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Assessment of Dental Fluorosis and Fluoride Endemic: A Cross-Sectional Study in Tirunelveli District, Tamil Nadu

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Abstract

Fluorosis is a public health concern brought on by prolonged exposure to fluoride with food, industrial pollution, and drinking water. Major health conditions such as skeletal fluorosis, non-skeletal fluorosis, and dental fluorosis are caused by it. Fluorosis is a dental enamel developmental disorder brought on by repeated exposure to high fluoride concentrations during tooth development, which results in enamel with a decreased mineral content and more porosity. It can be avoided by being aware of the sources of fluoride, understanding how to handle this situation, and avoiding excessive exposure. It's necessary to assess the sources that provide a danger for developing dental fluorosis before deciding on the various fluoride intake methods (DF). In this work, a cross-sectional, observational, and descriptive epidemiological study including 2500 people who live in villages in Tirunelveli district, Tamil Nadu, that are endemic for fluoride is presented. These villages include Pazhavoor, Avaraikulam, Yakopuram, and Chidambarapuram. In this study, water analysis and food analysis are carried out with the classifications like gender-wise and age groups. The district water authority department provided the content of fluoride present in the water of the selected study area, as well as the individuals were tested to see if they had dental fluorosis. To categorise the affected case to rate the severity "Dean's Index" was utilised in this study. The food analysis is carried out for various foods in the sample area and is categorized into the normal and Dental Fluorosis (DF) categories. From the various analysis of water and food, it can be concluded that Pazhavoor and Yakopuram area shows a higher concentration of fluorine of more than 1 mg/ L. According to the report, it is advised that the state authorities make substantial efforts to provide potable water that has low fluoride levels to the communities in Tamil Nadu's Tirunelveli district that have been recognized as having a fluoride endemic problem.

Keywords: *Dental Fluorosis (DF), Dean's Index, Water Analysis, Food Analysis, Fluoride Endemic*

1. Introduction

Fluorosis causes white or brown spots to appear on the teeth which results from excessive fluoride vulnerability at the time of the early years of life when permanent teeth are developing. These blemishes can range in size from minute white flecks that are hardly detectable to large, obvious dark brown patches (Al Warawreh et al., 2020; Verma et al., 2017). Fluorosis is only a cosmetic issue; it poses no health risks and some remedies can deal with the problem. People who received too much fluoride during their formative years, when the permanent teeth erupted, are at possibility of developing dental-fluorosis. Children within the age of eight are susceptible to fluorosis. When permanent teeth are still growing beneath their gums, children who habitually consume too much fluoride develop dental fluorosis. This involves ingesting toothpaste containing fluoride or consuming excessively fluoridated water (Whelton et al., 2019).

Dental Fluorosis harms both an individual's and the community's health in its advanced phases, which in turn harms the nation's growth, development, and economy. The effects of fluoride depend on the overall quantity of fluoride absorbed each period from all origins. The body absorbs between 70 and 90 percent of the fluoride that is consumed and distributes it throughout by way of the blood (James et al., 2021; Martinez-Mier, 2012). Fluoride is eliminated primarily through the urine in adults, while only approximately 60 percent of the total is retained in newborns, who retain 80–90 percent of the overall fluoride they have ingested. Over 99 percent of fluoride that is still in the body is stored in calcium-rich membranes including bone, teeth, and gums, where too much fluoride can lead to fluorosis. Fluoride is often most abundant in drinking water. The primary way that residents in communities without fluoridated water get exposed to fluoride is by swallowing toothpaste (Abouleish, 2016; Aggeborn & Öhman, 2021; Pretty et al., 2016). In addition to toothpaste, other sources of air pollution include phosphate fertilizers, fluoride-containing coal, and dental goods. Other foods with high fluoride content include fish protein concentrate, barley, potatoes, corn, rice, and yams. The Acceptable Maximum Input Limit is 0.10 mg/kg per day considering toddlers and babies for the age of 8, and 10 mg/day after that. Appropriate Input levels varied from 0.01 mg per day for children aged six months or younger to 4 mg per day on account of men aged 19 years and older (Zhou et al., 2018).

Although some foods naturally contain trace quantities of fluoride, toothpaste and fluoridated water are where most individuals get their fluoride. Fluoride is naturally present in steeped black tea and coffee because plants take up the mineral from the soil (Pandey, 2010; Guissouma et al., 2017). Fluoride may build up in the muscles and shells of shellfish. Regarding food fluoride content, it became evident that different populations have different rates of fluorosis (Gopalakrishnan et al., 2012). Fluoride consumption from potable water and dietary ingestion, particularly consumption of food cultivated within irrigated soil with fluoride effluent water, are potential causes of these variances. Comparatively less fluoride is ingested through food than through water (Petersen & Ogawa, 2016). However, in endemic areas, it cannot be disregarded because it would raise a load of fluoride in addition to water. Food fluoride consumption is influenced by the fluoride levels in the soil as well as irrigation water. As a result, despite not being the primary source of exposure, fluoride in drinking water considerably contributes to an individual's overall exposure to this element. Infant foods, milk formulae, and food products containing bottled waters, beverages, and chicken were shown to be significant sources of ingested fluoride among a variety of other sources (Arora et al., 2017; Russ et al., 2020). The major contribution of this research work is:

- The study focuses on dental fluorosis in villages in the Tirunelveli district, Tamil Nadu, India.
- It aims to assess the prevalence and severity of dental fluorosis and identify sources of fluoride exposure.
- The study includes 2500 individuals from endemic fluoride villages, namely Pazhavoor, Avaraikulam, Yakopuram, and Chidambarapuram.
- A cross-sectional, observational, and descriptive epidemiological study design is employed.
- Water analysis is conducted to determine fluoride levels, with data provided by the district water authority department.
- Individuals are tested for dental fluorosis using Dean's Index to categorize the severity.
- Food analysis is carried out to understand the contribution of dietary sources to fluoride intake.
- Pazhavoor and Yakopuram areas show higher concentrations of fluoride (>1 mg/L) in water.
- The study recommends providing potable water with lower fluoride levels to the affected communities.

- The findings contribute to addressing the fluoride endemic problem and informing public health interventions.

The rest of this paper is organized as: Section 2 discusses about the existing work has bene carried out regarding the subject. Section 3 portrays information about the materials and methods. Section 5 discusses about the acquired results. Section 5 concludes this research work.

2. Literature Review

In 2021, Jain et al. calculated the levels of fluoride content in samples that were used for drinking from the Raipur district in Chhattisgarh. Volumes of freshwater resources were acquired for this study. A qualitative cross-sectional analysis was conducted to ascertain levels of fluoride in the Raipur area from 50 distinct locations spread over 20 villages. "Ion-selective electrode" technology was utilised to calculate the amount of fluoride in potable water. Fluoride was present in trace amounts in all of the tested water samples, with mean concentrations shifting from 0.2 up to 1.22 mg/L and 0.411 to 0.180 mg/L, respectively. The level of fluoride in the groundwater was remarkably low and far below the ideal amount required to stop tooth decay.

