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Prevalence of Dental Fluorosis Among Primary School Children in Rural Areas of Tiruchengode block, Namakkal District, TN, India

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Abstract

Fluoride analysis is one of the major emerging areas of drinking water quality criterion and the majority of people is forced to consume fluoride contaminated water due to necessity. High fluoride groundwater is found in many parts of the developing world, and several millions of people rely on groundwater having concentrations more than the WHO, APHA and BIS guidelines. Estimation of fluoride concentrations in groundwater, identification of sources and monitoring the impact of fluoride on school children was undertaken in different villages of Tiruchengode block, Namakkal district, Tamilnadu. Most of the inhabitants of the study area rely on groundwater for domestic use due to inadequate pipe-borne drinking water supply. A preliminary survey showing that some of the residents in selected villages have mottled teeth motivated the study. A database was created by obtaining information on the impact of fluoride on school children. Four primary schools, in four distinct villages were visited and the students interviewed. The presence and severity of dental fluorosis were recorded. Fluoride concentrations in groundwater of these villages were found to be higher than the prescribed limit of APHA. The overall prevalence of dental fluorosis was found to be 28.28 % in our study samples. Based on the finding of this study dental fluorosis was associated with higher fluoride level in groundwater. On a scale of measurement the people are having 0 to grade III stage of dental fluorosis.

Keywords: *Fluoride, groundwater; Tiruchengode block; Namakkal district; Dental fluorosis.*

1. INTRODUCTION

As water is the elixir of human life, it is the most practical and economical, safe and effective vehicle for the fluoridation in compared with other available methods like salt and milk, which are not very popular (Sunanya *et al*. 2013). Water fluoridation is used in countries like the United States, United Kingdom, Sweden, Canada, Ireland, Australia, New Zealand and Switzerland. Ireland is the sole nation to have a mandatory law with respect to water fluoridation (Ole *et al*. 1994).

Fluorine, a gaseous element, is a halogen with a high electro negativity and reactive and does not occur in free form in nature. Fluoride combines directly with most elements and immediately with little to form fluorides. Fluorides are ubiquitous in nature and are present in rocks, soils, water, plant, foods and even air (Kodali *et al*. 2013). The prevalence of fluorosis in India ranges from 90-95% in different population groups (Soben *et al*. 2003). A study showed that fluoride toxicity may lead to dental fluorosis, and be associated with Alzheimer's disease and other types of dementia, formation of a crippling bone disease called skeletal fluorosis, disruption of thyroid gland activity and reduction in melatonin level (Giambro *et al*. 1995). Sometimes fluoride is considered a carcinogen and its intake increases probability of hip fracture. Moreover, fluoride increases infertility (Izquierdo-Vega *et al*. 2008).

2. MATERIALS AND METHODS

2.1 Spatial Location and Salient Features of The Investigation Area

The investigated area is spatially located in Namakkal district of Tamilnadu state (Fig 1), covering

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an aerial extent of 844.16 sq km and geographically extending between 11° 22'49.8" North latitude and 77° 53' 42.45" East longitudes. The study area falls under subtropical climatic condition with mean annual rainfall of 742.3 mm and mean annual temperature is 27.88°C. The altitude is about 150–200 meters msl.

2.2 Sample Collection

A total of 75 groundwater samples was collected periodically during the Pre-monsoon season of 2013 (April-July), following the standard water sampling procedures in 2L, polyethylene bottles by considering lithological formation from sites spread all over the study area. The collected samples were analyzed to determine the diverse range of physical-chemical parameters, by employing Standard procedures as per APHA (1995) and Trivedi and Goel (1984) (Trivedi *et al.* 1984). pH of the samples was recorded in situ and remaining parameters were analyzed in the laboratory. Fluoride analysis was done by Ion Selective Electrode method. From the analysis, four stations were identified as the potential fluoride zones, namely Pirithi, Sirumolasi, Pudupuliyampatti, Animoor.

2.3 Examination of Dental Fluorosis

A health implication survey was conducted in the above four stations and found that most of the children's were affected by dental fluorosis. An age group of 6 to 13 years of children from these four villages of Tiruchengode block was selected. Teeth of different children were carefully examined in proper Daylight for the examination of dental fluorosis. Following indexes and classification was used in survey to measure the presence and Severity of dental fluorosis. The occurrence and severity of dental fluorosis were recorded.

