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Endemic Fluorosis in YSR District, Kadapa, Andhra Pradesh

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ABSTRACT
Fluoride in groundwater is one of the most critical health-related geo-environmental concerns due to its high concentration. Endemic Fluorosis is noticed in few areas of Andhra Pradesh, India, due to high fluoride levels in drinking water (over 1.5 ppm). To estimate the Prevalence of Dental fluorosis and Skeletal fluorosis among children and adults in 6 villages belonging to badvel and rayachoty mandals of YSR Kadapa district. Three steps followed in the study 1.School and community surveys for estimation of prevalence of Dental fluorosis and Skeletal fluorosis 2. Collection of drinking water samples in schools and villages for estimation of fluoride level (water survey) 3. Collection of urine samples in fluorosis cases for confirmation of the case. Study area includes Veerapalli, Guntapalle, Guntlammayapalliin Badvel mandal and Sibyala, Rayachoty, and Indukurupalli villages in Rayachoty Mandal, YSR Kadapa district, Andhrapradesh as they have found to be comparatively higher fluoride levels in drinking water sources compared to other parts of the district . Dental fluorosis was found in 215 children (44.05%) and 363 adults. (55.7%) Fluorosis in adults only (23.82 percent). No kids suffered skeletal fluorosis in the trial. Table 4 compares dental and skeletal fluorosis; the P value is 0.000, showing that the comparison is statistically significant. The elevated fluoride levels could cause morbidity that is characterized by dental fluorosis and skeletal fluorosis. It has been determined, after much deliberation, that the Kadapa district needs a reliable fluoride management plan, and that it is recommended for supply of fluoride free drinking water. It has not been identified specifically how there is a distinction between dental fluorosis and skeletal fluorosis; however, further research has to be done in order to answer this question.
Key Words: Fluoride, dental fluorosis, and skeletal fluorosis, groundwater, Kadapa district.

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INTRODUCTION

Fluoride levels in drinking water and the resulting ailment, "fluorosis", have been well present for years. An epidemic concern that affects people all over the world is the presence of dental fluorosis and skeletal fluorosis as a direct result of excessive amounts of fluoride in their drinking water [1-3]. Rural communities in developing countries like India, particularly those located in tropical climates, are particularly at risk since they are more likely to rely on groundwater sources as their primary source of domestic water supply. This presents a significant challenge for these people. [2] The maximum amount of fluoride that can be contained in drinking water in India is 1.5 mg/L, as specified by the standards of the Bureau of India for drinking water. The amount of fluoride that is present in the ground water in various places in India differs significantly from one another. Fluoride levels that were considered unsafe for human consumption were found in 230 districts across 20 states (after the bifurcation of Andhra Pradesh in 2014 [5].

In the states where fluoride-bearing minerals are endemic, the geological crust is densely packed with fluoride-containing minerals, and this fluoride eventually makes its way into the drinking water. Groundwater is being utilized for the purpose of drinking across the majority of the country because there is no centralized source of water supply. In various regions of the country, the levels of fluoride discovered in the drinking water have been shown to be low or normal. In India, unfortunately, proper fluoride mapping has not been carried out in order to discover areas with normal, low, or high levels of fluoride. This would allow for the identification of places where fluoride levels may vary [3,4]. There are a total of 51 mandals located within the Kadapa District. The majority of inhabitants in this region get their drinking water from the groundwater below them, as there are very few individuals who are serviced by water supply facilities [3].

According to geological standards, limestone is the rock that makes up the majority of the terrain in this region. These rocks contain fluoride-bearing minerals, which, when leached out into the groundwater, contribute to the high fluoride content that is already present in the groundwater. After conducting a comprehensive review of the relevant literature, it was discovered that reports are available on the amounts of fluoride that are found in the groundwater in a handful of the mandals that make up the Kadapa district. However, there is no published research on the incidence of fluorosis in the parts of the YSR Kadapa district that are contaminated by fluoride [3,5]. Because of this, we decided to carry out a study to investigate the prevalence of flourosis in the YSR Kadapa district, which has relatively high amounts of flouride in its drinking water. The study's objective is to determine the prevalence of dental and skeletal fluorosis in children and adults in six villages of two mandals in the YSR Kadapa district.