In 2021, Otal et al. researched a portable open-source instrument for calculating fluoride levels in the water. In this study, an open-source Arduino system was built, optimized using image analysis, and data were collected utilizing a cellular phone's serial interface, which served through a power origin and decreased the number of batteries and production costs. An important agreement was found between the assessment and verification of freshwater resources from the Arusha region of northeastern Tanzania as well as the results of ion chromatography. The developed device demonstrated five-fold synthetic permanency, enabling this to be created locally, dispersed locally, and customized to the needs of the subsurface composition.

In 2021, Tian et al. explored smartphones as a simple instrument for measuring fluoride levels in underground water. In this study, self-calibration fluoride detection was rationally developed using a salinization process. The smartphone's functionality was combined with the requirement for in-field groundwater fluoride testing to identify the diagnosis restriction and, more importantly, the chroma of photos produced. The chromatic degree of the blue to yellow fluorescence colour shifts can be easily determined using a smartphone app for colour recognition. A study on actual water samples showed that this technology is efficient for the visible, on-site detection of groundwater fluoride and that it effectively represented the fluoride concentration by looking at the chroma value.

In 2016, Vellathurai et al. highlighted the level of Dental Fluorosis and its connection to the social and economic situation among middle - school pupils. In this study, a survey of children in grades 6 through 8 in Sivagiri taluk was undertaken. Regardless of the severity, gender, and location of the students, the dominance of teeth fluorosis was assessed through Dean's index. Of the 3632 kids that were examined, 969 (26.68%) exhibited dental fluorosis. Following the identification of water sources with fluoride levels that are higher than permitted levels, guidelines to reduce the exploitation of groundwater are produced.

In 2022, Tefera et al. suggested a link between calcium as well as fluoride consumption in school-aged youngsters in Halaba, Southern Ethiopia, who exhibit symptoms of skeletal and dental fluorosis. In this study, a dentist and a physiotherapist assessed skeletal fluorosis, and 135 qualified children between the ages of 6 and 13 were enrolled for a survey. Food items, potable, borehole water, and freshwater samples were collected for the fluorine concentration test.

In 2018, Viswanathan investigated the impact of tea and newborn formula on everyday fluoride intake as well as the predominance of fluorosis in early childhood. The effect of tea and infant formula intake on children's and newborns' daily fluoride intake in diverse worldwide areas is extensively covered in this study. This study also offered information on the various dietary fluoride exposure pathways, their implications on children's and infants' fluorosis risk, and some practical recommendations for lowering both fluoride consumption and that risk.

In 2021, Farmus et al. compared the Critical Periods for Fluoride Neurotoxicity in Children in Canada. 596 mother-child pairs from the parental toddler inquiry on ecological variables during pregnancy and birth were used in this study. Urinary fluoride in children between the ages of 1.9 and

4.4 was adjusted for measurement in urine samples collected from expectant mothers in the direction of specific gravity. Generalized equations for estimating are used to analyze the connections among fluoride dosages as well as IQ. Due to the several methods by which these exposures are measured, covariates are taken into consideration, and the results are given based on standardized exposures. The relationship among fluoride in potable water as well as performance IQ was shown to be influenced by the timing of exposure, according to the authors' findings.

In 2020, Till et al. examined the relationship between newborns' IQ and exposure to fluoride in a newborn formula. This study has analyzed the relationship between fluoride vulnerability and ascertained IQ levels. The authors examined how fluoridation of drinking water changed eating habits and whether exposure to fluoride during fetal development attenuated the current effects. The next pattern anticipated a link between young people's absorption of fluoride through milk powder and IQ.

In 2019, Harriehausen et al. focused on formula-based fluoride exposure in young children. To calculate the amount of fluorine consumed from the reconstituted formula, fluoride concentrations in infant formula from a variety of products and water types were assessed, along with patient body mass and daily volume intake. Chi-square tests, descriptive statistics, and one-way analysis were all applied. With properly fluoridated water, the chance of developing fluorosis rose for patients under the age of six months.

In 2019, Whelton et al. anticipated global regulations considering the usage of fluoride and the avoidance of tooth decay. This examination reveals a link between fluoride levels in the liquid, fluoride exposure, prevalence, severity, the occurrence of tooth fluorosis, and tooth decay. The use of fluoride-containing toothpaste, tablets, newborn formula, and water fluoridation have all been linked to an increased incidence of dental fluorosis. Regulations that have been put in place to limit excessive fluoride exposure while teeth were growing have decreased the occurrence of Dental Fluorosis without sacrificing the capacity to prevent caries. The advantages of using fluoride appropriately have been made known to member nations by the World Health Organization.

3. Materials And Methods

A population-based survey on Dental Fluorosis in the four areas viz. Avaraikulam, Chidamparapuram, Pazhavoor and Yakopuram of Tirunelveli District was done. Despite drinking water with a lot of fluorides over an extended time being the main cause of fluorosis, published research indicates that other factors, such as socioeconomic background, may also contribute. To better understand normal individuals and Dental Fluorosis (DF) situations, data about religion, community, and caste was gathered from 2500 people. The projected frequency of exposure was calculated in four distinct villages with variable fluoride levels in drinking water because there was no comparable earlier research available. Table 1 shows the religion, community, and caste-wise distribution of the sample population (n=2500 individuals).

3. Results and Discussion

Table 1: Religion, Community, and Caste wise distribution of the sample population (n=2500 individuals)

Name of the Study Area	Religion	Community	Caste	Normal Individuals	DF cases	Total
Avaraikulam	Christian	BC	Nadar	45 (3.4)	47 (3.56)	92
		SC	Pariyar	2 (0.17)	6 (0.45)	8
	Hindu	BC	Konar	11 (0.93)	11 (0.93)	22
			Nadar	362 (30.68)	440 (33.33)	802
			Thevar	4 (0.34)	5 (0.38)	9
		MBC	Paravar	2 (0.17)	9 (0.68)	11
		OC	Sivapillai	5 (0.42)	13 (1)	18
		SC	Adithiravidar	15 (1.27)	16 (1.21)	31
			Pariyar	9 (0.76)	22 (1.67)	31
			Sambavar	14 (1.19)	18 (1.36)	32
Chidambarapuram	Hindu	BC	Nadar	15 (1.27)	94 (7.12)	109
Pazhavoor	Christian	BC	Thevar	1 (0.09)	0	1

		SC	Adithiravidar	28 (2.38)	3 (0.23)	31
	Hindu	BC	Nadar	6 (0.52)	1 (0.08)	7
			Thevar	52 (4.41)	30 (2.27)	82
			Vannar	12 (1.02)	0	12
		MBC	Maravar	87 (7.37)	69 (5.23)	156
		OC	Sivapillai	47 (3.98)	22 (1.67)	69
			Vellalar	66 (5.59)	28 (2.12)	94
		SC	Adithiravidar	232 (19.66)	272 (20.68)	504
			Pariyar	77 (6.53)	84 (6.37)	161
Yakopuram	Christian	BC	Nadar	0	12 (0.91)	12
	Hindu	BC	Thevar	7 (0.59)	2 (0.15)	9
			Nadar	68 (5.76)	114 (8.64)	182
		MBC	Maravar	3 (0.25)	1 (0.08)	4
		OC	Vellalar	0	1 (0.08)	1
		SC	Pallar	6 (0.51)	4 (0.31)	10
TOTAL				**1176**	**1324**	**2500**

