ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 5, Issue – 1, February - 2022, Page No. : 148 - 155

Evaluation of teeth & bone changes among children and adults: A study conducted in fluoride endemic areas of Garhwa district

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Citation of this Article: Dr Santosh T, Dr. Meghna, Dr Frank Antony Britto, Dr. Varsha R Shetty J, Dr. Pramod S Ingaleshwar, Dr. Alka Pandey, "Evaluation of teeth & bone changes among children and adults: A study conducted in fluoride endemic areas of Garhwa district", IJDSIR- February - 2022, Vol. – 5, Issue - 1, P. No. 148 – 155.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract:

Aim: Fluoride is an essential element for bone and teeth development found in calcified tissues of human body and optimum fluoride level in diet prevents dental caries, but high fluoride level exposures for a prolonged period results in dental fluorosis, skeletal fluorosis, and decrease in intelligence quotient. Fluorosis is one of the severe public health problems in India, as almost two-third states are fluoride endemic causing ill effects in children. Drinking water is the prime dietary source of fluorides. The fluoride level in underground water in many villages across Garhwa district around 3.5 -4 PPM (parts per million) as against permissible level of 1 PPM as prescribed by world health organization (WHO). The present study was conducted to evaluate the effect of fluoridated water on teeth and bones in Garhwa district.

Materials & Methods: A total of 450 subjects from urban and rural areas of Garhwa district were selected by

stratified sampling method. Dental examination was done to record Dean's flurosis index, socio-demographic, food consumption and oral hygiene data were recorded using a pre-tested structured questionnaire. Fluoride content was measured using Orion apparatus in different rural and urban areas of Garhwa district.

Results: The maximum percentage of samples exceeding the permissible limit is in Bishrampur and Dalton Ganj and the maximum fluoride value is also found in Dalton Ganj block. The study samples exhibited severe form of fluorosis in the younger age group.

Conclusion: The high fluoride content of the drinking water available from CFI data was positively correlated with dental fluorosis indicating consumption of drinking water to be related with high dental fluorosis among the participants.

Clinical Significance: More than permissible limits of fluoride content in drinking water in the study area points towards risk of deleterious effects among the population due to chronic fluoride exposure.

Keywords: Fluorosis, Community Fluorosis Index (CFI), PPM (parts per million, Orion apparatus.

Introduction

Fluorosis is one of the severe public health problems in India, as almost two-third states are fluoride endemic.[1] In India, approximately 25 million people are presently affected by fluorosis and 66 million are at risk of developing fluorosis, including children of age 14 years.[2] Drinking water is the prime dietary source of fluorides. In addition, fluoride can also be present in foods such as salt-water fish, sorghum, finger millets and crops grown in soil irrigated by water containing a high concentration of fluorides.[3,4]

There have been few studies reported in the literature which correlates relationship between fluoride concentration in water and fluorosis and investigate the indigenous risk factors causing dental fluorosis.[5,6]It is very difficult to isolate these factors and draw conclusions fluoride content in drinking water is the primary cause of fluorosis. It is suggested that other factors like altitude of residence,[7] climate,[8] dietary habits,[9] tea consumption,[10] nutritional status of the child,[11,12] duration of breast feeding,[13] infant formulae,[14] and use of fluoridated toothpaste[15] have an influence on the prevalence and severity of dental fluorosis.

Optimal fluoride concentration in drinking water may prevent dental caries and will not cause dental fluorosis. The objective of present study was to investigate risk factors of dental fluorosis in permanent teeth in an Indian context.

Garhwa is located in extreme parts of Jharkhand. The always highlighted groundwater quality problem in this area is Fluoride contamination. The Groundwater is the primary source of drinking water in the area and very few people are fed with PHE water supply scheme. Geologically the gneisses and granites are the most predominant rocks of the whole Garwah area these rocks have fluoride bearing minerals which are leached out to the groundwater and contribute high fluoride concentration in the groundwater.

To assess the health impact, check for dental and skeletal fluorosis is also done and it is found that the most of the people from Chukru, Bakhari, Kauria and Jorkat villages consume groundwater as their drinking water source which have reportedly high fluoride content in their groundwater and thus morbidity of dental fluorosis is very high in many villages.

