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# Water Fluoridation, Dental Fluorosis, Bone Fluorosis and Skeleton Fluorosis Among The Persons In Hojai District, Assam India: A Quantitative Overview of The Literature

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**Abstract**

The aim of this project was to study the prevalence and severity of dental fluorosis, bone fluorosis and skelton fluorosis among persons exposed high fluoride drinking water in Assam, India to assess the risk factors involved. Subjects aged 5 to 50 years who had been lifelong consumers of high-fluoride groundwater (> or = 10-22 mg F/L) were selected for the study. The ground water samples were collected in three seasons over one year in 2018- 2019 from 50 different sources in 30 locations on the predominantly rural and tribal area Hojai district, Assam, India. The nature of sources with their approximate depth were tube well, ring well, pond and P.H.E. water Fluoride concentrations in the water samples were determined using SPADNS method. The absorbance measurements were done at 570 nm with a cell of width 1cm using a UV spectrophotometer (Hitachi 3210). Fluoride concentration was read directly by operating the instrument in photometry mode calibrating against a standard and a blank. Among the consumers of high-fluoride water nearly100% showed dental fluorosis and 80% in the group consuming high-fluoride water were suffering from bone fluorosis and Skelton fluorosis. Sources, distribution and geochemistry of fluoride are also studied. In the study area, which was characterised by multiple fluoride sources uncontrolled groundwater high fluoride content was the most important factor in the development of dental fluorosis , bone fluorosis and skelton fluorosis. In order to prevent dental fluorosis , bone fluorosis and skelton fluorosis groundwater wells should routinely be analysed for fluoride.The fluoride concentration in the ground were also studied with the help of correlation between fluoride ion and other ions. The ground water in various part of Hojai district is highly contaminated with fluoride. Fluorosis diseases among the children and the adults were shown through photographs. The only way to prevent this disease is to stop the consumption of fluoride contaminated Children examined in 2018-2019were at higher risk for both dental fluorosis and bone fluorosis . This analysis showed that the risk of developing dental fluorosis, bone fluorosis and skeleton fluorosis among the children and the adults of tribal communities. Continuous exposure to water fluoridation had an observable effect on dental fluorosis, bone fluorosis and skeleton fluorosis.

**Keywords:** Fluoride, Fluoresis, Bone Fluorosis, Dental Fluorosis, Skeleton Fluorosis, Hojai District

**Introduction**

Water is essential for the survival of any form of life. Increasing industrial activities, rapid progress in science and technology, human activities, use of various chemicals in agriculture, etc. are the factors threatening the very quality of the life sustaining aquatic system. Moreover, the geology of soil also determines the presence of the chemical substance and their concentrations in water. Quality of water particularly that used for drinking is very much influenced by these substances. The pollutants often do not show immediate effect on human health unless they enter into the body in substantial amounts. However, prolonged exposure to the chemicals even in very low concentration causes accumulation of them and they begin to show

adverse effects. Sewage, industrials wastes and wide array of synthetic chemicals pollute considerable part of this limited quantity of water. The menace of water borne diseases and epidemics still threatens the well being of population, particularly in underdeveloped and developing countries. Thus the quality as well as the quantity of clean water supply is of vital significance for the welfare of mankind.

**Aim of the Study**

The present study reports the quality groundwater from a large number of locations of the Hojai district, Assam has been found to be affected with fluoride contamination. People are affected by a peculiar disease in which the neck movement is limited, spinal cord and joints are stiffened, legs are bifurcated and teeth are mounted in certain areas of Hojai district area. Hojai district is situated in the central Brahmaputra valley zone of the state of Assam. It is located between $92.45^0$E to $93^0$E latitude and between $26^0$E to $26.5^0$E longitude at an altitude of $44.3^0$ from the main river level. Hojai district has a total area of 1224 $Km^2$ with a population of 9.3 lakhs as per 2011 census (Source: Office of Hojai district Statistical Office ,Sankardev Nagar, Hojai district). The most widely used source of drinking water in the sub-Division is tube wells and ring wells. The Urban water scheme is inadequate and can supply water only in some locations in Hojai town. A large section of the people even in urban areas has to depend on ring wells and tube wells for their water needs. There is no large and medium industries in Hojai district are and the water sources are under tremendous pressure only due to high density of population.

**Material and Method**

The groundwater samples were collected in three seasons, shown below for one year 2018- 2019. The seasons were Pre-monsoon season, Monsoon season and winter.

The sampling stations and the important features are shown in table 1.

