



DENTAL FLUOROSIS AND FLUORIDE LEVEL IN GROUNDWATER IN RURAL AREAS OF DHARMAPURI DISTRICT, TAMILNADU, INDIA

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ABSTRACT

Fluoride is an essential element, which is good for the teeth enamel and helps to prevent dental caries. In excessive doses, however, it will lead to a chronic fluoride poisoning (fluorosis). Fluoride contamination of groundwater is a growing problem in many parts of the world. In the present study we investigated fluoride levels in the groundwater of rural areas in dharmapuri district, Tamil Nadu. Twenty four drinking water samples were collected and analysed for fluoride contamination from different villages located drinking water in rural areas of dharmapuri district Water samples were collected from July 2016 to June 2017. The residents from different villages have been identified with fluorosis and collected the information related to fluorosis. 40 villages level were identified as endemic area from the mapping were investigated. The fluoride in ground water of dental fluorosis were assessed in children attending schools from the selected villages. Fluoride concentration ranges from 0.14 – 5.68 mg/l with an average of 2.91 mg/l and standard deviation of 0.6927. The 9.93% of samples having fluoride concentration above desirable limit (1 mg/l) and 23.192% samples having fluoride concentration above 1.5 mg/l. Rest of the samples are within desirable limit. To assess the health impact, checked dental fluorosis and it is found that the most of the people from Athimutlu, Belamaranahalli, Belarahalli, Bevuhalli and Booganahalli villages of dharmapuri district and minimum is 0.14 mg/l in the Achalvadi and Agraharam 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 these villages .

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INTRODUCTION

Presence of high concentration of fluoride in drinking water causes dental and skeletal fluorosis in humans in several parts of the world. Water is one of the most precious resource in the earth. Groundwater is the major resource of fresh water to all living organism. Most of the rural and urban population uses groundwater for domestic purposes. The people living in rural areas are more exposed since there is no centrally supplied treated water in these areas. Dental fluorosis which manifests as discoloration of teeth is an aesthetic problem usually encountered. If the intake of fluoride in the formative years is excessive it may lead to dental and skeletal fluorosis. Fluoride in small amounts is an essential component for normal mineralization of bones and formation of dental enamel Wood (1974). The main source of fluoride for human body is usually drinking water, covering about 75 – 90% of daily intake Zohouri and Rugg-Gunn (2000). Fluoride concentration in groundwater depends on the pH, the intensity of the weathering process, and the amount of clay in the aquifer

material Saxena and Ahmed (2001). The natural concentration of fluoride depends on the geological, chemical and physical characteristics of the aquifers. Meenakshi, Garg *et al.*, (2004) excessive fluoride intake causes fluorosis Chen *et al.*, (1997), cancer, arthritis and other diseases Waldbott (1998) . Around 200 million people from 25 nations have health risks because of high fluoride in groundwater Ayoob and Gupta (2006). In India, there has been an increase in the incidence of dental and skeletal fluorosis with about 62 million people at risk Andezhath *et al.*, (1999) due to high fluoride concentration in drinking water. Dental fluorosis is endemic in 14 states and 150,000 villages in India with the problem most pronounced in the states of Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Punjab, Rajasthan, Tamil Nadu, and Uttar Pradesh Pillai and Stanley (2002) .

High concentration of fluoride is reported both from hard rock (granites & gneisses) as well as alluvial aquifers. Many people are not at all aware of the water borne diseases affecting their health due to high concentration of fluoride in drinking water which causes dental and skeletal fluorosis to humans (WHO, 2008). Standard Fluoride, beyond desirable amounts (0.6 to 1.5 mg/l) in groundwater causes serious health hazards to humans and irreversible damage to plants. The objective of

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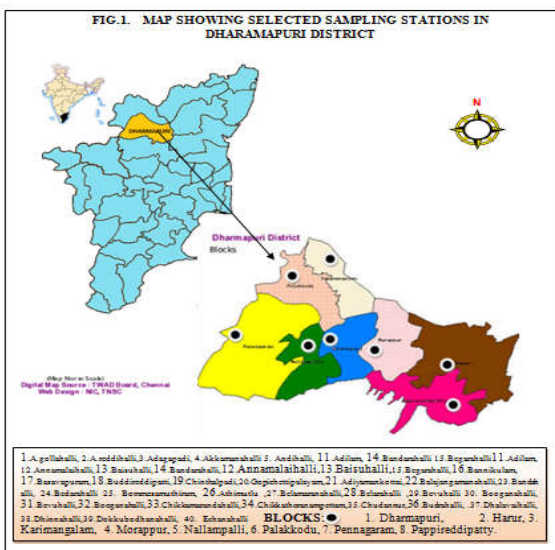
this study was to detect the fluorosis cases in rural areas of dharmapuri district in tamilnadu and correlate this with the level of fluoride in the water used for consumption and decide whether defluoridaton of these water sources are needed. Cases of fluorosis were detected and water from their drinking sources were collected in sterile plastic containers and fluoride level was estimated by ion selective exchange method. (Muralidharan *et al.*, 2002).

