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Epidemiological Study of Fluorosis on Different Age Groups in Tirunelveli District, Tamil Nadu, India

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Abstract

The component fluorine has long been documented to have benefits for dental well-being. High doses have been linked to the development of dental fluorosis, skeletal fluorosis, and deformation of bones in children and adults. High fluoride concentrations are most often associated with groundwater as these accumulate fluoride from minerals sources. The use of this study was to determine the fluoride level of drinking water interrelated to different age groups of people nearby Radhapuram block, Tirunelveli district, Tamil Nadu, India. In the present study, 2500 samples were collected, analyzed, and performed to ascertain the prevalence of epidemiological fluorosis. Information on the total population 2500 in different age groups are recorded, among the normal people, 1273 (51.1%) were male and 1227 (48.9%) were female affected in Radhapuram block. Information on the total sample of 1183, 48.9% were male and 51.1% of females normal. Among the total number samples 328, 57.0% were male and 43.0% of females were questionable, 427 samples, 44.7% were male and 55.3% of females very mild, 228 samples, 45.2% were male and 54.8% of females mild, 262 samples, 47.3% were male and 52.7% of females moderate, and 72 samples, 59.7% were male and 40.3% of females were found severely affected. The persons belong to 11–20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years, and 60 above were normal (39, 52, 58, 50, 63, and 70%), questionable (18, 11, 9, 9, 5, and 0%), very mild (20, 18, 11, 17, 8, and 11%), mild (9, 8, 10, 9, 7, and 4%), moderate (10, 10, 9, 12, 13, and 15%), and severe (3, 2, 3, 3, 4, and 0%), respectively. The selected 2500 total population 2109 persons used tap water, 161 persons used mineral water, 147 persons used borewell water, and only 83 persons used municipal water for their drinking purpose.

Keywords: Age groups, Drinking water, Fluoride, Fluorosis

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Introduction

India is one of the countries where hydrofluorosis is a major public health problem; Tamil Nadu is one of the 18 states affected by fluorosis. The maximum acceptance limit of fluoride in drinking water specified by the World Health Organization (WHO) is 1.5 mg/l. Fluoride occurs free in nature and found as fluoride ion small dose of fluoride has beneficial effects on the teeth, skeletal systems and protects teeth against microbial attack, especially in childhood.[1] Excessive fluoride concentration in take water has both helpful and harmful effects on teeth and skeletal tissues in human health. The ill effects of high fluoride on human health, including dental fluorosis and a few cases of skeletal fluorosis, were experiential in villages in the high fluoride region of Sirohi, although complete medical statistics has not been reported.[2]

Fluoride is a non-toxic element for recommended dose but change to toxic if dose increases up to the normal level. It is associated with bones and teeth within 24 h of ingestion: That which is not retained is usually eliminated through the kidneys. Various factors affect the retention of fluoride in the human body, such as diet and metabolism and age groups. Required normal levels of fluoride are estimated to be approximately 0.1–0.5 mg F/d for children <6 months old, while for adults the ranged 4.5–4.0 mg F/d. The most significant consequences of fluoride exposures in male reproduction are changes in the structure and functional function of spermatozoa and disruption of spermatogenesis while in experimental results involving female rats showed that high fluoride concentration less the pregnancy rate and the number of implantation. Fluorosis is a crippling disorder due to entry of fluoride in the human body, which affects all organs, tissues, cells in the body, and results in human health complaints having overlapping manifestations with some other diseases such as gouts and osteoporosis. Fluoride damages the pineal gland, which secretes melatonin hormone in the human brain. It also affects the reproductive systems and intelligence.[3]

The environmental quality is greatly focused on water because of its importance in maintaining the human health and health of the other ecosystem. The study of water quality deals with the physical, chemical, and biological characteristics of water and its relationship to all other hydrological properties. The quality of water is poorly understood due to the variety in the interactions between water and soluble minerals, sparingly soluble minerals, salts, and both natural and anthropogenic activities. The major problem of high fluoride contamination in groundwater has been reported by several researches in India, China, Japan, Sri Lanka, Brazil, Malawi, North Jordan, Ethiopia, Canada, Norway, Kenya, South Caroline, etc.[4]