Dental fluorosis grade

- **Grade 0:** Normal, translucent, smooth, glossy teeth.
- **Grade I:** White opacities, faint and yellow line.
- **Grade II:** Changes as in Grade I with brown stains.
- **Grade III:** Brown line, pitting and chipped off edges.
- **Grade IV:** Brown black and/loss of teeth.

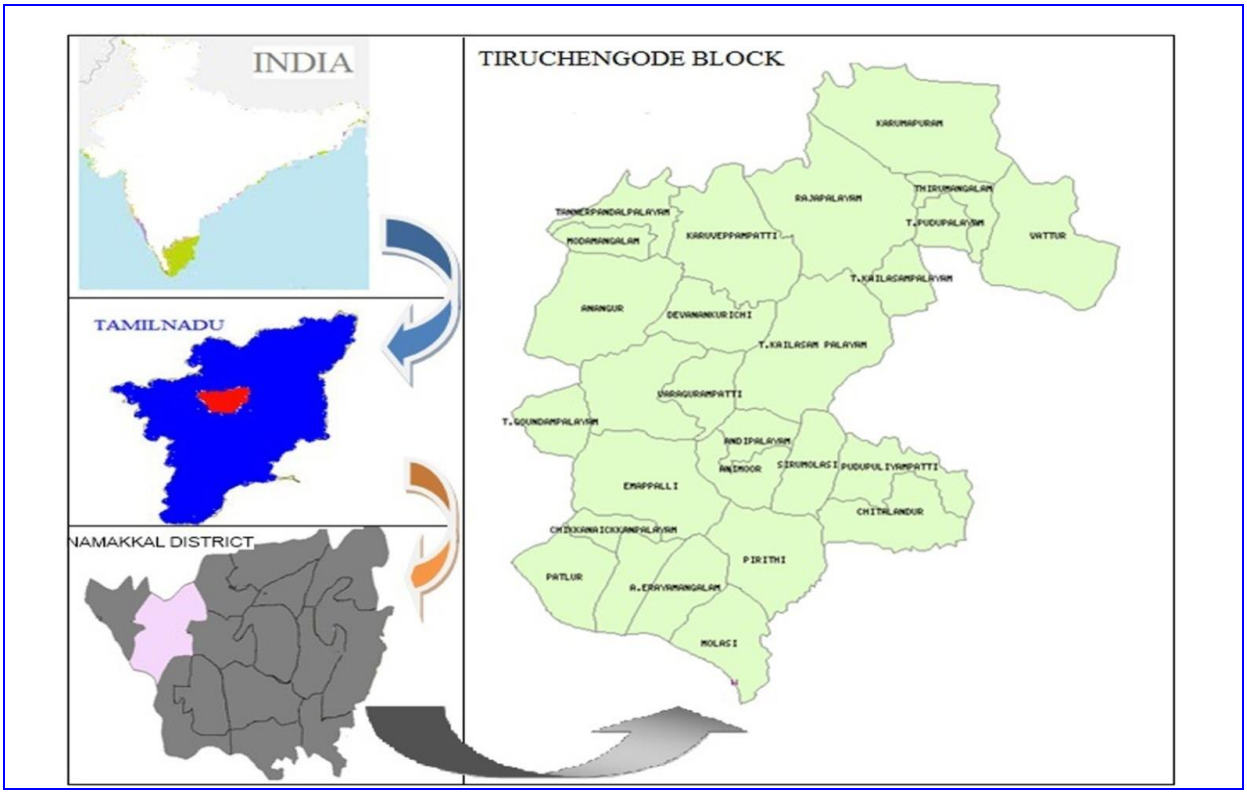

Fig. 1: Geological Setup of the study area

Table 1. The Geographical Co-ordinates of the study region

Station Code	Station Name	Sample	Latitude	Longitude
A	T Pudupalayam	S1	11°39.576'N	77°86.870'E
		S2	11°33.473'N	77°84.614'E
		S3	11°30.162'N	77°87.416'E
B	Varagoorampatti	S1	11°36.572'N	77°86.245'E
		S2	11°35.710'N	77°83.236'E
		S3	11°34.238'N	77°79.353'E
C	Anangur	S1	11° 23. 638'N	77° 48. 994'E
		S2	11°39.615'N	77°82.386'E
		S3	11°37.713'N	77°80.453'E
D	Devanankurichi	S1	11° 24. 383' N	77° 51. 669'E
		S2	11°38.777'N	77°85.673'E
		S3	11°28.626'N	77°82.765'E
E	Srinivasampalayam	S1	11° 22.547' N	77° 52. 659' E
		S2	11°24.879'N	77°49.471'E
		S3	11°23.912'N	77°51.738'E
F	Pirithi	S1	11° 16. 575' N	77° 51. 845' E
		S2	11°29.154'N	77°87.749'E
		S3	11°25.835'N	77°83.914'E
G	Molasi	S1	11° 15. 725' N	77° 50. 741' E
		S2	11°25.969'N	77°85.673'E
		S3	11°22.342'N	77°81.562'E
H	Eryamangalam	S1	11° 16. 197' N	77° 50. 533' E
		S2	11°26.631'N	77°83.400'E
		S3	11°23.116'N	77°79.262'E
I	Patlur	S1	11° 16. 880' N	77° 47. 161' E
		S2	11°27.571'N	77°80.670'E
		S3	11°25.436'N	77°78.430'E
J	Chitalandur	S1	11° 19. 237' N	77° 55. 009' E
		S2	11°31.239'N	77°91.960'E
		S3	11°30.527'N	77°86.346'E
K	Pudupuliyampatti	S1	11° 20. 770' N	77° 53. 954' E
		S2	11°37.847'N	77°89.449'E