The present work was carried out from February 2018 to January 2019. The water samples were collects in pre-cleaned plastic containers of 5 L capacity. The samples were pretreated and preserved properly and analysis of fluoride was carried out following standard procedure (APHA, 1995). Fluoride was determined spectrophotometrically by the SPADNA method. Fluoride reacts with the coloured complex of zircon I acid and SPADNA reagent (sodium -2) Parasulphopherylaze ) 1.8 dihydroxy 3-6 naphthalene disulphonate ) forming colorless Zr $F6)^2$ and releasing the dye. This reaction which can be followed conveniently by calorimetric measurement of the dye is the basis method. The absorbance measurements were done at 570 mm with help of UV spectrophotometer (Hitachi, 3210). Fluoride concentration was read directly by operating the instrument in photometry mode calibrating against a standard and a blank. The samples were also analyzed for PH electrical conductivity, carbonate, bicarbonate, calcium, magnesium and total hardness.

Sampling stations, nature of source and their approximate depth (m) of Hojai district

**Table: 1**

| Sl No | Location of Station | Nature of Source | Depth, (Meter) | Sl. No. | Location of Station | Nature of Source | Depth, (Meter) |
|---|---|---|---|---|---|---|---|
| 1 | Nilbagan | Tube Well | 30.4 | 26 | Urdhagaon | Tube Well | 35.5 |
| 2 | Nilbagan | PHE | 36.5 | 27 | Parokhowa | Tube Well | 53.3 |
| 3 | Nilbagan | Ring Well | 56.3 | 28 | Parokhowa | Tube Well | 44.1 |
| 4 | Jaynagar | Tube Well | 32.9 | 29 | Parokhowa | Tube Well | 38.1 |
| 5 | Jaynagar | Tube Well | 32.0 | 30 | Parokhowa | Ring Well | 38.1 |
| 6 | Murazar | Tube Well | 24.3 | 31 | Akashi Gangabazar | Tube Well | 30.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | Pir Bazar | PHE | 30.4 | 32 | Nij Parokhowa | Tube Well | 24.3 |
| 8 | Chital Mari | Tube Well | 24.3 | 33 | Nij Parokhowa | Tube Well | 35.0 |
| 9 | Methi Gaon | Ring Well | 36.5 | 34 | Akashi Ganga | Tube Well | 36.5 |
| 10 | Swarajpur | Ring Well | 30.4 | 35 | Nij Parokhowa | Tube Well | 33.5 |
| 11 | Charang Pather | Tube Well | 64.0 | 36 | Nij Parokhowa | Ring Well | 25.9 |
| 12 | Chomorali | Tube Well | 22.8 | 37 | Nij Parokhowa | PHE | 30.4 |
| 13 | Choudhury Bazar | PHE | 64.0 | 38 | Nij Parokhowa | PHE | 38.1 |
| 14 | Chota Haibar | Tube Well | 36.5 | 39 | Haldikhati | Ring Well | 24.3 |
| 15 | Pubthoria | PHE | 24.3 | 40 | Haldikhati | Tube Well | 25.9 |
| 16 | Hatipora | Tube Well | 35.9 | 41 | Haldikhati | Tube Well | 33.5 |
| 17 | Doboka Town | Tube Well | 33.5 | 42 | Haldikhati | Tube Well | 27.4 |
| 18 | Doboka Town | Tube Well | 39.6 | 43 | Tapajuri | Ring Well | 36.5 |
| 19 | Nam Doboka | PHE | 38.1 | 44 | Tapajuri | PHE | 21.9 |
| 20 | Ganipur | Tube Well | 64.0 | 45 | Tapajuri | Tube Well | 30.9 |
| 21 | Ambari | Ring Well | 36.5 | 46 | Tapajuri | Tube Well | 30.4 |
| 22 | Debasthan | Tube Well | 58.1 | 47 | Jugijan | Tube Well | 36.5 |
| 23 | Moudenga Pather | Ring Well | 52.4 | 48 | Rampur Basti | Tube Well | 56.3 |
| 24 | Urdhagaon | PHE | 64.0 | 49 | Hojai Town | Tube Well | 33.9 |
| 25 | Urdhagaon | Ring Well | 34.4 | 50 | Dimropar | Tube Well | 32.0 |
| 26 | Urdhagaon | Tube Well | 35.5 | | | | |
| 27 | Parokhowa | Tube Well | 53.3 | | | | |