MATERIAL AND METHODS

It consists of 3 steps.

1. Oral examination for Dental fluorosis and General examination for skeletal fluorosis of children and adults in schools (school survey) and villages (community survey)
2. Samples of drinking water from schools and villages will be taken to figure out how much fluoride is in the water (water survey).
3. Urine samples were collected from patients with dental fluorosis and skeletal fluorosis in the study villages to estimate fluoride levels in the urine for confirmation of the case

The villages of Rayachoty mandal of YSR Kadapa district, Andhra pradesh were observed to have more fluoride in their drinking water from borewells. These villages are located in the northern part of the YSR Kadapa district. It is about 150 km away from Kadapa city.

Inclusion Criteria

1. A school survey of students aged 10 to 14 years
2. Children and adults who have lived in the area since birth.
3. Children with at least half of their crowns erupted but no restoration.
4. Children and adults who were present on the day of the examination
5. Adults over the age of 21, as well as adults who have lived in one of the villages for more than 15 years, are eligible.

Exclusion Criteria

1. Those who did not get consent forms signed by their parents
2. Children above the age of 14 years or below 8 years
3. Children who have not resided in that particular area since birth.
4. Adults with skeletal deformities without dental fluorosis

Survey methodology

Two types of surveys, the school survey and community survey, were carried out for the estimation of dental fluorosis and skeletal fluorosis in 6 villages of 2 mandals of YSR Kadapa district, AP. The school survey is for the estimation of dental fluorosis (DF) and bone deformities (SK) in school children, class by class. A community survey was conducted for the estimation of dental fluorosis and skeletal fluorosis among villagers from house to house in the selected villages.

Ethical Approval, Permission, and Consent: ethical approval taken from the ethical committee, Saveetha University, Chennai. Permission to conduct the study was obtained from the District Educational Officer and School Head Master/Mistress, and informed consent was obtained from each participant before data collection.

Drinking Water Sources and Fluoride Estimation

All villages studied had both rural water supply and borewater for drinking and cooking purposes. Water samples were collected in 500ml sterile plastic bottles. They were labelled, coded and sent to the laboratory for fluoride estimation on the same day. Fluoride analysis was done by using an electrode ion metre [3,5].

Questionnaire

A schedule for the interviews was prepared, keeping in view of the scope and objectives of the study. A structurally well-prepared and pretested questionnaire was developed after perusing the available literature. Thus, the final interview schedule consists of all the relevant items, such as profile characteristics, etc., for measuring the variables included in the study. After pre-testing the questionnaire at the proposed study area, necessary modifications were incorporated. The finalised questionnaire, which was used in the interview schedule for obtaining the primary data, is attached herewith. Name, Gender, and Habits Education number of family members and occupation, drinking water sources, water consumption, toothpaste type, and residence How many times do you brush per day? Have you ever considered teeth whitening? How often do you make dental visits? How many cups of tea per day?

The Dean's fluorosis index method was used in assessing dental fluorosis and skeletal fluorosis as per the criteria mentioned in the National Fluorosis Prevention Programme [1,3]. Dean's Fluorosis Index In 1942, H.T. Dean developed an index to describe and diagnose enamel fluorosis. An individual's fluorosis score is based on the most severe form of fluorosis found on two or more teeth [3,9].