This study provide an overview of the fluoride content in drinking water and the extent of human exposure to different level of fluoride contamination in the blocks of Dharmapuri district, Tamilnadu. Most of people in this area suffer from dental & skeletal flurosos such as mottling of teeth, osteosclerosis of pelvis and vertebral column, chronic joint pain. This will narrate the well proven fact that fluorosis is caused by intake of fluoride in excess amounts during the formative years. We conclude that the excess intake must have been due to supplementation from dietary sources, toothpastes or from any other sources. It may also be due to the air borne fluorides or defective fluoride metabolism due to any drug intake. The present contribution has been focused on the investigation of fluoride in groundwater of dharmapuri district and dental fluorosis survey was conducted to make the people aware of the possible defluoridation techniques and consumption of drinking water with desirable fluoride content.

MATERIALS AND METHODS

Study Area

The study area of Dharmapuri District, Tamilnadu is situated 12.12° N 78.26° E, which is bounded by Tiruvannamalai and Villupuram Districts on the east, Salem District on the South, Krishnagiri District on the north and Cauvery River on the west. The famous Hogenakkal waterfalls is in Dharmapuri district. The sub basin area is bounded by Harur, Palakodu, Pennagaram, Dharmapuri, Pappireddipatti Taluks. Dharmapuri district goes through a hot climate during the summer (March-May) with a temperature upto 36°C and in winter it varies between 16°C - 12°C. The district has an average annual rainfall of about 895.56 mm.



Geomorphology

Dharmapuri district forms part of the upland plateau region of Tamil Nadu with many hill ranges and undulating plains. The

western part of the district between Pennagaram and Denkanikottai has hill ranges of Mysore Plateau with a chain of undulating hills. The southern boundary of the district is occupied by the Shevaroy hill ranges. The plains occupying the central, eastern and southern parts of the district have an average elevation of 488 m. above Mean Sea Level. The Plateau region along the western boundary and the northwestern part of the district has an average elevation of 914 m. above Mean Sea Level.

Collection & Sampling Technique

Water samples were collected in clean Jerri Can bottles of 2 Liters capacity. The sampling bottles were soaked in 1:1 diluted HCl solution for 24 h, washed with distilled water, and were washed again prior to each sampling with the filtrates of the sample. In the case of bore wells, water samples were collected after pumping the water for 10 min. In the case of open wells, water samples were collected 40 cm below the water level. The sample bottle are closed tightly and labeled. The samples were preserved, cooled and protected from breakage while transporting the bottles to the laboratory. Within 24 hrs the sample is shifted to the Lab for analysis. Fluoride was analyzed using a MERCK SQ118 Photometer. The reaction time was approximately five minutes during which the sample turns a bluish-purple color, and it is then poured in to a glass cuvette which is inserted in the Photometer. A light beam passes through the sample and a certain amount of light is absorbed. The absorbed light is proportional to the concentration of fluoride in the sample, which is shown on the display.

Table 1 Fluoride Status in India

| Sl.No | Region/State | Range of F-Concentration (mg/l) | Severity of Fluorosis |
|-------|------------------|---------------------------------|-----------------------|
| 1 | North-west India | 0.4-19 | Sever |
| 2 | Central India | 0.2-10 | Moderate |
| 3 | South India | 0.2-20 | Sever |
| 4 | Deccan Province | 0.4-8 | Moderate |

Table 2 Minerals containing Fluoride (Veerati Radhika *et al.*, 2012)

| Sl.No | Fluoride bearing Minerals | Chemical formula | Rocks where minerals are found |
|-------|---------------------------|--|------------------------------------|
| 1 | Fluorite | CaF2. 3Ca3(PO4)2 | Pneumatolitic deposits,,Pegmatite, |
| 2 | Fluorite | CaF2. | Metamorphosed limestone, Pegmatite |
| 3 | Lepidolite | K2 (Li,Al)5 (Si6 Al2)O20(OH)2 | Dolerites ,Gabbros |
| 4 | Tremolite, Actinolite | Ca2(MgFe+2)5(Si8 O22)(OH)2 | Clay |
| 5 | Rock Phosphate | NaCa2(MgFe+2)4(AlFe+2)(SiAl)8 O22(OH)2 | Limestone, Fossils |

Human Health Effects

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. (Teotia and Teotia, 1988). In Non-skeletal sclerosis, intake of fluoride contaminated water impart 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

(Tailor and Chandel, 2010, Singh, *et.al.*,2011). The area is again sampled for assessing the dental fluorosis situation on the basis of Dean Index (Dean and Elvove, 1936) in some of the selected schools of selected villages which have shown constantly fluoride contamination in their groundwater. There are four types of indices for the assessment of dental fluorosis like Dean index, Thylstrup and Fejerskov index (TFI), tooth surface index of fluorosis (TSIF) , fluorosis risk index (FRI) (N.Kumari and G.Pathak, 2014) . The assessed children were in the age group between 5-12 years. The criteria applied for the interpretation of the results are given in the following table (Wang *et.al.*, 1999). The area were mostly the communities depend on the groundwater for their drinking water use, have high morbidity of dental fluorosis.