**Geochemistry of fluoride**

During the process of chemical weathering dissolution of fluoride species in the natural water is controlled by calcium and governed by thermodynamic principal. The Calcium carbonates Equilibrium in the ground water place and important role in the process. The equilibrium constant with respect to calcite can be evaluated from the reactions.

$$CaCO_3 + H^+ \Leftrightarrow Ca^2 + HCO_3^-$$

$$K_{CaCO_3} = \frac{a(Ca^{2+})a(HCO_3^-)}{a(H^+)}$$

= 97 at 25$^0$C (Hem, 1970) ……. (1)

The fluoride equilibrium is given by :

$$CaF \Leftrightarrow Ca^{2+} + 2F^-$$

$$K_{CaF} = a(Ca^{2+})a(F^-)^2$$

= $10^{-10}$ at 25$^0$C (Brown et al., 1977) …….. (2)

Dividing the first equation by the second the solubility of calcite and fluoride can be represented by a third constant K:

$$\frac{a(HCO_3^-)}{a(H^-)a(F^-)^2} = K$$

$$\Rightarrow (a - F^-)^2 = K' \frac{a(HCO_3^-)}{A(H^-)}$$

where $K' = \frac{1}{K}$

$$\Rightarrow aF\alpha \frac{(HCO_3^-)}{(H^-)}$$

It is evident that if $P^H$ remains constant the activity fluoride ion will be proportional to that of by carbonate ion. The following the principal of ionic activity product, if the concentration of calcium and fluoride in natural water exceeds.

**Results and Discussion**

The concentration of fluoride in all seasons in one year and their mean are listed in table below. After a careful study of the topography and other aspects of Hojai Sub-Division drinking water samples are collected from 50 different sampling points, one set in each season. Three seasons were considered spreading over a period of one year (Feb. 2018 to Jan. 2019) is listed below:

i) Pre – monsoon (February 10th 2018– May 10th 2018)

ii) Monsoon season (June 10th 2018– September 10th 2018)

iii) Winter (October 10th 2018– January 11th 2019)

| Station | Sampling Seasons A= Pre – monsoon, B = Monsoon season, C= Winter | | | Mean |
|---|---|---|---|---|
| | A concentration of flouride in mg/L | B concentration of flouride in mg/L | C concentration of flouride in mg/L | |
| 1 | 7.5 | 5.2 | 7 | 6.6 |
| 2 | 8 | 7.9 | 8 | 8 |
| 3 | 6.5 | 5.9 | 5.1 | 5.8 |
| 4 | 5.5 | 5.5 | 5.2 | 5.4 |
| 5 | 6 | 5.4 | 5.1 | 5.5 |
| 6 | 5.5 | 5.3 | 5.3 | 5.4 |
| 7 | 3.5 | 3 | 3.1 | 3.2 |
| 8 | 5.5 | 5.6 | 5.3 | 5.5 |
| 9 | 5 | 5 | 4.6 | 4.9 |
| 10 | 3.3 | 3.2 | 3.2 | 3.2 |
| 11 | 7.2 | 7 | 7.1 | 7.1 |
| 12 | 6.2 | 4.2 | 4.1 | 4.8 |
| 13 | 4.6 | 3.9 | 3.5 | 4 |
| 14 | 5.9 | 5 | 5.1 | 5.3 |
| 15 | 3.9 | 2.9 | 2.3 | 3 |
| 16 | 8.6 | 8 | 8 | 8.2 |
| 17 | 9 | 8 | 8.1 | 8.4 |
| 18 | 10 | 8.2 | 7.6 | 8.6 |
| 19 | 5.5 | 5.3 | 5.2 | 5.3 |
| 20 | 5.2 | 5 | 4.6 | 4.9 |
| 21 | 7.2 | 7 | 7.4 | 7.2 |
| 22 | 7.5 | 6.5 | 6.2 | 6.7 |
| 23 | 5.5 | 5.2 | 5.1 | 5.3 |
| 24 | 10.3 | 10 | 9.5 | 9.9 |
| 25 | 6.9 | 6 | 5.2 | 6 |
| 26 | 11.5 | 10.1 | 11 | 10.9 |
| 27 | 15.5 | 14 | 15 | 14.8 |
| 28 | 13.5 | 13.1 | 12.9 | 13.2 |
| 29 | 14 | 12 | 11.8 | 12.6 |
| 30 | 18.2 | 18 | 18 | 18.1 |
| 31 | 13.2 | 13 | 12.6 | 12.9 |
| 32 | 22 | 22 | 22 | 22 |
| 33 | 19 | 18.1 | 17.9 | 18.3 |