Classification of Dental Fluorosis according to DEAN's Fluorosis Index

1.Normal (1): The enamel surface is smooth and glossy, and the colour is usually a pale creamy white.The enamel represents the usual translucent semivitriform (glass-like) type of structure. The surface is smooth, glossy and usually of a pale, creamy white color.
2 Very Mild (2): Small, opaque, paper-white areas scattered irregularly over the tooth but not involving as much as approximately 25% of the tooth surface. Teeth that have no more than 1–2 mm of white opacity at the tip of the top of the cusps of the bicuspids or second molars are often put in this category.
3.Mild (3): The white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50% of the teeth.
4.Moderate (4): All enamel surfaces of the teeth are affected, and surfaces subject to attrition show wear. Brown stains are frequently a disfiguring feature.
5. Severe (5): All surfaces of the enamel are affected, and the hypoplasia is so severe that the tooth's shape may be changed. The major diagnostic sign of this classification is discrete or confluent pitting. Brown stains are widespread, and teeth often present a corroded-like appearance.

Skeletal fluorosis

Any case with a history of residing in an area with fluoride above 1.0 mg/l along with one or more of the following health complaints:

1. Pain and stiffness in the neck, backbone (lumbar region), shoulder, knee, and hip Pain may commence in either 1 or 2 or more joints. The patient has restricted mobility of the cervical and/or lumbar spine and has to turn the whole body towards that side to see.
2. Knock knee/bow leg (in children and adolescents)
3. Inability to swim (advanced stage of skeletal fluorosis)
4. Ugly gait and posture (advanced stage of skeletal fluorosis) school survey

The severity of the dental fluorosis was assessed by Dean's index with the help of a dentist, and total samples were tested and classified according to the severity of dental fluorosis. The classification was divided into normal, questionable, very mild, mild, moderate, and severe. The study involves the collection of both primary and secondary data. The primary data was collected from the selected victims of dental fluorosis with the help of a duly pre-tested questionnaire. The drinking water in the schools and a few urine samples are collected from the children who are found to be affected by dental fluorosis for estimation of fluoride in urine, which supports the case. Almost all the selected villages are higher than the permissible level of 1 ppm according to WHO (World Health Organization, 1994) [3]. Six villages of two different mandals were selected as the study area as they were found to have higher fluoride levels in drinking water compared to other villages. A cross-sectional study was conducted to determine the prevalence of dental fluorosis and skeletal fluorosis among children and adults as per the criteria mentioned above. In addition to the 2-3 clinically identified fluorotic subjects (> 30 years), each village was also examined radiographically for further evidence of skeletal fluorosis or other skeletal changes [3,5].

RESULTS

A total of 1150 people who are living in the endemically fluorosed area of Andhra Pradesh villages were evaluated. People who participated in the study were in the age group of 10 to 80.

Table 1- Prevalence of Dental fluorosis and Skeletal fluorosis in the study area

S.N.	Name of the village	Fluoride level mean	Fluoride level range	Dental fluorosis in children(<14years)	Dental fluorosis in adults (>21years)	Total	Skeletal fluorosis (>21years)	Crippling fluorosis
1	Veerapalii	3.35	3.2-3.5	38/56 (67.9%)	84/102 (82.4%)	122/158 (77.21%)	40/102 (39.2%)	+ve
2	Guntapalli	1.7	1.6-1.8	23/88 (26.1%)	34/112 (30.4%)	57/200 (28.5%)	10/112 (8.9%)	-ve
3	Guntlammayapalli	4.1	4.0-4.2	68/98 (69.4%)	106/142 (74.6%)	174/240 (72.5%)	52/142 (36.6%)	+ve
4	Sibyala	2.55	2.4-2.7	34/78 (43.6%)	55/105 (52.4%)	89/183 (48.6%)	27/105 (25.7%)	-ve
5	Rayachoty (Rural)	1	1.0-1.2	15/76 (19.7%)	35/94 (37.2%)	50/170 (28.4%)	8/94 (8.5%)	-ve
6	Indukurupalli	2.2	1.9-2.5	37/92 (40.2%)	49/104 (47.1%)	86/196 (43.87%)	20/104 (19.2%)	-ve
Total				215/488 (44.05%)	363/659 (55.08%)	578/1147 (50.39%)	157/659 (23.8%)	