		S3	11°35.614'N	77°87.118'E
L	Sirumolasi	S1	11° 20. 245' N	77° 52. 610' E
		S2	11°32.925'N	77°88.960'E
		S3	11°28.367'N	77°85.527'E
M	Animoor	S1	11° 22. 304' N	77° 53. 100' E
		S2	11°33.301'N	77°87.960'E
		S3	11°31.838'N	77°86.517'E
N	Chickanaikanpalayam	S1	11° 16. 001' N	77° 48. 502' E
		S2	11°37.847'N	77°89.449'E
		S3	11°35.214'N	77°84.843'E
O	T Goundampalayam	S1	11° 19. 753' N	77° 50. 021' E
		S2	11°29.205'N	77°79.812'E
		S3	11°27.962'N	77°77.136'E
P	Emapalli	S1	11° 20. 260' N	77° 59. 927' E
		S2	11°37.847'N	77°89.449'E
		S3	11°38.311'N	77°87.621'E

Table 1. Continued

Station Code	Station Name	Sample	Latitude	Longitude
Q	Andipalayam	S1	11° 21. 671' N	77° 48. 230' E
		S2	11°34.792'N	77°87.045'E
		S3	11°35.417'N	77°88.107'E
R	Thaneerpandalpalayam	S1	11° 25. 564' N	77° 51. 013' E
		S2	11°41.844'N	77°84.030'E
		S3	11°39.735'N	77°86.263'E
S	Valrasapalayam	S1	11° 25. 153' N	77° 49. 478' E
		S2	11°54.289'N	78°05.647'E
		S3	11°52.062'N	77°98.912'E
T	Modamangalam	S1	11° 25.025' N	77° 49. 478' E
		S2	11°41.966'N	77°82.925'E
		S3	11°42.326'N	77°64.216'E
U	Karuvepampatti	S1	11° 24. 146' N	77° 52. 939' E
		S2	11°40.097'N	77°87.245'E
		S3	11°37.325'N	77°84.112'E
V	Vattur	S1	11° 26. 251' N	77° 57. 278' E
		S2	11°40.915'N	77°95.940'E
		S3	11°42.143'N	77°88.364'E
W	T Kailasampalayam	S1	11° 24. 789' N	77° 54. 037' E
		S2	11°39.427'N	77°91.246'E
		S3	11°41.104'N	77°86.512'E
X	Thirumangalam	S1	11° 26. 027' N	77° 55. 948' E
		S2	11°42.054'N	77°94.102'E
		S3	11°36.219'N	77°90.232'E
Y	Karumapuram	S1	11° 25. 316' N	77° 56. 270' E
		S2	11°45.013'N	77°93.174'E
		S3	11°43.726'N	77°84.319'E