Table 3 Different Fluoride doses and their health effects

| Sl.No | F Concentration (mg/l) | Effect |
|-------|------------------------|--|
| 1 | Nil | Limited growth and fertility |
| 2 | <0.5 | Dental caries |
| 3 | 0.5-1.5 | Promotes Dental health, prevents tooth Decay |
| 4 | 1.5-4.0 | Dental fluorosis (mottling and pitting of teeth) |
| 5 | 4.0-10 | Skeletal fluorosis |
| 6 | >10 | Crippling fluorosis |

(Ref: International Drinking water standards (1971), WHO, Geneva and Sunitha,V. and Ramakrishna reddy,M,2008)

Table 4 Criteria used for the interpretation of Dental fluorosis

| Sl.No | Class | Symptoms of Dental fluorosis |
|-------|---|--|
| 1 | A-Normal | No apparent abnormality |
| 2 | B- Slight(questionable,Mild, very mild) | Yellowish teeth with slight erosion |
| 3 | C-Heavy (Moderate and Severe) | Mottling or extended erosion or extensive damage to the teeth. |

In this analysis, A= 0 and 0.5 , B= 1 and 2, C= 3 and 4. These are the points given to the suffering people according to the level of severity and then total percentage is calculated. % Morbidity = B+C

RESULT AND CONCLUSION

The statistical analysis and their results are lined up in the Table-4 and 5. These tables gives the detail account of the situation prevailing in the district. The maximum limit of fluoride found in the area is 6.58 mg/l in the Athimutlu, Belamaranahalli, Belarahalli, Bevuhalli and Booganahalli villages of dharmapuri district and minimum is 0.14 mg/l in the Achalvadi and Agraharam. The percentage of samples which are exceeding desirable limit needs to be managed properly so that it can remain within permissible limit. These areas needs a well-crafted groundwater management plan. The areas where the fluoride limit exceeded the permissible limit, installation of defluoridation devices are needed or alternative supply of safe water is the urgent need. 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.

Table 3 Fluoride doses and its corresponding human health effects. (Meenakshi and Maheshwari, 2006)

| Fluoride (mg/l) | Effect on human health |
|-----------------|--|
| = or < 1.0mg/l | Safe limit |
| 1.0-3.0 | Dental fluorosis |
| 3.0-4.0 | Stiff and brittle joints/bones |
| = or >4.0 | Deformities in knees; crippling fluorosis; bones finally paralysed resulting inability to walk or stand straight |

Table 4 The distribution of the fluoride Level in the Groundwater sample of selected blocks of Dharmapuri district

| Sl. No | Blocks Dharmapuri District | Name of the villages | No. of samples | Fluoride level | | | | | | |
|--------|----------------------------|--|----------------|----------------|-----------|----------|----------|-----------|------|---|
| | | | | <0.5 | 0.5- <1.0 | 1.0- 1.5 | 1.5- 2.0 | 2.0 - 2.5 | >3.0 | |
| 1 | Dharmapuri | A.gollahalli, A.reddihalli, Adagapadi, Akkamanahalli and Annasagaram | 5 | 2 | 4 | 1 | 1 | 2 | 1 | 3 |
| 2 | Harur | Achalvadi, Agraharam Bairanaickanpatti, Chellampatti and Chinnakuppam | 5 | 2 | 3 | - | - | - | - | - |
| 3 | Karimangalam | Adilam, Annamalahalli Baisuhalli, Bandarahalli and Begarahalli | 5 | 1 | - | 2 | 1 | 1 | 2 | 1 |
| 4 | Pennagaram | Bannikulam,Basavapuram Buddireddipatti, Chinthalpadi and Gopichettipalayam | 5 | 3 | 1 | 1 | - | 2 | - | - |
| 5 | Morappur | Adiyamankottai, Balajanganahalli ,Bandahalli,Bedarahalli and Bommesamuthiram | 5 | 1 | 2 | - | - | - | - | 1 |
| 6 | Nallampalli | Athimutlu, Belamaranahalli Belarahalli, Bevuhalli and Booganahalli | 5 | 2 | 3 | 1 | 2 | 4 | 3 | 5 |
| 7 | Palakkodu | Bevuhalli,Booganahalli Chikkamarandahalli Chikkathoranampettam and Chudamnur | 5 | 1 | 3 | 1 | 2 | 1 | 3 | 6 |
| 8 | Pappireddipatty | Budrahalli .Dhalavaihalli Dhinnahalli, Dokkubodhanahalli, and Echanahalli | 5 | 3 | 1 | 2 | 1 | 3 | 1 | 2 |