The results of this study are presented in Table 1, which shows that the village of Guntlammayapalli had the highest range of fluoride (4.0 to 4.2), while the village of Rayachoty had the lowest range (1.0 to 1.2). The village of Guntlammayapalli had the greatest incidence of dental fluorosis and fluorosis in people older than 14 years (69.4 percent), while the fluorosis rate in people older than 21 years was 74.6 percent. The lowest recorded instances of dental fluorosis were found in Raychoty among both the juvenile (19.7 percent) and adult populations (37.2 percent). Highest prevalence of skeletal fluorosis was identified in Veerapalli (39.2 percent), and Raychoty had the lowest prevalence (8.5 percent). Flourosis cases were confirmed by testing their urine samples for presence of fluoride. Fluorosis, a severe illness, has been discovered in the villages of Veerapalli, Guntapali, and Guntlammayapalli.

Table-2-Prevalence of Dental fluorosis in study population

Dental fluorosis	n% Children	n% Adults	Total
Present	215(44.05)	363(55.76)	578
Absent	273(55.94)	295(44.83)	568
Total	488	659	1147

According to Table:2, The prevalence of dental fluorosis among children was 215 (44.05 percent), whereas the prevalence among adults was 363. (55.76 percent).

Table 3-Prevalence of skeletal fluorosis in study population

Skeletal fluorosis	n% Children	n% Adults	Total
Present	0(0)	157(23.82)	157(23.82)
Absent	488(100)	502(76.17)	990(86.31)
Total	488 (42.54)	659(57.45)	1147(100)

Table 3 : Showed that skeletal fluorosis prevalence in only adults(23.82%). No children had skeletal fluorosis in present study.

Table 4 –Correlation of Dental fluorosis and Skeletal fluorosis

Deans Index (Dental fluorosis)	Skeletal fluorosis		Total(n%)	X2
	Present (n%)	Absent (n%)		
Normal	-	-	-	0.00*
Questionable	-	-	-	
Very mild	19(5.23)	16(4.40)	35	
Mild	57(15.7)	95(26.1)	152	
Moderate	53(14.6)	93(25.61)	146	
severe	18 (4.95)	12(3.33)	30	
Total	147(40.4)	216(59.5)	363	

*P-value statistically significant

Dental fluorosis and skeletal fluorosis were compared in Table 4, and the resulting P value was found to be 0.000, indicating that the comparison is statistically significant.

DISCUSSION

Fluoride is a cumulative poison that accumulates in mineralized tissues, particularly in the lattice of bone and tooth crystals. This makes fluoride particularly harmful to teeth and bones. The bones and teeth are known to be the organs that fluoride primarily affects, and the bones have a tendency to collect this element as people get older. Dental fluorosis and fluorosis of the skeleton are the two most prominent symptoms of the condition [3,5].The chronic fluoride-induced disorder known as dental fluorosis occurs when an excessive amount of fluoride is integrated into the developing tooth enamel, which causes enamel production to be disrupted and leads to dental fluorosis. The first evident harmful effect of F-exposure is dental fluorosis, which emerges as pitting of tooth enamel and yellow-cracked teeth in both adults and children. This condition is known as fluorosis [3,5].When it comes to investigating the effects of fluoride on human health, researchers have focused most of their attention on the teeth. In dental fluorosis, the hypo mineralization of the afflicted enamel has been linked to a few different potential causes. These mechanisms have been hypothesised as a result of significant research. According to one of them, this is not caused by the general effects of fluoride on the calcium metabolism or by the poisoning effects that suppress the fluoride's effect on the calcium metabolism. Instead, it is primarily due to the in situ toxic effects of fluoride on the ameloblasts during enamel formation [10,11,13]. Neither the general effects of fluoride on the calcium metabolism nor the poisoning effects cause this. It was hypothesised that an excessive amount of fluoride ions would change the rate at which enamel matrix proteins (amelogenin) would be enzymatically broken down, as well as the rate at which the subsequent breakdown products would be removed from the extracellular environment of maturing enamel. This would be the case if an excess of fluoride ions were present. Fluoride may potentially indirectly affect the function of protease by reducing the availability of free calcium ions in the mineralization environment. This can happen if fluoride is present in high enough concentrations [13]. The following steps are required in order to transform hydroxyapatite into flourohydroxy apatite.