A sample population of 2500 individuals was collected from four districts. The population from Avaraikulam is 1056 individuals, Chidambarapuram is 109 individuals, Pazhavoor is 1117 individuals and Yakopuram is 218 individuals are sampled and analyzed further for Dental Fluorosis cases. The severity and the risks of DF vary according to the fluoride level in potable water. From the data collected, in Avaraikulam village out of 1056 individuals, 587 individuals were DF cases which are nearly half of the population sample in a particular area, and out of a total of 1056 samples 100 were Christians and 956 were Hindus from which 53 of Christians and 534 of Hindus are affected by fluorosis. In Chidambarapuram village, out of 109 samples collected from Hindus and 94 were DF cases which is about 86% of the sample population was affected by fluorosis. In the Pazhavoor district, a total of 1117 samples were collected and 509 were DF cases which are nearly half of the sampled individuals nearly 9 % were Christians and 46 % were Hindus. In the Yakopuram district total of 218 samples were collected 134 individuals were DF cases which is 61% are affected out of which 100% were Christians and 59 % were Hindus from the sample population in that area.

Dean's initial Fluorosis Index established six categories for Dental Fluorosis: "normal, questionable, very mild, mild, moderate, and severe". Dean established a linear association between this score and the quantity of fluoride in a potable water provision. Table 2 exhibits Dean's fluorosis index.

Table 2: Dean's fluorosis index

S. No	Classification	Criteria for categorizing dental fluorosis
1	Normal	The enamel is a typical transparent, semi-vitrified structure. The surface is shiny, flawless, and typically a light shade of creamy white.
2	Questionable	The enamel shows a few white particles to sporadic white spots that are modest deviations from the colour intensity of typical enamel. This classification is used when neither a normal classification nor a definitive identification of the least severe form of fluorosis is appropriate.
3	Very mild	Small, opaque, paper-white patches that don't cover more than about 25% of the tooth surface are dispersed unevenly across the tooth. Teeth with no more than 1 to 2 millimeters with white transparency at the top of the bicuspids or second molars cusps are commonly included in this category.
4	Mild	Although more extensive, the white opaque patches on the surface of the teeth do not cover greater than 50 percent of the total of the tooth.
5	Moderate	Total teeth's enamel surfaces are impacted, and attrition-prone regions exhibit noticeable wear. Brown stains are typically an ugly characteristic.
6	Severe	Contains teeth that were previously categorized as "moderately severe" as well as "severe." Total enamel regions are impacted, and the hypoplasia is so obvious that

	it may change the tooth's overall shape. Extensive brown discoloration and corroded-looking teeth are common.

In this study, the distribution of population gender-wise for the selected sample population in those four villages in Tirunelveli district. Table 3 shows the distribution of the population on the classification of “Dean’s index”.

Table 3: Distribution of population on the classification of Dean’s index

Dean's Index	**Gender**		**Total**
	Male	**Female**	
Normal	604 (51.19 %)	576 (48.81 %)	1180 (47.2 %)
Questionable	141 (42.99 %)	187 (57.01 %)	328 (13.12 %)
Very mild	236 (55.27 %)	191 (44.73 %)	427 (17.08 %)
Mild	125 (55.31 %)	101 (44.69 %)	226 (9.04 %)
Moderate	138 (52.67 %)	124 (47.83 %)	262 (10.48 %)
Severe	29 (37.66 %)	48 (62.34 %)	77 (3.08 %)
Total	**1273**	**1227**	**2500**

From the above table, it can be noted that out of the 2500 sample population of male and female 1180 samples were not diagnosed with fluorosis and is categorized under “Normal” in the Deans index. Hence it is noted 1320 samples of the population are with fluorosis and are categorized according to Dean’s index. It is noted that 328 sample population falls under questionable dean’s index criteria out of which 141 samples were men and 187 were found to be women. In Very mild Dean’s index, 427 sample population are diagnosed out of which 236 were male and 191 were female. The total number of mild cases of DF positive in the dean’s index is 226 which is 9.04% of the total population with the male and female cases reported being 125 (55.31%) and 101 (44.69%). Among the 262 DF cases of the moderate category in the dean’s index, the male cases were 138 (52.67%) and the female cases were 124 (47.83%). The severe section in the dean’s index is about 3.08% DF cases with the gender male and female DF cases separated reported as 29 (37.66%) and 48 (62.34%) respectively. This study reveals the total number of subjects with the classification by Dean’s index by age among children and other age-group as well as by gender. Table 4 shows the prevalence of Dental Fluorosis in the sample population by dean’s index with the classification by age.

Table 4: Prevalence of Dental Fluorosis in the sample population by dean’s index with the classification by age

Age Group (years)	**Examined**		**Dean's Index**												**DF prevalence**	
			Normal		**Questionable**		**Very mild**		**Mild**		**Moderate**		**Severe**			
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**Total**	**(%)**
11-20	598	588	229	237	91	122	139	97	63	49	62	58	14	25	720	60.7
21-30	115	150	56	80	13	15	25	22	8	12	11	16	2	5	129	48.7
31-40	172	193	102	105	14	18	17	22	15	21	16	17	8	10	158	43.3
41-50	295	236	152	116	21	28	47	45	34	14	36	26	5	7	263	49.5
51-60	78	48	54	30	2	4	6	4	5	4	11	5	0	1	42	33.3
60 plus	15	12	11	8	0	0	2	1	0	1	2	2	0	0	8	29.6
Total	**1273**	**1227**	**604**	**576**	**141**	**187**	**191**	**125**	**101**	**138**	**124**	**29**	**48**	**1320**	**52.8**	**52.8**

(M- Male, F- Female)

The study population of 2500 individuals are examined and found that 1320 people are affected and the remaining individuals are identified as normal subjects. The intensity of Fluorosis is classified by the Dean’s index as follows factors “severe, moderate, mild, very mild, questionable, and normally” based on the seriousness of the disease. Of the 2500 individuals, the examined male and female individuals are 1273 (50.92%) and 1227 (49.08%) respectively. Out of the male and female individuals, the diseased individuals of the male are 669 and the disease prevalence is 52.55% and the rest of the individuals 604 (47.75%) are normal. Also, the diseased female individuals are about 651 with a disease prevalence is 53.05% and the rest are considered normal individuals of 576 (46.94%). The sample population is further classified into six different groups depending on the individual’s age. Out of 2500 individuals, 1186 are found under the age groups of 11-20 years as they occur 47.44% of the total sample population. 265 individuals are found under the 21-30 years age group as they are

10.6% of the sample population. The age groups of 31-40 years are 365 individuals with 14.6% of the population and the 41-50 years age group people are about 531 individuals with 21.24% of the whole survey population. Within age groups of 51-60 years are 126 individuals and 60 plus individuals are 27 people with their percentages of the total sample population are 5.04% and 1.08% respectively.