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In India, 62.5 million people are suffering from disorders of teeth or bones by fluorosis. Seventeen states in India have been known as endemic for fluorosis and Tamil Nadu state is one of them.[5] High fluoride groundwater are found in various parts of the developing world in particular and many thousands of people rely on groundwater with concentrations above the WHO instruction value for their normal drinking water supply. High fluoride content in the deeper aquifers of Maharashtra is due to long residence time than the shallow aquifers. The granitic rocks in Nalgonda district contain fluoride from 325 to 3200 mg/kg and are the main source of fluoride in groundwater. Presence of high fluoride in groundwater is, therefore, strongly linked to increasing exploitation of groundwater in a number of areas, especially the arid region of Gujarat and Rajasthan.

Jacks *et al.*[6] noticed that high fluoride in groundwater in several parts of India was due to evaporation, transpiration of groundwater with residual alkalinity. Fluoride element has been shown to cause significant effects in human through many ways, namely, drinking water, air, dental products, food, beverages, and salts. Narsimha *et al.*[7] reported the distribution of fluoride in the groundwater and to understand the relationship of fluoride with other major ions and also to identify the high fluoride-bearing groundwater zones. Narsimha *et al.*[8] studied that the 107 groundwater samples and analyzed various physicochemical parameters including fluoride in the Shasler Vagu (SV) watershed of Nalgonda India. Hence, in the present investigation was planned to determine the fluoride level of drinking water inter related to different age group of people nearby Radhapuram block, Tirunelveli district, Tamil Nadu, India.

Materials And Methods

The present survey was carried out in four villages of Radhapuram block of Tirunelveli district, Tamil Nadu, India. The climate of these areas is very hot in summer and cold in winter. The monsoon, annual rainfall is also very low in these areas and surface water may not be available in all seasons for drinking purpose. For this reason, people depend on groundwater for their use. Drinking water is considered to be the main source of fluorides and standards are fixed by various authorities for the permissible limit of fluorides. A fluoride in drinking water causing dental fluorosis has been found through many surveys. A house-to-house survey was conducted using questionnaire. The data collected by the questionnaire from the sample population were raised for the whole population. Totally, 2500 samples were collected, analyzed, and performed to ascertain the prevalence of epidemiological fluorosis on both males and females separately. Based on age, they were categorized into six different age groups.[9,10]

Results

Information on the total population male and female were normal and affected by fluorosis given in Table 1 and Figure 1. Among the total sample of 1183, 48.9% were male and 51.1% of females normal. Among the total samples 328, 57.0% were male and 43.0% of females were questionable, 427 samples, 44.7% were male and 55.3% of females very mild, 228 samples, 45.2% were male and 54.8% of females mild, 262 samples, 47.3% were male and 52.7% of females moderate, and 72 samples, 59.7% were male and 40.3% of females were found severely affected.

The normal, fluorosis, and disease prevalence in different age groups are given in Table 2 and Figure 2. In terms of persons the level of fluorosis concentration recorded in 11-20 years of age groups were normal in 39%, questionable level is 18%, very mild level is 20%, mild level is 9%, moderate level about 10% and severe level is 3%. The persons belong to 21–30 years were normal (52%), questionable (11%), very mild (18%), mild (8%), moderate (10%), and severe (2%), respectively. The persons 31–40 years were normal (58%), questionable (9%), very mild (11%), mild (10%), moderate (9%), and severe (3%), respectively. The persons belong to 41–50 years were normal (50%), questionable (9%), very mild (17%), mild (9%), moderate (12%), and severe (3%), respectively. The number of persons 51–60 years were normal (63%), questionable (5%), very mild (8%), mild (7%), moderate (13%), and severe (4%), respectively. The persons above 60 years were normal (70%), questionable (0%), very mild 1%), mild (4%), moderate (15%), and severe (0%), respectively.