3. RESULTS AND DISCUSSION

It has been observed that 28.28% of the examined children had fluorosis even when the fluoride concentration exceeds 1.5 mg/L. The maximum prevalence of dental fluorosis was found in the 9-13 years age group with higher prevalence in males than females, have shown that dental fluorosis was more prevalent among boys than girls. Many studies in the past have proved a direct link between the degree of dental fluorosis and the amount of fluoride in drinking water (Gladys *et al*. 1991; Tan *et al*. 2005; Nemre *et al*. 2007). The symptoms include mild rheumatic/ arthritic pain in the joints and muscles to severe pain the cervical spine region along with stiffness and rigidity of the joints (Saksena *et al*. 2012). It was revealed in a study carried out in four villages of Tiruchengode block, out of 251 children, 71 children were affected by dental fluorosis and 41 male children and 30 female children were affected by clinical dental fluorosis. It was also found that out of 251 children scanned, 28.28% of children were affected by dental fluorosis grade 0-III. The groundwater in the area has not received proper attention from the health department till date. Since, these people are dependent on the groundwater for drinking and other domestic use. The remedial measures such as rainwater harvesting and supply of drinking water from other places are suggested. Furthermore, a plan is required to attend to the dental treatment needs for these children.

Table 2. Physico-chemical characteristics of the groundwater samples during Pre- Monsoon