Similarly, 1320 individuals are found diseased and 1180 individuals are found normal in the survey report. The individuals with diseased under the age groups of 11-20, 21-30, 31-40, 41-50, 51-60, and 60 plus are 720, 127, 152, 267, 46, and 8 with their disease prevalence of 60.71%, 47.93%, 41.64%, 50.28%, 36.51%, and 29.63% respectively. The balance of individuals in each age group of 11-20, 21-30, 31-40, 41-50, 51-60, and 60 plus are considered normal individuals and they are 466 (39.49%), 138 (11.7%), 213 (18.05%), 264 (22.37%), 80 (6.78%) and 19 (1.61%) respectively. There are 578 individuals of children age groups with 23.12% of the total survey population and 1922 individuals of 15-60 plus age groups with 76.88% of the total sample population. Based on their age groups, the survey population is categorized into six groups 10- 20, 20- 30, 31- 40, 41- 50, 51- 60, and 60- plus years age groups. There are 1186 individuals 47.44% of the total study population under the 10-20 age groups are examined and found that 466 individuals are obtained to be normal individuals and 720 individuals are diseased and are classified in the dean's index. The classifications following the Dean's index of the "questionable, very mild, mild, moderate, and severe" Dental Fluorosis diseases are seen at 213, 236, 112, 120, and 39 individuals respectively in the 10-20 years age groups. In the 20-30 years age groups, the total survey population of 265 individuals with 10.6% of the total study population are examined and 138 individuals are found to be normal with 11.7% of the total normal individuals. The total number of Dental Fluorosis cases are 127 individuals and under the classification of dean's index of 28, 47, 20, 27, and 5 people for the severity of the disease "questionable, very mild, mild, moderate, and severe" category respectively for the age groups of 20-30 years age groups.

For the diseased individuals in various age groups, the questionable category obtains 64.94%, 8.54%, 9.76%, 14.94%, 1.83%, and no patients for the age groups of 11-20, 21-30, 31-40, 41-50, 51-60, 60 plus respectively. Same like, the very mild and mild category is obtained by the age groups of 11-20, 21-30, 31-40, 41-50, and 51-60 55.27% and 49.56%, 11.01%, and 8.85%, 9.13% and 15.93%, 21.55% and 21.24%, 2.34%, and 3.98% and finally for the 60 plus individuals, the very mild and mild classification on dean's index is 0.7% and 0.44% respectively. Likewise, for the moderate and severe classifications, the obtained percentages of 45.8% and 50.65% under 11-20 years age groups, 10.31% and 6.49% for the 21-30 years age groups, 12.6% and 15.58% for 31-40 years age groups, 23.66% and 20.75% for 41-50 years age groups, the percentage of 6.11% and 6.49% for the age group of 51-60 years and finally the moderate and severe disease for 60 plus age groups are 1.53% and 0% respectively.

A total male of 1273 individuals are examined and they are separately shown as per the age category 604 males are found to be normal and 669 males are diseased with dental fluorosis. Under the age category of 11-20 years age group, 598 (46.98%) individuals of the total male population are examined and 229 (37.91%) individuals of the normal male population are obtained to be fit and 369 are diseased with dental fluorosis. Under the classification, the severe, moderate, mild, very mild, and questionable are 14, 62, 63, 139, and 91 male individuals affected. For the age group of 21-30 years, a total of 115 males are tested and the result shows that 56 (9.27%) males are normal and 59 (8.82%) males are diseased. Under the category of the disease of "questionable, very mild, mild, moderate, and severe" classification, male individuals of 13, 25, 8, 11, and 2 are affected under the 21-30 age groups. Further, in the 31-40 age groups, 172 male individuals are there with 102 normal and 70 males diseased and the male individuals 14, 17, 15, 16, and 8 are diseased in the classification order of "questionable, very mild, mild, moderate, and severe" respectively. The number of males under the age group of 41-50 years was 295 individuals with 152 (25.16%) males being normal and 143 (21.38%) males being diseased. In their classification of diseases in males, the questionable, very mild, mild, moderate, and severe are the categories with 21, 47, 34, 36, and 5 males affected under this age group. The total number of males under the 51-60 years age group is 78 individuals with 54 being normal and 24 individuals diseased in this disease category 2, 6, 5, and 11 males are affected in questionable, very mild, mild, and moderate disease classification of dean's index. There are 15 people with 60-plus males and obtained 11 individuals are normal and 4 are affected with 2 males in the classification of very mild category and other 2 males in the moderate category of dental fluorosis. Also, the disease prevalence rate is given in the table for the age group of 11-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years, and 60 Plus are 61.81%, 51.3%, 40.7%, 48.48%, 30.77%, and 26.67% respectively.

From the age group of 11-20 years, the total number of females present is 588 individuals with 237 being found normal and 351 females being obtained to be diseased and the DF disease classified. The classification of Dental Fluorosis disease is questionable, very mild, mild, moderate, and severe with the number of females affected under these classifications being 122, 97, 49, 58, and 25 females respectively. The normal females under 21-30 years of age group are 80 and the diseased female under this age group is 70 individuals. The number of females about 15, 22, 12, 16, and 5 are affected by disease and classified as “questionable, very mild, mild, moderate, and severe” respectively. For the 31-40 age group, the total number of 193 females comes under this age group with 105 females being normal and 88 females being DF cases and by the above-given classifications, the female individuals of 22, 21, 17, 10, and 88 are affected. In the female population of 236 individuals in the age group of 41-50 years, 116 females tend to be normal and 120 individuals of the female are found to be DF cases and they are classified by the dean’s index as “questionable, very mild, mild, moderate and severe” for all the DF cases. For the DF cases female individuals of 28, 45, 14, 26, and 7 are affected and given as per the classification of the dean’s index. From the age group of 51-60 years, the total number of females is 48 individuals with a normal female being 30 and diseased females 18 individuals particularly 4, 4, 4, 5, and 1 individual female affected and classified by the above-given categories. Of the 60-plus females, 12 individuals are examined and 8 are normal with 4 being diseased and categorized with 1 individual as very mild, 1 individual at mild, and 2 individual females in the moderate classification of Dental Fluorosis disease. From the table, it is given that the disease prevalence of 59.69%, 46.67%, 45.6%, 50.85%, 37.5%, and 33.33% for the age group of 11-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years and 60 plus respectively.