The details of water in four different villages are given in Table 3 and Figure 3. In Radhapuram block, the villages such as Uzhavoor, Avaraikulam, Chidamparapuram, and Zionpuram depend on borewell, tap water, municipal water, and mineral water for their drinking and cooking purpose. The selected 2500 sample population 2109 samples used tap water, 161 samples used mineral water, 147 samples used borewell water, and only 83 samples used municipal water for their drinking purpose. The population in these villages belonged to four different water consumed. The number of persons belongs to normal in borewell (54%), mineral water (65%), municipal water (61%), and tap water (45%), respectively. The number of persons recorded in questionable level in bore well water is 7%, mineral water is 15%, municipal water is 8%, and tap water is 14%. The persons recorded in very mild in bore well water is 16%, mineral water is 11%, municipal water is 14% and tap

Table 1: Sex-wise distribution of the population on the basis of deans index

Subjects	*Number of sample*	*Female (%)*	*Male (%)*
Normal	1183	48.9	51.1
Questionable	328	57.0	43.0
Very mild	427	44.7	55.3
Mild	228	45.2	54.8
Moderate	262	47.3	52.7
Severe	72	59.7	40.3

Table 2: Total number of subjects with severity of fluorosis and disease prevalence in different age groups

Age group	*Normal (%)*	*Questionable (%)*	*Very mild (%)*	*Mild (%)*	*Moderate (%)*	*Severe (%)*
11–20	39	18	20	9	10	3
21–30	52	11	18	8	10	2
31–40	58	9	11	10	9	3
41–50	50	9	17	9	12	3
51–60	63	5	8	7	13	4
60 above	70	0	11	4	15	0

Table 3: Various water used in drinking and cooking purpose

Types of water	*Normal*	*Questionable*	*Very mild*	*Mild*	*Moderate*	*Severe*	*Examined*
Borewell	54	7	16	10	11	2	147
Mineral water	65	15	11	4	4	1	161
Municipal water	61	8	14	11	4	1	83
Tap water	45	14	18	9	11	3	2109

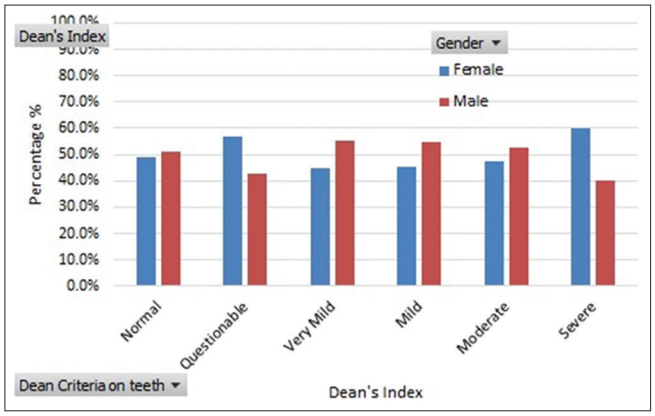

Figure 1: Sex-wise distribution of the population on the basis of deans index

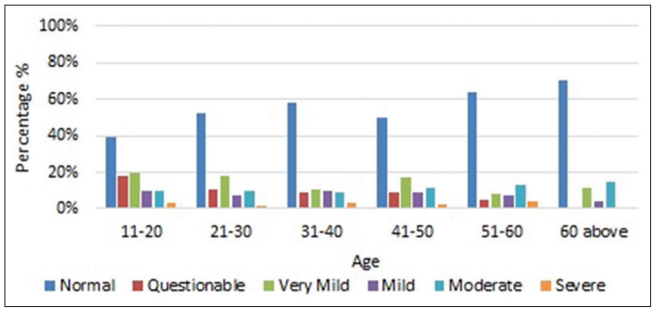

Figure 2: Total number of subjects with severity of fluorosis and disease prevalence in different age groups

