluoride content in vegetation in comparison to the control sites. Earlier studies indicate a relatively higher accumulation of fluoride in the forage of Hirakud in comparison to Deogarh and Kuchinda which may be contributing to prevalence of fluorosis among cattle in Hirakud.As a precautionary and preventing measure, Hindalco Industries limited may create awareness among school children and public about dos and don'ts in order to prevent fluorosis among children and cattle population.

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