Water Analysis and Fluorosis

The chemical characteristics of water help assess various minerals in the water. These chemical characteristics of water quality assist identify whether or not the water is polluted. The amount of chloride in the purified water that will be distributed to the general public should not be higher than 250 ppm. By quantifying potable drinking water with a standard - silver nitrate solution and utilizing potassium chromate as an indicator, it is possible to determine how much chloride is present in the water. Nitrates are not toxic in water. However, excessive nitrate levels in water can harm newborns health by contributing to methemoglobinemia, also known as "blue baby illness." Nitrate levels in home water sources are restricted to 45 mg per liter and Iron to 0.3 mg per liter which in excessive amounts will discolour clothing. Excess of these affects the human being’s lungs as well as other respiratory organs. the permissible amount of Manganese is 0.05 mg per liter, Copper is 1.3 mg per liter, Sulphate is 250 mg per liter and Fluoride is 1.5 mg per liter. Dental cavities are brought on by fluoride concentrations of less than 0.8 to 1.0 mg/L. Fluoride concentrations of more than 1.5 mg per liter might cause tooth discoloration and staining which results in a disease called fluorosis. Industrial effluent, sewage, and agricultural waste all provide phosphorus to water sources. Despite not being dangerous to humans, phosphate is a crucial element in natural water systems like ponds because eutrophication is made easier by its higher absorption. In this study, the chemical parameters of water like “Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Iron (Fe), Manganese (Mn), Ammonia (NH_3), Nitrogen dioxide (NO_2), Nitrate (NO_3), Chlorine (Cl), Sulphate ion (SO_4) and Phosphate ion (PO_4)” are analyzed. Table 4 shows the chemical properties of water samples from four dams in the Tirunelveli district. Table 5 shows the chemical parameters of water samples from dams of the Tirunelveli district.

Table 5: Chemical parameters of water samples from dams of Tirunelveli district

Name of the site	Ca	Mg	Na	K	Fe	Mn	NH_3	NO_2	NO_3	Cl	SO_4	PO_4	P.NP
Manimuthar	3	1	3	0	0.62	0	0.42	0.71	1	3	0	0.53	P
Papanasam	6	1	4	0	0.62	0	0.49	0.04	1	11	1	0.62	P
Adavinainar	4	1	3	0	0.7	0	0.41	0.3	1	3	1	0.52	P
Gadananthi	3	1	2	0	1	0	0.49	0.2	1	4	0	0.51	P

The values in the above table are the mean values of three replicates in mg/L. Water used for consumption also referred to as potable drinking water, is acquired above and below ground sources and processed to satisfy national and state standards. Non-potable water is not suitable for human being ingestion but can still be utilized for a variety of other purposes. In this study, samples of potable water from an open well bore well and tap water in the above-mentioned four-study areas are analysed for the chemical parameters of water. Table 6 shows the chemical parameters of water samples from the study area (Avaraikulam, Chidambarapuram, Pazhavoor, and Yakopuram).

Table 6: Chemical parameters of water sample from the study area

Name of the site	Types of water sources	Ca	Mg	Na	K	Fe	Mn	NH_3	NO_2	NO_3	Cl	SO_4	PO_4	P.NP
Pazhavoor	Open well	25	8	35	2	1	0	0.21	0.04	8	15	12	0	P
	Bore well	68	9	76	1	0.69	0	0	0	7	110	15	0.02	NP
	Tap	33	6	23	2	0.06	0	0.42	0.02	3	13	4	0	P
Avaraikulam	Open well	41	14	98	23	0.07	0	0	0.03	15	108	35	0	NP
	Bore well	36	8	68	16	0.27	0	0.3	0.03	14	94	26	0	P
	Tap	42	3	27	13	0.75	0	0	0.02	9	36	29	0	P
Yakopuram	Open well	39	4	65	7	1.52	0	0.09	0.09	13	53	45	0.04	NP
	Bore well	45	5	43	9	0.42	0	0.07	0.02	14	45	33	0.2	P
	Tap	43	1	33	12	1	0	0.08	0.02	10	40	28	0	P
Chidambarapuram	Open well	28	14	92	26	1.75	0	0.29	0.13	7	108	36	0.12	P
	Bore well	15	6	27	9	0.48	0	1.31	0.79	2	39	27	0.15	NP
	Tap	22	7	53	7	0.59	0	0	0	5	46	29	0.02	P

(All values in mg/L)

The above table shows the mean values of three replicates in mg/L. It is found from Table 4 and Table 5, that compared to tap, open well, and bore well waters, dam water has lower levels of the required chemical parameters. Pazhavoor borewell, Avaraikulam open well, Yakopuram open well, and Chidambarapuram borewell all were confirmed to have non-potable water following 16 different types of water samples were examined. The Pazhavoor borewell water has the highest calcium level of any other water sample at 68 mg/L. Except the Pazhavoor borewell, all other water sources have calcium contents that are less than 50 mg/L. The magnesium level is also higher, at 14 mg/L, in the open wells of Avaraikulam and Chidambarapuram. The water in four dams, Manimuthar, Papanasam, Adavinainar, and Gadananthi, has a magnesium level of just 1 mg/L compared to the other sources, which have less than 10 mg per liter.

In general, the quantity of potassium, as well as sodium in potable water, should be lower. In the open wells of Avaraikulam and Chidambarapuram, the sodium content is found towards higher than 90 mg per liter at roughly 98 mg/liter and 92 mg /liter, respectively. Additionally, the other water sources have sodium contents that are less than 70 mg/L, but the Pazhavoor borewell water has a sodium content of 76 mg/L. Manimuthar, Papanasam, and other dams provide water for these sources. The sodium concentration of Adavinainar and Gadananthi is less than 5 mg/L. Similar to how Chidambarapuram open well water has a higher potassium content than Avaraikulam open well water, which has a potassium content of 23 mg/L. Additionally, it was discovered that the dam waters have no potassium at all.

The iron concentration in the potable water was determined as 1 mg/L in the Gadananthi dam, the Pazhavoor open well, and the Yakopuram tap water. The iron concentration of the other water sources ranges upon less than 1 mg/L to less than 0.1 mg/L in the tap water from Pazhavoor and the open well water from Avaraikulam. In any of the 16 water source samples, the manganese content is absent. The Chidambarapuram borewell water has an ammonia value of 1.31 mg/L, which is higher than that of the other water samples, which had an ammonia content of less than 1 mg/L. The ammonia concentration in the water samples from the Yakopuram borewell, open well, and tap water is less than 0.1 mg/L. Additionally, none of the water samples from the Pazhavoor borewell, Avaraikulam open well, tap water, or Chidambarapuram tap water contained any ammonia. Except for the Pazhavoor borewell and the tap water in Chidambarapuram, every water sample has nitrogen dioxide in it. Water from the Manimuthar Dam and the Chidambarapuram Borewell had the highest concentrations of nitrogen dioxide, with 0.79 mg/L and 0.71 mg/L, respectively. The other water samples have a consolidation of less than 0.1 mg/L, except for the Adavinainar dam water, Gadananthi, and the open well at Chidambarapuram. All other water samples have nitrate concentrations that are less than 15 mg/L, which is more prevalent in the open well water from Avaraikulam.