| | | | | |
|---|---|---|---|---|
| 34 | 19.2 | 19 | 18.2 | 18.8 |
| 35 | 18 | 17 | 17.2 | 17.4 |
| 36 | 10.5 | 10.3 | 9.9 | 10.2 |
| 37 | 16.5 | 15.2 | 14.2 | 15.3 |
| 38 | 17 | 15.2 | 14.6 | 15.6 |
| 39 | 12 | 11 | 10.2 | 11.1 |
| 40 | 18 | 17.1 | 15.9 | 17 |
| 41 | 16.2 | 15.2 | 15.2 | 15.5 |
| 42 | 17.5 | 16.2 | 15.4 | 16.4 |
| 43 | 16 | 15 | 14 | 15 |
| 44 | 12 | 10.2 | 9.9 | 10.7 |
| 45 | 14.2 | 13.1 | 13 | 13.4 |
| 46 | 16 | 16 | 15.2 | 15.7 |
| 47 | 3.2 | 2.2 | 2.2 | 2.5 |
| 48 | 2.6 | 2.5 | 2.5 | 2.5 |
| 49 | 1.5 | 1.5 | 3.2 | 2.1 |
| 50 | 3.2 | 3 | 2.9 | 3 |

i) A = Pre – monsoon (February 10th 2018– May 10th 2018)
ii) B = Monsoon season (June 10th 2018– September 10th 2018)
iii) C = Winter (October 10th 2018– January 11th 2019)

| | | | |
|---|---|---|---|
| 1 | Nilbagan | 26 | Urdhagaon |
| 2 | Nilbagan | 27 | Parokhowa |
| 3 | Nilbagan | 28 | Parokhowa |
| 4 | Jaynagar | 29 | Parokhowa |
| 5 | Jaynagar | 30 | Parokhowa |
| 6 | Murazar | 31 | Akashi Gangabazar |
| 7 | Pir Bazar | 32 | Nij Parokhowa |
| 8 | Chital Mari | 33 | Nij Parokhowa |
| 9 | Methi Gaon | 34 | Akashi Ganga |
| 10 | Swarajpur | 35 | Nij Parokhowa |
| 11 | Charang Pather | 36 | Nij Parokhowa |
| 12 | Chomorali | 37 | Nij Parokhowa |
| 13 | Choudhury Bazar | 38 | Nij Parokhowa |
| 14 | Chota Haibar | 39 | Haldikhati |
| 15 | Pubthoria | 40 | Haldikhati |
| 16 | Hatipora | 41 | Haldikhati |
| 17 | Doboka Town | 42 | Haldikhati |
| 18 | Doboka Town | 43 | Tapajuri |
| 19 | Nam Doboka | 44 | Tapajuri |
| 20 | Ganipur | 45 | Tapajuri |
| 21 | Ambari | 46 | Tapajuri |
| 22 | Debasthan | 47 | Jugijan |
| 23 | Moudenga Pather | 48 | Rampur Basti |
| 24 | Urdhagaon | 49 | Hojai Town |
| 25 | Urdhagaon | 50 | Dimropar |

The distribution of fluoride concentration in the groundwater samples from the 50 samples stations of Hojai Sub-Division area are shown in table 2. WHO (1984) guideline for fluoride content in drinking water is 1 mg/L and ISI limit is 0.6 to 1.2 mg/L. In the present investigation the fluoride concentration was above the permissible range in all cases. The highest value of the fluoride content (22 mg/L) was observed in sampling source Niz Parokhowa L.P. School the lowest value (2.1mg/L) was observed in the sampling sourceof Hojai Town.

The fluoride concentration in the water of tube well was seen to be higher comparison to other sources. Moreover its concentration was also higher in Monsoon (May to Oct) in comparison to dry season (Nov to April). This may be due to surface run off. The fluoride contamination occurs naturally in the water samples of groundwater in some areas may due to weathering of fluoropatite rocks (Sax 1974, Shrivastava, 1995). Fluoride causes dental fluorosis if present in excess of 1.5 mg/L. and skeletal fluorosis beyond 3mg/L if such water in consumed for about 8 to 10 year (Nawlakhe and Buluse, 1989) In the present study it is seen that 607 habitations were found to affected by dental fluorosis and skeleton fluorosis. The fluoride cause non-skeletal fluorosis (Susheela, 1984, 1985).