$Ca10(PO4)(OH)2n + F^{-}+H = Ca10(PO4)6(OH)F$

This hypomineralized enamel appears opaque and lacklustre in comparison to normal enamel because its optical characteristics have been altered[14].A condition known as enamel hypoplasia has been used to describe severe fluorosis; however, enamel hypoplasia is not a consequence of fluorosis. Damage to the extremely hypomineralized, brittle and fragile enamel that occurs after the teeth erupt into the mouth is the cause of the pits, bands, and loss of sections of enamel that are visible in severe fluorosis. This damage can be seen on the teeth [13]. Fluoride's positive effects on dental caries are mostly due to the topical impact of fluoride once the teeth have emerged into the oral cavity. In contrast, harmful consequences are caused by systemic absorption during tooth development, which results in dental fluorosis (also known as fluorosis of the teeth).

Skeletal fluorosis is a metabolic bone disease that mostly affects bones and joints. Osteosclerosis is the most prominent clinical indication of skeletal fluorosis. It causes calcifications in the ligaments, in addition to variable degrees of osteopenia, osteoporosis, and osteomalacia. The incorporation of fluorine, a trace element, into bone mineral occurs naturally throughout the process of bone development. The formation of fluorapatite results from the replacement of the hydroxyl group in hydroxyapatite by fluoride. Osteoblasts are cells that are responsible for the formation of bone, whereas osteoclasts are cells that are responsible for the breakdown of bone. Bone mineral, bone cells, and the architecture of the bone can all be altered by fluoride's presence. At physiological levels, fluoride increases osteoblast activity, promotes the proliferation of osteoblasts, and results in increased bone mass. This is accomplished through the up-regulation of osteoblast markers such as alkaline phosphatase (ALP), bone morphogenetic protein (BMP), and bone gla protein (BGP)[6,8,13]. However, there is some evidence that fluoride can increase osteoblastic activity while also delaying the mineralization of new bone. On the other hand, osteoclasts are only responsible for bone resorption; they are produced from hematopoietic progenitors in the bone marrow and are found in the bone marrow. The mechanism that is related with the osteoclasts is complex; nonetheless, some studies have demonstrated that high concentrations of fluoride may either increase the production of osteoclasts or reduce the number of osteoclasts and diminish their ability to resorb bone. Others hypothesised that fluoride had a negligible impact on the total number of osteoclasts and had no impact whatsoever on the development of osteoclasts. Intake of excessive amounts of fluoride can, in fact, disrupt the processes of bone formation and resorption, which can result in diseases of bone turnover and skeletal fluorosis. Osteoblasts and osteoclasts work together to maintain a dynamic balance that controls bone turnover. An excessive amount of fluoride causes a disruption in this balance, which then has an effect on the differentiation of osteoblasts and osteoclasts, which ultimately leads to the formation of bone lesions. It's possible that this has something to do with particular signaling routes and mechanisms [15-17].

Present study Table 1: highest range of fluoride (4.0 to 4.2) was detected in Guntlammayapalli Village and lowest range (1.0 to 1.2) in Raychoty Village. Guntlammayapalli village has the greatest incidence of dental fluorosis (> 14 years) at 69.4 percent and above 21 years at 74.6 percent. Raychoty has the lowest dental fluorosis incidence in both children (19.7%) and adults (13.3%) (37.2 percent). skekeltal flurosis highest incidence in Veerapalli (39.2%) and lowest prevalence in Raychoty (8.5 percent). Fluorosis detected at Veerapalli, Guntapali, Guntlammayapalli Village.