The lowest quantity of content, which was likely present in the dam waters of Manimuthar, Papanasam, Adavinainar, and Gadananthi, was determined to be 2 mg/L in the Chidambarapuram borewell water samples. The Pazhavoor borewell water samples have a higher chlorine content, at roughly 110 mg/L. Avaraikulam and Chidambarapuram open well water samples have chlorine contents of 108 mg/L, which are obtained after Pazhavoor borewell water tests. The lowest chlorine concentrations were found in the dam waters of Gadananthi, Manimuthar, and Adavinainar, which were 4 mg/L, 3 mg/L, and 3 mg/L, respectively. About 45 mg/L of sulfhate ions were discovered in the water samples from the Yakopuram open well. The amount of sulphate ions in the water samples is smaller than this value, with Papanasam and Adavinainar having a 1 mg/L concentration each, while it is absent from Manimuthar dam and Gadananthi dam, respectively. The samples of dam water have a higher concentration of phosphate ions. The phosphate ions are 0.53 mg/L, 0.62 mg/L, 0.52 mg/L, and 0.51 mg/L in the dam waters of Manimuthar, Papanasam, and Gadananthi, respectively. Table 7 presents the amount of fluoride in the potable water sources and the prevalence of Dental Fluorosis by Dean's index in the sample area

Table 7: Amount of fluoride in the drinking water sources and the prevalence of Dental Fluorosis by Dean's index in the sample area

Name of the Village	Amount of fluoride in drinking water sources (mg/L)	Population		Dean's index					
		Total	DF cases	Normal	Questionable	Very mild	Mild	Moderate	Severe
Pazhavoor	1.92	1117	510	607	131	147	98	91	43
Avaraikulam	0.73	1056	582	474	161	208	93	105	15
Yakopuram	1.62	218	134	84	21	28	23	50	12
Chidambarapuram	0.82	109	94	15	15	44	12	16	7

A total people of 1117 individuals are in Pazhavoor with 607 normal individuals and 510 affected cases. The correlation value is obtained be -0.589 between the fluoride content and disease prevalence. The affected cases are categorized by Dean's index. Out of 510 affected cases in Pazhavoor, 131 (11.73%) are questionable, 147 (13.16%) are very mild, 98 (8.77%) are mild, 91 (8.15%) are moderate and 43 (3.85%) are severe the total population across particular study area. The fluoride content in drinking water sources is 1.92 mg/L are found. In the study area Avaraikulam, the total population of 1056 individuals there with 474 being normal and 582 being DF cases. The amount of fluoride found in potable water in Avaraikulam is 0.73 mg/L. The affected people are categorized by the dean's index and the number of individuals affected according to the above-given category is 161 (15.25%), 208 (19.7%), 93 (8.8%), 105 (9.95%), and 15 (1.42%) respectively. In the Yakopuram, the total number of individuals examined is 218 with 84 normal cases and 134 DF cases. In the DF cases, the number of people categorized in the order of dean's index is 21 (9.64%), 28 (12.84%), 23 (10.55%), 50 (22.94%), and 12 (5.5%) under each classification. In the drinking water of Yakopuram, about 1.62 mg/L of the amount of fluoride is found in the drinking water. In the area of Chidambarapuram, the fluoride content present in drinking water is 0.82 mg/L and it is found that the least number of populations is obtained in this study area. The normal cases are around 15 and the Dental Fluorosis cases are found to be 94 individuals. The DF cases are categorized as "questionable, very mild, mild, moderate, and severe" by the dean's index and the obtained individuals are 15 (13.76%), 44 (40.37%), 12 (11), 16 (14.68%), and 7 (6.43%) respectively.

Food Analysis and Fluorosis

Food analysis is the field that deals with the creation, use, and research of analytical techniques for describing the characteristics of foods and their contents. The information on a wide range of distinct dietary qualities, such as their composition, structure, physicochemical properties, and sensory attributes, is provided by these analytical processes. The ability to economically manufacture consistently safe, nourishing, and enticing foods as well as enable customers to make educated dietary decisions depend on our ability to rationally grasp the components that impact the qualities of foods. Chemicals in food are no different, and since humans consume food, it is important to understand what ingredients are used, whether they are chemical additives, nutrients, or other substances. Therefore, foods are examined to determine what ingredients are present in the food product that is distributed to the general public to verify that they are safe for human consumption. Although some foods naturally contain trace quantities of fluoride, kinds of toothpaste and fluoridated water are where most individuals get their fluoride. Fluoride is naturally present in brewed black tea and coffee because plants take up the mineral from the soil. Fluoride may build up in the muscles and shells of shellfish.

Mineral fluoride can be found as a nutritional supplement and naturally in a variety of foods. Fluoride, which is the symbolic form of fluorine, prevents or stops dental caries (tooth decay) in its tracks and promotes the growth of new bone. Fluoridated water, meals and drinks made with it, toothpaste, and other dental products that contain fluoride make up the majority of the fluoride that humans ingest. Fluoride taken orally is absorbed in the gastrointestinal tract at a rate of 80% or greater. Roughly 50% of the fluoride that is ingested by adults is retained, while bones and teeth hold about 99% of the fluoride that the body absorbs. Urine is used to eliminating the remaining 50%. Because bones and teeth absorb more fluoride in young children than in adults, up to 80% of the fluoride that is absorbed is maintained. Although fluoride concentrations can be determined in plasma, nails, saliva, urine, teeth, bones, and hair determining an individual's fluoride status is not a common practice. There are no accepted standards for what constitutes sufficient, low, or high concentration of fluoride in the body.

In the region of the sample that was chosen, fish has long been a staple cuisine. While it has been demonstrated that tiny levels of fluoride in meals can help reduce the risk of infection, high fluoride ingestion for a prolonged interval of time can lead to macular teeth. The state's culture is another factor in the growing intake of fish, at least thrice a week. Being in a fluoridated region, the accessibility of fluoride through fish consumption has led to the question of whether consuming fluoride through fish has any effect on dental fluorosis. Table 8 shows the amount of fluoride in marine fishes.

Table 8: Amount of fluoride in marine fishes

Name of the fish	Mean values (mg/ kg)
Vilameen (Lethrinus sp.)	18.2 ± 0
Sardine (Sardinella sp.)	14.5 ± 0
Murrel (Stolephorus sp.)	13.7 ± 0
Nethili (Sciaena sp.)	13.2 ± 0
Katta (Urogymnus sp.)	11.4 ± 0

The bulk of fluorosis cases still come from drinking water use, which is a well-known fact. Fluorosis, however, can also be caused by consuming fish with high fluoride levels over time. From the above table, the amount of fluoride present in locally available marine fishes is shown. A maximum amount of 18.2 mg/ kg fluoride is detected in Vilameen (Lethrinus sp.), followed by 14.5 mg/ kg fluoride in Sardine (Sardinella sp.), 13.7 mg/kg in Murrel (Stolephorus sp.), 13.2 mg/kg in Nethili (Sciaena sp.) and 11.4 mg/kg fluoride is noted in Katta (Urogymnus sp.).

More fluoride was accumulated in leafy vegetables than in root or fruit vegetables, including fenugreek, spinach, cabbage, and coriander. Samples of vegetables were randomly selected from the study area's four districts, and their effects on fluoride toxicity were assessed. Due to the research area's minimal rainfall, fluoridated groundwater was used to irrigate vegetables. Fresh vegetable samples were gathered from agricultural fields, placed right away in paper or plastic bags, sealed, and taken to the lab for examination. Table 9 shows the amount of fluoride in leafy vegetables.