The results of the initial survey in fluoride affected area indicate that 75% of the population of the village was affected by the skeletal fluorosis. The physical appearance and some symptoms of skeletal fluoritic patient were observed to be curvature of arms and legs and stiffness in joints and spinal cord. The other usual complains were he stiffness of he vertebral column and the pain in the neck movement. It was also observed that the adults were more affected than children as expected. The fluoride is a cumulative toxic, which is due to excessive fluoride ingestion, which increases with the increase in the priod of ingestion Disposition of fluoride s calcium floroapite cause thickening of bone results constriction of Inver vertebral foremen thus exerting excessive pressure on spinal nerves leading to paralysis. It was also observed that above 90% population has been suffering from dental fluorosis. The important symptoms are loses of shining appearance of the teeth enamel and it became yellowish brown and black. Dental fluorosis cuse brown mottling of teeth, decay of teeth because the fF ions make the enamel on teeth much harder by converting hydroxyl apatite [$3Ca_3(PO_3)_2$ $Ca(OH)_2$] (the enamel on the surface of teeth) into the much harder fluoroapatite [3Ca3 (PO4)4) CaF2] (Lee). Fluoride concentration in permissible limit is essential because of its physiological effects in human health. It is beneficial to certain extent when present in concentration of 0.8 to 1.0mg/L for calcification of dental enamel specially for the children below 8 year of age (Sudarshan and Reddy, 1991). The non skeletal fluorosis due to ingestion of fluoride in excess is also known to occur. It includes neurological manifestations (nervousness, depression, tingling sensations in fingers/toe and excessive thirts). Muscular manifestations (Muscle weakness, stiffness and muscle spasm).

Allergic manifestations (allergic manifestations can be of various nature) Gastro intestinal manifestation (diarrhea, constipation acute abdominal pain nausea and vomiting). Urinary tract manifestation (itching and tendency to urinate more frequently ). The present study indicates that many victims complain of severe anemia, diarrhea acute abdominal pain kidney failure may causing premature death. The situation of fluoride effected area is fast deteriorating and more and more people particularly children and women becoming victims of the danger fluorosis diseases. The colour of well water and tube well water clean through out all the season. But the pond water was muddy during rainy season due to the erosion of soil and village waste discharges in fluoride affected area. The PH is above 7 in all season which indicates that the sample water were alkaline. There exist a liner relationship between PH and fluoride concentration. It is reported that when the fluorine levels is water is high the water will highly alkaline and become softer (Teotaia and Mandsingh in bone is favoured by the high PH values of water or in the alkaline conditions (Bagga, 1980).

The different method so far tried for the removal of excess fluoride from water can be broadly classified into four categories, namely adsorption method, ion exchange method, precipitation method and miscellaneous methods (Kilder and Bhargava, 1988, MRD, 1993). Out of the above precipitation method using lime, alum and bleaching powder is most commonly used. In fluoride area people are advised to removed fluoride effected by precipitation method. For this there should be a 40 L plastic bucket and there will be a tap above 8 inches from the bottom of the bucket. 100 mg alum and 5 to 7 mg lime is mixed with per litre of water. Stirring is done for 10 to 15min and left for 1 hr. Precipitation of fluoride takes place and people get water free from fluoride by this process.

The chemical reactions involving between F and aluminum species are complex. It

is a combination of polyhydro aluminium species complexation with fluoride and their absorption on polymeric alumino hydroxide flocs. Lime helps hydrolysis of aluminium salt, so that residual aluminium does not remain in the treated water (Susheela, 1993, 1998). Prevention measures should be taken if water contains not be used for cooking ad drinking purpose. Expectant/lactating mothers are advised to use defluoridation water to have a a healthy baby. If any of the symptoms as discussed above is detected, the major source of fluoride in take should be avoided. Diet should have adequate calcium. Calcium rich vegetable and more milk should be consumed. Intake of vitamin C rich food items in large amount is advisable.

**Conclusion**

The ground water in various part of Hojai district in highly contaminated with fluoride. This is perhaps the primary reason for the increased incidents of the problem. Fluorosis is currently incurable, however, it can be prevented if diagnosed at an early stage. The only way to prevent this diseases is to stop the consumption of fluoride contaminated water. According to available statistical data (PHE, Diphu Sub-division 2000) at least 20000 children and young people are in the grip of fluorosis in Assam. As with identical fluoride concentration water samples with low value of $P^H$ and alkalinity and high values of hardness are less harmful, steps may taken to decreases the PH. As prevention is the only known solution, massive health education is the need of the hour. Treatment of water is required before using the water for drinking purpose. At the same time drinking water may be supplied from the nearby village through pipe line to this twin fluoride affected area in Hojai Sub-division.

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