The present study was conducted to evaluate the effect of fluoride on teeth and bones in Garhwa district by

estimating increased PPM level of fluoride against the permissible level of fluoride that can cause dental fluorosis which could later leads to various bone deformities

Materials and method

In the present study, samples of children and adolescents in fluoride exposed areas are tabulated, to see any changes in teeth and bones.

The study was conducted in the Urban and rural areas in different talukas of garhwa district. In the present study four taluka were selected meral taluka, sagma taluka, dhumki and nagarutari taluka. The participating subjects gave written informed consent for the study and consent was obtained after explaining the study purpose to the study subjects.

Subjects in the areas affected by level of fluoride between 3.5-4 PPM (parts per million) and also having Familial exposure of fluoride were included in the study. Subjects with developmental disturbances of teeth, severely stained teeth due to guthka exclusively, any drugs induced deformities, bone disorders other than fluorosis such as polio, scurvy were excluded from the study.

A selection of Subjects been enrolled according to the fluoride contamination across Garhwa district as such and it's possible role of causing dental fluorosis. A case history performa was prepared for each subjects who have enrolled for dental check-up. The performa was divided into following parts:

- 1PPM (parts per million) been kept as a permissible level of fluoride.
- Any deviation in the PPM in accordance to the permissible levels is noted registering affected villages and the subject
- Accordingly, subject been selected against their demographic exposure and duration. and its effects on teeth.

A total of 450 subjects from urban and rural areas of Garhwa district were selected by stratified sampling method. Dental examination was done to record Dean's flurosisindex, socio-demographic, food consumption and oral hygiene data were recorded using a pre-tested structured questionnaire. Fluoride content was measured using Orion apparatus in different rural and urban areas of Garhwa district.

Results

The fluoride level in underground water in many villages across Garhwa district around 3.5 -4 PPM (parts per million) as against permissible level of 1 PPM as prescribed by world health organization (WHO) is taken into consideration in this particular study. (TABLE 1).

Annual avg. maximum daily air temp.(°C)	Recommended F⁻ concentration mg/l			Maximum allowable F⁻ conc. Mg/l
	Lower	Optimum	Upper	
<or=12	0.9	1.2	1.7	2.4
12.1-14.6	0.9	1.1	1.5	2.2
14.7-17.7	0.8	1.0	1.3	2.0
17.8-21.4	0.7	0.9	1.2	1.8
21.5-26.2	0.7	0.8	1.0	1.6
➢ Or = 26.3	0.6	0.7	0.8	1.4
Standards for Indian condition				
BIS (1991) standards	0.6	1.0	1.5	
WHO standards	0.5	1.0	1.5	.

Table 1: range of maximum allowable fluoride content in drinking water.

The samples with fluoride in the range of 0.6- 1.0 mg/l is desirable for good dental health as it prevents tooth decay.

As the principle dissolved ions which contribute to the hardness of water are carbonates, bicarbonates, fluorides, chlorides, nitrates, sodium, potassium, calcium, magnesium. The total hardness is mainly associated with the carbonates, bicarbonates and chlorides of the calcium and magnesium ions. (TABLE 2).

Parameter	Mean	S.D.	sK	Min	Max
Depth	25.46	20.16	0.73	6.10	64.02
E.C.	955.4	483.91	1.53	330.00	2580.00
pH	7.58	0.30	0.21	6.85	8.23
HCO3	396.4	139.35	0.67	110.00	930.00
Cl	74.17	94.43	4.04	7.10	688.70
F	1.37	1.16	2.08	0.14	6.98
Ca	72.21	40.30	1.57	2.00	230.00
Mg	30.98	20.22	1.13	2.40	92.00
T.H.	308.1	145.23	1.38	65.00	890.00
Na	80.79	75.52	2.96	12.00	506.00
K	2.48	2.26	2.39	0.30	14.00

S.D. = Standard Deviation, sK = Skewness, Min = Minimum, Max = Maximum.

Table 2: statistical analysis of all parameters have been expressed AS mg/l except pH and EC .EC unit is Ms.