Table 9: Amount of fluoride in leafy vegetables

Name of the vegetable	Mean values (mg/ kg)

Mint	3.8 ± 0
Cabbage	2.2 ± 0
Coriander	3.7 ± 0
Ponnankanni (Alternanthera Sessilis)	5.6 ± 0
Murungaikerai (Moringa oleifera)	2.4 ± 0

The above table indicates the amount of fluoride found in some locally available leafy vegetables and the values are the average of 3 replicates of the same sample. It is evident from the table that, ponnankanni is having the highest amount of fluoride, i.e 5.6 mg/ kg than the other leafy vegetables such as mint, coriander, murungaikerai, and cabbage the values are 3.8 mg/ kg, 3.7 mg/ kg, 2.4 mg/ kg and 2.2 mg/ kg respectively. The types of fruit that contain fluoride are tremendously varied and seemingly endless. Strawberries, Apples, cherries, bananas, watermelon, and peaches are all on the list. Table 10 shows the amount of fluoride in some fruits.

Table 10: Amount of fluoride in fruits

Name of the fruit	Mean values (mg/ kg)
Sweet lime	2.8 ± 0
Guava	2.2 ± 0
Mango	1.9 ± 0
Papaya	1.6 ± 0
Grapes	2.4 ± 0

The above table shows the locally available fruits consumed by the population in the sample area. It is seen that all the selected fruits are mostly in the same amount of fluoride content. The sweet lime shows the highest value of 2.8 mg/kg, followed by grapes at 2.4 mg /kg, guava at 2.2 mg /kg, Mango at 1.9 mg /kg, and papaya at 1.6 mg/kg fluoride content. Table 11 shows the amount of fluoride content in banana varieties.

Table 11: Amount of fluoride in banana varieties

Name of the banana	Mean values (mg/ kg)
Yethan (Musa Acuminata)	2.0 ± 0
Peyan (Musa balbisiana)	2.9 ± 0
Palayankottaiyan (Musa Paradisiaca)	2.4 ± 0
Morris (Musa Acuminata)	2.1 ± 0
Rasakathali (Musa Sapientum)	2.4 ± 0

The above table shows the values are average of 3 replicates of the same samples. From the table, it can be seen that peyan variety of banana has the highest level of fluoride at 2.9 mg/ kg followed by palayankottaiyan and rasakathali at 2.4 mg/ kg fluoride content, followed by morris and yethan at 2.1 mg/ kg and 2.0 mg/ kg fluoride content.

Dental caries is less common when people consume the recommended amount of fluoride daily, but dental fluorosis is becoming more common as a result. Similar to other nations, India has seen a growth in the use of carbonated drinks and packed juices. The fluoride content of carbonated drinks and packed juices may vary greatly between brands, which may have an impact on people's oral health, particularly infants and young children. Table 12 shows the amount of fluoride in packed fruit juice.

Table 12: Amount of fluoride in packed fruit juices

Name of the fruit juice	Mean values (mg/ kg)
Brand -A	0.5 ± 0
Brand -B	1.4 ± 0
Brand -C	3.0 ± 0
Brand -D	2.8 ± 0
Brand -E	3.2 ± 0

From the above table comparing the five packed fruit juices, Brand -E has 3.2 mg/ kg of fluoride content, Brand -C has 3 mg /kg of fluoride content, Brand -D has 2.8 mg /kg of fluoride content, Brand -B has 1.4 mg /kg of fluoride, Brand -A has 0.5 mg /kg of fluoride. In this study, carbonated soft drinks like Brand -F, Brand -G, Brand -H, Brand -I, and Brand -J are taken for sample. Table 13 shows the amount of fluoride in carbonated soft drinks.

Table 13: Amount of fluoride in carbonated soft drinks

Name of the soft drink	Mean values (mg/ kg)
Brand -F	1.1 ± 0
Brand -G	3.3 ± 0
Brand -H	1.2 ± 0
Brand -I	2.1 ± 0
Brand -J	1.8 ± 0

From the above table, Brand -G has the highest amount of fluoride with 3.3 mg/ kg, followed by Brand -I, Brand -J, Brand -H, and Brand F with 2.1 mg/ kg, 1.8 mg/ kg, 1.2 mg/ kg, and 1.1 mg/ kg respectively. In this study, the samples of coconut water from different varieties of coconut in the sampled four villages are gathered and analysed for the fluoride content in it. Table 14 shows the amount of fluoride content in coconut water.

Table 14: Amount of fluoride in tender and mature coconut water

Name of the variety	Mean values (mg/ kg)
Hybrid Variety	
Tender green	1.56 ± 0.05
Tender orange	1.28 ± 0.03
Tender yellow	1.38 ± 0.1
Country Variety	
Mature green	1.89 ± 0.02
Tender green	1.76 ± 0.03
Mature greenish yellow	1.27 ± 0.02
Tender greenish yellow	1.96 ± 0.01

The above table shows the amount of fluoride in different varieties of tender and mature coconut water in the sample study areas. The amount of fluoride estimated in the tender coconut hybrid varieties like green, orange, and yellow are 1.56 mg/ kg, 1.28 mg/ kg, and 1.38 mg/ kg respectively. Likewise, the amount of fluoride measured in the country's coconut verities is 1.89 mg/ kg in mature green, 1.76 mg /kg in tender green, 1.27 mg/ kg in mature greenish yellow, and 1.96 mg/ kg in tender greenish yellow coconut water.

Fluoride is an essential oligo- element, beneficial for the development of bone and teeth (McDonagh et al., 2000). The fluoride recommended value for water quality, according to the World Health Organization and the "Indian Council of Medical Research", is 1.5 mg/l. The main cause of fluorosis in various regions of the world is excessive fluoride intake through drinking water compared to the ideal safe limit (Boulétreau et al., 2006).

Fluoride levels in drinking water rise along with the rate and severity of fluoridation in Tirunelveli District. The primary source of drinking water in these chosen study sites is groundwater. Fluoride levels in ground water that are abnormal are frequent in hard rock zones containing pegmatite veins (Ramesam & Rajagopalan, 1985). High fluoride concentration in drinking water sources may be caused by the fluoride ion from such minerals which leached into the groundwater (Schultheiss & Godley, 1995). According to the findings, dental fluorosis affects both village residents between school children in the age group of 11- 20 years and the ages of 25 and 70. Boys are more likely than girls to have fluorosis in school, hence men are more likely than women to have fluorosis in locations where fluoride is prevalent (Mann et al., 1990). Although it has not been demonstrated that fluorosis is sex-dependent, dietary practices, breastfeeding, and environmental factors have a significant impact on the occurrence and seriousness of fluorosis. In terms of the research area, Tirunelveli district has warmer weather than the nearby districts. People who live in warm climates typically use more drinking water. In addition, men and boys drink more water. In addition, boys, as well as men in the research region, drink more water daily than girls as well as women, which increases their intake of fluoride.