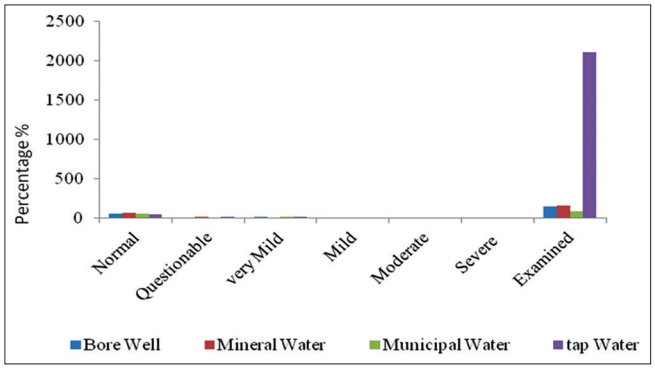

Figure 3: Various water uses in drinking and cooking purpose

water is 18%. The mild water level were used by number of persons in bore well is 10%, mineral water is 4%, municipal water is 11% and tap water is 9%. The moderate level water used by number of persons in bore well is 11%, mineral water is 4%, municipal water is 4% and tap water is 11%. The severe level is water used by number of persons in bore well is 2%, mineral water is 1%, municipal water is 1% and tap water is 3%. The total number of persons examined in borewell (147), mineral water (161), municipal water (83), and tap water (2109), respectively.

Discussion

Fluoride contamination in drinking water has been documented as one of the major problems worldwide which is a serious threat to human health. In India, approximately 62 million people, including 6 million children, suffer from fluorosis because of use of water with high fluoride concentration. Due to its strong electronegativity, fluoride is attracted by positively charged calcium in teeth and bones causing dental fluorosis, teeth molting, skeletal fluorosis, and deformation of bones in children as well as in adult. High fluoride has a long-term effect on human health it is essential to monitor its concentration in groundwater used for drinking periodically and take steps to bring them within the permissible range of 0.6–1.5 mg/l. More than 90% of the rural Indian population uses groundwater for drinking purpose.

In the present investigation, the total population 2500 in different age groups are recorded, among the normal people, 1273 (51.1%) were male and 1227 (48.9%) were female found. The details of the fluorosis status of the population in 51.1% of females and 48.9% of males were affected in Radhapuram block. Statistical analysis showed that people of <20 years age are more affected by dental fluorosis and people above 20 years age group are more affected by skeletal and different non-skeletal fluorosis diseases are high which are 55% and 38%.[11] Akbar *et al*.[12] found that skeletal fluorosis of people who live in areas with high fluoride concentration is 18.1% higher than that of individuals who live in areas with low fluoride concentration and skeletal fluorosis (54.5%) was observed in the age group of 71 years and was more commonly found in females than males. Fluoride in groundwater was recorded to vary from 0.5 to 2.4 mg/l with an average concentration of 0.46 mg/l. Fluoride in urine ranged from below the detection limit to 1.8 mg/l among girls and 0.17–1.2 mg/l among the boys. Higher average concentration of fluoride in urine (0.65 mg/l for boys and 0.34 mg/l for girls) may be qualified to exposure to bioavailable fluoride through food, milk, tea, toothpaste, etc., in addition to intake through groundwater.[13] Narsimha *et al*.[8] reported that the fluoride concentration ranged from 1.4 to 5.9 mg/l in the groundwater samples, which was significantly higher than the recommended limit of 1.5 mg/l for drinking uses; hazard quotient (HQ) estimates are in the ranges of 0.90–3.78 and 1.21–5.11 in adults and children populations of the SV watershed of Nalgonda district, India. In developing area nutritional status, several diets have been reported to be associated with increased risk for fluorosis even in the communities with less than optimal concentration of fluoride in drinking water. Certain foods rich in fluoride, for example, tea, and locally grown food items in areas where the fluoride concentration in water used for irrigation is high may play an important role in development of fluorosis.

The implication is that the children in the 6–12 months age groups range are more likely to suffer from health complications associated with utilization of water laden with a high concentration of fluoride.[14] The prevalence of dental mottling (DM) was high among the total population in the districts of Dharmapuri (36%), Krishnagiri (24%), and Salem (33%), where the mean fluoride levels were 2.7, 2.2, and 1.2 ppm, respectively; the prevalence of DM was still high among the children (5–14 years) in the above three districts (53%, 43%, and 42%, respectively).[15] Emenike *et al*.[16] noticed that the associated HQ for infants between the age range of 6 and 12 months within about 91% of surpassed the accepted HQ limit and the HQ for age categories 11–16 years; >65 years; 18–21 years; ≥21 years; and 16–18 years within 95.2%, 90.5%, 80.95%, and 100% of the local dwellers of Ogun State (Abeokuta south), Nigeria. In the present investigation, the persons belong to 11–20 years, 21–30 years, 31–40 years, 41–50 years, 51–60 years, and 60 above were normal (39, 52, 58, 50, 63, and 70%), questionable (18, 11, 9,