Dental fluorosis affects adults at a rate of 55.08 percent (363/659), while skeletal fluorosis affects adults at a rate of 23.8 percent (157/659), according to NaduMaya Ramesh et al. There is a high prevalence of dental fluorosis and skeletal fluorosis in villages where the fluoride concentration in drinking water is between 3 and 4 parts per million (ppm)[20].In the present research, children were found to have dental fluorosis but not skeletal fluorosis.

In this study, 44.05 percent of the children had mild to severe dental fluorosis, but none of them had skeletal fluorosis. The current study found that 55.08 percent of individuals had dental fluorosis and 23.82 percent had skeletal fluorosis. Skeletal fluorosis was shown to be more common in our research participants who had higher grades of dental fluorosis[22].

According to the findings of our study, individuals over the age of 40 had a higher prevalence of skeletal fluorosis, while adults over the age of 50 had a slight decrease. This could be because the participants in our study over the age of 50 lived in areas with lower fluoride levels in their drinking water. Males, according to our findings, are more prone than females to feel bone soreness. The bulk of the studies

discovered that men had greater rates of skeletal fluorosis than women. In our study, a greater proportion of individuals reported back pain, knee pain, and trouble bending. In this study, 2.41 percent of patients had all three signs of skeletal fluorosis. For statistical purposes, the Chi-square test was used [22].
Maya et al noticed that skeletal fluorosis was more prevalent in participants with higher grades of dental fluorosis. This is similar to Abhay Nirgude's study, which found skeletal fluorosis in 24.9 percent of people and dental fluorosis in 30.6 percent. [23] When compared to other grades of dental fluorosis, the current study found a significant prevalence of skeletal fluorosis in mild to moderate dental fluorosis cases. A statistically significant relationship between F concentration and the occurrence of dental fluorosis was discovered in both children and adults. In India, dental fluorosis has previously been described in humans consuming 1.0 to 1.5 ppm F- in drinking water, with concentrations ranging from 3.4 to higher causing 100% dental fluorosis. However, in the current study, only 72.5 percent of people had dental fluorosis and 36.6 percent had skeletal fluorosis in Guntapalli, Badvel mandal, where the F concentration in the drinking water was 4-4.2 ppm.
The reason for this could be that the occurrence of fluorosis varies greatly between different locations with nearly identical F-concentrations in drinking water and can be influenced by a variety of factors including nutrition, climate, individual susceptibility and response, duration of Fluoride exposure, and dissolved salts in drinking water. Aside from these factors, the variance in F levels between villages with nearly identical F levels appears to be attributable to differences in fluoride consumption frequency. Another significant finding is that in a few households, drinking water purchased from private organisations contains permitted fluoride levels. The difference between dental fluorosis and skeletal fluorosis can be attributed to the fact that enamel fluorosis occurs only once in a lifetime, during amelogenesis, and thus hypomineralisation begins during development, with further continuous damage to the enamel caused by loss of hypomineralised enamel during chewing and mastication, whereas bone undergoes continuous remodeling throughout life.If no or little exposure to fluoride during osteogenesis causes bone injury, this could explain why dental fluorosis is more common than skeletal fluorosis. Because old bone can be replaced by new bone, this may explain why dental fluorosis is more common than skeletal fluorosis.

CONCLUSION

Extremely high fluoride levels may consequence in morbidity such as dental fluorosis and skeletal fluorosis. In our study once again found that skeletal fluorosis is noticed in dental fluorosis patient's compared to non dentalfluorotisc patients. After much deliberation, it has been determined that the Kadapa district requires a dependable fluoride management plan, and that fluoride be removed from drinking water. This is preliminary observation, more research is required to establish the prevalence of fluororsis.

CONFLICTS OF INTEREST: None
SOURCE OF FUNDING -self

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