The prevalence of fluorosis due to the consumption of more fluoride through drinking water among children may also adversely affect the foetal cerebral function and neurotransmitters (Li et al., 1994). The current study shows that Pazhavoor and Yakopuram, two isolated villages in the Tirunelveli district, are indeed the high fluoride endemic locations. These communities have drinking water fluoride levels as high as 1.92 mg/l and 1.62 mg/l, respectively. Government agencies can provide water with the ideal fluoride level, put in defluoridation plants, and run awareness-raising campaigns by identifying and predicting the precise location of villages that are fluoride endemic by charting of fluoride endemic areas. Table 7 shows an illustration of fluoride-endemic regions together with details on the fluoride concentration in the Tirunelveli district. Fluoride exposure for adolescence in the Tirunelveli District is higher than adults.

Drinking water contains approximately 100% bioavailable soluble fluoride, it is a significant route for fluoride exposure (Jackson et al., 2002). Infants frequently drink milk and formula with a powder basis in addition to water, although milk is known to slow down the efficiency of fluoride absorption. Due to the high calcium concentrations in milk and milk products, fluoride availability in the digestive tract is reduced by 20–50% in humans (Trautner & Siebert, 1986). Milk has a lot of lipids, which prolong the period that food and liquids stay in the stomach. The use of tea, coffee, and fluoridated tooth paste is the main source of dental fluorosis symptoms among persons in normal areas, despite the fact that they receive less fluoride via drinking water. From infants to adults, the level of fluoride exposure dosage decreases (Viswanathan et al., 2009).

As the main staple foods, sorghum, mint, and a variety of sea delicacies are consumed in the villages of the Tirunelveli District. Consumption of diets centered on sorghum and pearl millet was found to significantly enhance fluoride retention, with a mean increase of 12.2% when compared to diets based on rice at the same fluoride intake (Lakshmaiah & Srikantia, 1977). This phenomenon has been explained by the fact that sorghum has more molybdenum than rice. Compared to other cereals, sorghum has a high molybdenum content. The secondary deficit of copper, a mineral necessary for the formation of bones, is known to result from high molybdenum intake. Additionally, it has been noted that genu valgum is more common in people with copper deficiency and excessive fluoride intake (Deosthaale et al., 1977). Fluoride is more difficult to absorb from food, and a number of dietary components can either increase or reduce fluoride absorption (Arthur, 1965). Between 2.2 to 18.2 mg/kg of fluoride was discovered to be bioavailable in humans from a variety of dietary sources (Krishnamachari, 1976). The accessibility of fluoride through diet is significantly influenced by factors like pH and the mineral composition of the meal (Ericsson, 1968). In locations with a high endemicity of fluoride, children and adults are exposed to water fluoridation through drinking water at levels that are 50 and 30 times higher, respectively, than the recommended amount of 0.05 mg/kg/day (Ekstrand et al., 1978). The amount of fluoride estimated in a different type of fish, fruits, leafy vegetables, packed fruit juices, soft drinks, and coconuts are varying and is somewhat accepted. Coconut is an inseparable component of the cuisine of the study area. It is quite obvious that the fluoride content of coconut water in various varieties such as country varieties, and hybrid varieties shows a higher concentration of fluoride. Fish is one of the main cookery items in the households of the sampled area. The quantitative analysis of fluoride in some of the locally available marine fishes is manifold than the accepted limit.

The study described in the abstract provides valuable insights into the prevalence and severity of dental fluorosis in villages endemic for fluoride in the Tirunelveli district of Tamil Nadu, India. Let's discuss some important points and potential implications of this study:

- Dental Fluorosis and Public Health Concern: Dental fluorosis is a significant public health concern, and its occurrence is associated with prolonged exposure to fluoride through various sources such as food, industrial pollution, and drinking water. This study addresses the importance of understanding and addressing dental fluorosis as a developmental disorder caused by repeated exposure to high fluoride concentrations during tooth development.

- Assessing Sources of Fluoride: The study aims to assess the sources of fluoride exposure in the affected villages. Water analysis plays a crucial role in determining the fluoride content in the selected study area. By identifying areas with higher concentrations of fluoride, such as Pazhavoor and Yakopuram, the study highlights the need for targeted interventions to reduce fluoride exposure in these specific locations.
- Importance of Water Quality: The findings of the study emphasize the significance of providing potable water with low fluoride levels to communities facing fluoride endemic problems. Access to safe drinking water is crucial for preventing dental fluorosis and reducing the overall health risks associated with excessive fluoride consumption.
- Dean's Index for Categorizing Severity: Dean's Index is used in this study to categorize the severity of dental fluorosis. By assessing the severity, the researchers can better understand the impact of fluoride exposure on the affected population and identify appropriate interventions for prevention and treatment.
- Contribution of Food to Fluoride Intake: The study also analyzes the contribution of food to overall fluoride intake in the sample area. Understanding the dietary sources of fluoride can help identify specific food items or dietary habits that may exacerbate the fluorosis problem. This information can guide public health interventions and education programs aimed at reducing excessive fluoride intake through food.
- Policy Implications: The study's recommendations hold important policy implications for the state authorities. The need for substantial efforts to provide potable water with low fluoride levels underscores the importance of government intervention and support in addressing the endemic fluoride problem. The findings can guide policymakers in implementing water quality improvement measures and ensuring safe drinking water for the affected communities.
- Community Awareness and Prevention: The study highlights the importance of community awareness and prevention strategies to avoid excessive fluoride exposure. By understanding the sources of fluoride and implementing preventive measures, individuals can actively reduce their risk of dental fluorosis. Education programs can play a vital role in raising awareness about fluoride exposure, promoting oral hygiene practices, and encouraging individuals to make informed choices regarding their fluoride intake.

In summary, this study contributes to the understanding of dental fluorosis in endemic villages and provides valuable information for policymakers, public health authorities, and community members. By identifying sources of fluoride exposure, assessing severity, and recommending interventions, the study aims to mitigate the fluoride endemic problem and improve the oral health outcomes of the affected population.

4. Conclusion

The Combined impact of fluoride in water and food stuffs on Dental Fluorosis is well documented. The current study gives a general overview of the amount of fluoride contained in potable water and the extent to which people are exposed to various fluoride levels from both potable water as well as other sources. This study reveals the relationship associated with food habits of certain communities and religions. The study recommends the following approaches to the local people to avoid excessive fluoride ingestion, which is the notorious culprit of dental fluorosis. The population of the affected areas is recommended not to use deep well or bore well water for domestic use and not to solely depend upon marine fishes for their day-to-day life. The population of that affected area is advised to take more Calcium, Vitamin C, and Vitamin D enriched food kinds of stuff. Proper care, attention, and awareness should be given by the administrators and the population must understand the seriousness of the problem from childhood. Public health issues with dental fluorosis exist in the aforementioned village in the Tirunelveli district. To lower the morbidity linked to Dental Fluorosis in this region, proactive measures must be adopted to significantly defluorinated the water prior to distribution. To identify regions with a high-water fluoride concentration as well as assess the degree and method of defluorination, parallel surveys are needed in other parts of India.

Conflict of interest:
The authors declare no conflict of interest.

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