The maximum percentage of samples exceeding the permissible limit is in Bishrampur and Dalton Ganj and the maximum fluoride value is also found in Dalton Ganj block only. Therefore, the groundwater of Dalton Ganj especially in villages like Chukru, Bakhari. Jorkat, Chianki are severely affected. The reason behind is the presence of granitic rocks in water bearing formation.

These rocks contain fluoride bearing minerals which leach out to groundwater and the physical factors like arid climate and scanty rainfall, less recharge of aquifers than discharge consequently lead to depletion of groundwater level and these factors raise the fluoride concentration in the groundwater. (Table-3) (Fig 1).

Name of the Block.	Maximum (mg/l)	Average (mg/l)	Range of values	% exceeding Desirable limit (1.0 mg/l)	% exceeding permissible Limit (1.5 mg/l)
Daltonganj(CT)	6.98	2.14	0.22-6.98	11.11	55.55
Hariharganj	0.99	0.658	0.17-0.99	Nil	Nil
Pandu	1.1	0.808	0.22-0.808	20	Nil
Chatarpur	3.11	1.45	0.38-3.11	23.07	38.46
Hussainabad	0.96	0.812	0.63-0.96	Nil	Nil
Satbarwa	2.01	0.611	0.18-2.01	Nil	14.28
Chainpur	3.15	1.49	0.54-3.15	16.66	50
Bishrampur	4.58	1.91	0.4-4.58	9.09	63.63
Lesliegaanj	0.73	0.52	0.14-0.73	Nil	Nil
Patan	2.97	0.98	0.48 - 2.97	20	10

Table 3: statistical analysis of fluoride level at different blocks of Garwa district.

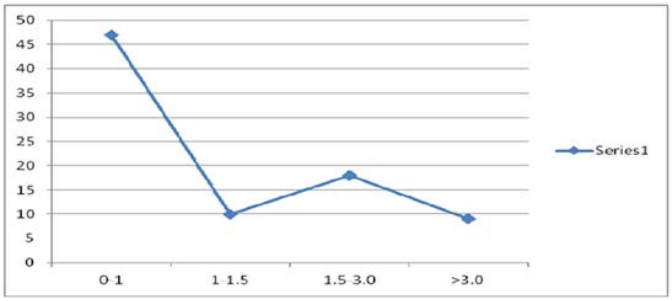

Figure 1: fluoride distribution frequency in study area.

The responses of the study participants were found to be students among genders on severity of impact on smiling was found to be absent in (82.5%), (80.8%), mild fluorosis among 58 (12.7%), 97 (16.8%), moderate among 12 (2.6%) ,10 (1.7%) and severe 10 (2.2%), 4 (0.7%) among males and females respectively. The results were statistically significant (p≤0.044, S). (Figure- 2).

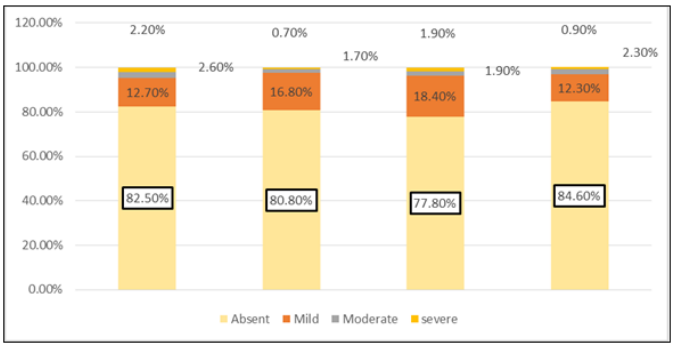

Figure 2: dental fluorosis prevalence and severity among four groups classified according to deans fluorosis index.