Table 5 Dental fluorosis by severity level in the Dharmapuri, Harur, Karimangalam, Pennagaram, Morappur, Nallampalli, Palakkodu and Pappireddipatty Villages of Dharmapuri District blocks and Matlampatti schools: (Age Group = 13 yrs)

| Sl.No | Dharmapuri District blocks | Total Point | A | B | C | % Morbidity |
|-------|--------------------------------|-------------|-------|-------|-------|-------------|
| 1 | Dharmapuri | 24 | 0 | 45.26 | 54.23 | 99.49 |
| 2 | Harur | 24 | 4.25 | 53.45 | 43.25 | 96.7 |
| 3 | Karimangalam | 24 | 0 | 54.23 | 36.12 | 90.35 |
| 4 | Pennagaram | 24 | 6.21 | 62.12 | 22.43 | 84.55 |
| 5 | Morappur | 24 | 0 | 48.59 | 37.25 | 85.84 |
| 6 | Nallampalli | 24 | 5.42 | 77.82 | 21.23 | 99.55 |
| 7 | Palakkodu | 24 | 8.24 | 79.74 | 18.24 | 97.98 |
| 8 | Pappireddipatty | 24 | 7.12 | 87.45 | 27.48 | 114.93 |
| 9 | Govt.Hr.Sec.School Matlampatti | 50 | 75.72 | 37.82 | 2.45 | 40.27 |

This information is obtained in order to confirm the link between high fluoride levels in groundwater, the consumption of this fluoride contaminated water and the occurrence of dental fluorosis in the same areas. The results shows that the most of the people Dharmapuri, Harur, Karimangalam, Morappur, Nallampalli, Palakkodu and Pappireddipatty 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 whereas the groundwater in Matlampatti Govt.Hr.Sec.School, is comparatively more safe for drinking purpose with respect to fluoride content, showing comparatively less morbidity for dental fluorosis.

Remedial Measures

The inhabitants from this Dharmapuri district area have been suffering from the dental fluorosis. This is the high time to find the feasible solution of this problem and for the problem mitigation following action plan can be suggested Household defluoridation system: two types of defluoridation technique like one is Nalgonda technique and the other one is activated alumina type are practiced (Bulusu and Nawlakhe, 1990). On the basis of these techniques following defluoridation plants

are adopted (1) community defluoridation plants (fill and draw type), (2) Handpump attached defluoridation plants, (3) Domestic defluoridation system. Highly alkaline soils can be remedied by the use of Gypsum, Pyrite, or sulphuric acid. Afforestation of plant species like *Acacia nilotica*, *albizia lebbek* and *Populus deltoids* helps in alleviation of sodicity in soil. Others like Water from ponds after some treatment can be used for household activities. Nutritional supplements based on Ca, Vitamin C, E, D as higher intake of Ca can mitigate the effect of fluoride. Excess Fluoride causes hypocalcaemia, whereas Ca can prevent Fluoride uptake in the intestine. (Teotia and Teotia, 1988). Others like Water from ponds after some treatment can be used for household activities. Nutritional supplements based on Ca, Vitamin C, E, D as higher intake of Ca can mitigate the effect of fluoride. Excess Fluoride causes hypocalcaemia, whereas Ca can prevent Fluoride uptake in the intestine.

CONCLUSION/ RECOMMENDATION

The Block like Nallampalli, Palakkodu need to be look or higher concentration of fluoride and related disease, where as Dharmapuri and Pappireddy for lower concentration of fluoride and related diseases. The efforts by organization like UNICEF for demarcating safe and unsafe sources of potable water in the region would provide awareness to masses towards ill effects of using water with fluoride concentration beyond permissible limits. The signs and symptoms exhibited by the villagers indicate clearly that they are suffering from skeletal/dental fluorosis. Hence this paper is done for creating awareness about the fluoride contamination severity in Dharmapuri district and also helps to get the Hogenakkal drinking water Supply which is done through JUNNRM funding to this region at the earliest by the government of Tamilnadu.

Some of the areas of dharmapuri districts have constantly shown the high amount of fluoride in their groundwater (>1.5 mg/l) as the problem is geogenic. The chemical processes like dissociation, ecomposition, and dissolution are key for the mobility and transport of fluoride into groundwater. The geochemical assessment have shown that fluoride is negatively related with calcium (Ca). 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 fluoride originates from the bedrock, the high levels of sodium help to dissolve calcite and dolomite to precipitate and high level of calcium and magnesium decrease level of fluoride on water. 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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