9, 5, and 0%), very mild (20, 18, 11, 17, 8, and 11%), mild (9, 8, 10, 9, 7, and 4%), moderate (10, 10, 9, 12, 13, and 15%), and severe (3, 2, 3, 3, 4, and 0%), respectively. Chronic effects in adults, increased chance of developing pits in tooth enamel for children and younger for dental fluorosis. Dental fluorosis is hypomineralization of tooth enamel caused by intake of too much fluoride during enamel formation. Fluorosis appears as a range of visual changes in enamel resulting degrees of intrinsic tooth discoloration. The severity of the condition is dependent on the dose, duration, and age groups of the individual.

Fluoride contamination in many parts of UP (Unnao, 2 mg/l; Debraspur, 2.1 mg/l; Janghai, 3.2 mg/l; Babera, 3.3 mg/l; Jhansi, 2.8 mg/l; and Etah, 3 mg/l) has been reported mainly in the Quaternary-Upper Tertiary deposits.[17] Amalraj and Anitha[9] reported that the fluorosis was estimated that the 22 villages were Akkarakaranpatti, Silukuvarpatti, and Thoppinayakkanpatti contain more than 3 mg/l fluoride, which is 3 times higher than the safe fluoride level in drinking water; among them, 14% of drinking water samples of the selected villages have more than 3 mg/l of fluoride, remaining 86% of drinking water samples have more than 1.5 mg/l fluoride. In Andhra Pradesh, Kandukur revenue the concentration of fluoride ion in all drinking water samples has varied from 1.22 to 3.09 mg/l and 1.4 to 4.6 mg/l.[18] In Gujarat, the number of fluoride affected people was increased from 2826 in the year 1992 to 4187 by year 2003. In groundwater of Gujarat, the fluoride concentration in these villages population ranged from 1.5 mg/l to as a 18.90 mg/l.[19] Fluoride was found to be in the range of 0.43 mg/l–2.0 mg/l In Nanded city municipal tap water and ground water recorded the fluoride concentration above 1.5mg/l.[20] In Tamil Nadu, the high concentration of fluoride compound in groundwater is found to be in Dharmapuri, Krishnagiri, Salem, Coimbatore, Madurai, Trichy, Dindugal, and Chidambaram district. The districts having low fluoride are Tirunelveli, Pudukkottai, North Arcot, and Ramnad district. In Dharmapuri district, region of Karimangalam having the fluoride availability in groundwater varies from 0 to 2 mg/l. In Thoothukudi district, in the region of Ottapidaram, having fluoride distribution was ranged from 0.936 to 4.34 mg/l with highest fluoride level at Akkanaickenpatti (4.34 mg/l) and lowest at Saminatham (0.936 mg/l).[21] In the present investigation Radhapuram block, the villages such as Uzhavoor, Avaraikulam, Chidamparapuram, and Zionpuram depend on borewell, tap water, municipal water, and mineral water for their drinking and cooking purpose. The selected 2500 samples population 2109 samples used tap water, 161 samples used mineral water, 147 samples used borewell water, and 83 samples used municipal water for their drinking purpose. Dwellers were normal and the remaining percentage of samples was affected by fluorosis. The number of fluorosis cases was find out in mineral water dwellers 35% and the maximum number of fluorosis cases were find out those who were used tap water 55% for their drinking water purpose.

Conclusion

Fluoride is a ubiquitous element, from natural and anthropogenic sources and is present in all regions on the ecosystems. As the main source of drinking water is the groundwater-based borewell, tap water, municipal water, and mineral water, by drinking this fluoride-contaminated water, large number of people has been suffering from different types of fluorosis diseases such as dental, skeletal, and non-skeletal fluorosis. Unfortunately, there has not been much research that demonstrates positive effects of fluoride on people; the high fluoride content in the water this results in foliage damage. Several remedial measures are recommended and action programs have been chalked out to get rid of fluorosis problems. Planning the provider of low fluoride water for a fluoride endemic community requires a thorough knowledge of local hydrogeological conditions and an exhaustive inventory of the water sources being used by the community is essential for the safety and security of public health.

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