Discussion

In Garhwa districts, Vindhyan formations are concentrated in the northwestern Jharkhand along the son river valley (CGWB, 2007). Minerals like Limestone, Dolomite, and Sandstone are found in these areas. As per CGWB report, the major water bearing formation in the area is Chotanagpur Granite Gneiss, Vindhyan Limestone, Recent alluvium, Gondwana sandstone and Shale. The microscopic study of Granite gneisses confirms the presence of minerals having fluoride like apatite and fluorite. The leaching of minerals, is guided by draining solutions pH and

dissolved carbon dioxide in the soil. In deep groundwater a positive correlation of pH with fluoride and negative with the calcium is very commonly observed. Rock-water interaction plays a vital role in fluoride enrichment process.[16]

The Skeletal fluorosis symptoms are increased bone density, calcification of ligaments, bending of the vertebral column, rheumatic or arthritic pain in joints and muscles along with stiffness and rigidity of the joints etc. In individuals, disease can be present at subclinical, chronic or acute levels of manifestation.[17,18]

In Non-skeletal sclerosis, intake of fluoride contaminated water impart ill health effects on other soft tissues, organs and systems apart from bones and teeth like Cardiac problems, Repeated abortions or still birth, male infertility, gastro intestinal complains, diarrhea, muscular weakness, neurological health problems.[19]

Various studies in the past established a linear relationship between the degree of dental fluorosis and the amount of fluoride in drinking water**.** [20,21,22]

Fluoride uptake by the enamel occurs during the development of enamel i.e., mineralization stage. Dental mottling usually occurs in permanent teeth and is visible clearly in age groups of 5 years and above. Therefore, the prevalence of dental fluorosis among the children of growing age is considered as the expression of the current problem of fluorosis. Our study results showed that nearly two third of participants had experienced dental fluorosis. Similar studies conducted in different parts of India reported the prevalence as 66.7, 71.3 and 69.3% among school children.[23,24,25] On the other hand, a comparatively lower prevalence of 32.6 and 15.8% was recorded in Kerala and Tamil Nadu respectively.[26,27]

These differences of prevalence in dental fluorosis were mainly due to fluoride content in the water available in the area. Studies from China and Brazil have detected high fluoride prevalence ranging from 50 to 80.4%, the results which are similar to present study [45, 46].[28,29]

The present study examined predictors of dental fluorosis among the participants. The significantly related factors to dental fluorosis were living in the study area for more than 5 years and studying in government schools, which in turn were related to low socio-economic status.

According to the present study, occurrence of dental fluorosis was similar among children who consumed water from the bore well (63.7%) or tap via pipe supply (64.8%). A study done by Gopalakrishnan et al. in Kerala reported prevalence of dental fluorosis was significantly higher among children who consumed pipe water (44.8%) as compared to children who consumed well water (12.7%).[6]

The high fluoride content of the drinking water available from CFI data was positively correlated with dental fluorosis indicating consumption of drinking water to be related with high dental fluorosis among the participants.[30]

The WHO guideline for the maximum permissible limit of fluoride in drinking water is 1.5 mg/L, higher concentrations of fluoride can cause fluorosis of varying degrees. Bureau of Indian standards has further reduced the safer limit of fluoride intake to 1.1 mg/L. The mean value of the fluoride content, among six villages, was 1.4 with a standard deviation of 0.38 whereas the maximum and minimum fluoride content, in samples collected at various locations in the village, was found to be 2.0 and 0.4 mg/L respectively.[31]

More than permissible limits of fluoride content in drinking water in the study area point towards risk of deleterious effects among the population due to chronic fluoride exposure.

The present study reported a Community Fluorosis Index of 2.3 which is very high in comparison to CFI of 0.59–0.79 reported in two Chilean cities and Ramnagaram district, Karnataka, where it was reported as 1.76. [32,33]

A significant positive correlation was observed between CFI and fluoride content of drinking water (rho = 0.570), which reinforces the fact that villages with a higher level of fluoride have higher Community Fluorosis Index. Several other studies have similar findings for correlation between CFI and fluoride content of drinking water.[1, 11, 12,33]

Conclusion

Some of the areas of Palamu districts have constantly shown the high amount of fluoride in their groundwater (>1.5 mg/l) as the problem is geogenic. The geochemical assessment have shown that fluoride is negatively related with Ca. The constant intake of high F water will cause fluorosis. The present situation of contamination of Fluoride in drinking water has reached an alarming level and needs urgent attention and intervention of local bodies, NGOs, Government organizations. The remedial measures should be taken which will be suitable for the geo-hydrological, socio-cultural, eco-political, and environmental aspects of the area and for the inhabitants concerned.

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