Sample	pH	EC	TDS	TEMP	TH	Na	K	Ca	Mg	HCO3	Cl	SO4	NO3	F
A-1	7.2	1147	768	32.4	263	46	4	40.07	48.28	140	188.2	32.80	2.3	0.37
A-2	7.1	1152	772	34.0	300	37	8	45.07	50.42	120	166.1	39.15	1.9	0.63
A-3	7.3	1079	723	31.7	216	48	37	27.34	43.37	160	152.1	33.42	1.3	0.58
B-1	7.1	1468	984	33.2	348	67	35	79.46	37.84	120	247.6	42.84	2.0	0.71
B-2	6.6	2328	1560	32.8	660	64	28	123.47	84.25	140	452.1	42.35	5.1	0.73
B-3	6.9	1781	1193	33.6	468	62	21	106.41	52.21	120	328.5	42.16	5.0	0.54
C-1	7.1	2560	1780	34.2	420	116	19	50.1	71.95	180	653.2	39.95	0.25	0.67
C-2	6.8	2360	1630	34.1	592	83	18	112.22	76.07	120	646.1	26.47	0.38	1.2
C-3	7.0	551	397	34.3	208	76	15	38.07	27.55	120	106.5	33.21	0.37	**1.8**
D-1	7.0	1569	1110	33.9	360	68	33	84.16	36.56	180	319.5	33.69	4.6	1.2
D-2	7.0	566	403	34.1	216	42	2	42.08	27.06	100	99.4	28.40	1.42	**1.3**
D-3	6.7	1683	1200	34.2	508	32	34	84.16	72.67	140	461.5	30.80	1.8	0.9
E-1	6.6	2110	1510	34.1	560	81	21	112.22	68.26	140	589.3	29.36	3.1	1.1
E-2	6.5	2050	1460	34.0	576	79	13	108.21	74.61	120	560.9	37.54	2.1	1.1
E-3	7.1	2290	1580	33.1	712	76	17	132.26	93.14	100	688.7	28.40	3	0.7
F-1	7.0	2650	1870	33.4	556	94	42	62.12	97.81	100	596.4	40.91	4.5	0.8
F-2	7.7	3020	2140	33.3	180	128	51	26.05	28.05	60	511.2	50.54	1.81	0.6
F-3	7.1	2060	1450	33.6	448	40	12	64.12	70.24	120	418.9	38.50	4.5	**1.7**
G-1	6.9	944	672	33.4	316	42	3	36.07	55.12	120	134.9	38.02	4.5	**1.6**
G-2	6.8	895	632	33.3	344	39	3	24.04	69.29	120	99.4	36.10	3.9	0.8
G-3	6.8	1176	833	33.6	352	36	6	48.09	56.58	140	177.5	39.95	4.7	**1.4**
H-1	7.2	957	676	33.2	324	31	32	62.12	41.2	140	149.1	41.39	4.5	**1.3**
H-2	7.1	930	648	33.7	324	29	27	74.14	33.88	160	163.3	34.65	1.8	**1.6**
H-3	7.2	1166	814	33.3	284	36	3	38.07	46.1	120	184.6	28.88	2.1	**1.4**
I-1	7.1	760	534	33.5	300	31	6	44.08	46.34	100	142	37.06	1.6	0.9
I-2	7.3	894	625	33.1	216	43	38	24.04	38.05	160	149.1	31.28	1	0.5
I-3	7.1	924	650	33.4	348	68	32	82.16	34.85	120	163.3	40.91	2.1	0.3
J-1	6.6	1806	1280	33.4	660	64	26	128.25	82.9	100	397.6	42.35	5	0.7
J-2	6.9	1561	1130	33.3	468	56	19	104.2	50.7	120	326.6	38.98	5	1.2
J-3	6.8	1390	985	33.6	460	29	26	78.15	64.62	100	326.6	33.21	4.8	**1.9**
K-1	8.6	1480	1050	32.4	240	79	10	48.09	29.26	120	340.8	37.06	0.25	**2.2**
K-2	7.5	1575	1140	32.1	340	83	7	80.16	34.12	80	390.5	30.80	0.25	0.8
K-3	7.5	1210	875	32.4	420	78	13	64.12	63.41	120	276.9	35.62	3	1.1
L-1	7.1	1590	1140	32.2	530	56	19	64.12	63.41	180	369.2	33.21	1.1	0.6
L-2	7.8	1492	1060	32.2	380	78	13	44.08	46.34	160	298.2	46.21	0.22	0.5
L-3	7.3	2540	1800	32.1	620	64	26	76.15	104.88	180	653.2	57.76	0.25	0.9
M-1	7.3	3800	2700	32.3	610	164	15	104.2	85.35	80	1214.1	47.17	0.25	1.2
M-2	7.2	1030	740	32.5	310	52	8	68.13	34.13	200	220.1	36.10	0.8	0.8
M-3	6.9	3310	2260	32.9	106	56	10	128.25	82.9	140	1029.5	43.80	3	0.6
N-1	6.8	1445	1020	32.1	460	52	6	80.16	34.12	160	255.6	38.02	1.8	1.1
N-2	6.7	1450	1030	32.0	470	49	7	120.24	41.42	180	255.6	38.98	2	1
N-3	6.9	1485	1030	32.1	470	64	22	68.13	34.13	160	298.2	35.13	4.5	0.6
O-1	7.0	3500	2460	32.0	520	142	23	112.22	68.26	120	1008.2	47.17	0.25	0.2
O-2	7.3	898	638	32.0	350	34	12	56.11	51.21	60	191.7	31.76	3	0.6
O-3	7.2	1244	880	32.1	320	82	33	60.12	41.45	40	191.7	40.91	1.8	0.8
P-1	7.0	3370	2370	32.1	500	137	22	60.12	41.45	60	1015.3	41.39	3	0.9
P-2	7.2	1540	1080	32.2	370	66	13	56.11	51.21	100	276.9	39.95	3	1.1
P-3	6.8	1602	1150	32.0	520	46	7	76.15	104.88	140	291.1	38.02	1.8	**1.3**
Q-1	6.9	1624	1150	32.0	600	62	76	48.09	29.26	180	326.6	34.17	0.8	1
Q-2	7.1	1178	836	31.9	460	43	18	60.12	41.45	40	213	36.58	3	0.8
Q-3	7.1	1610	1140	32.1	490	88	7	60.12	41.45	140	418.9	30.80	1.2	1
R-1	6.8	1190	845	32.1	500	48	8	76.15	104.88	100	213	34.65	1.1	0.8
R-2	6.8	1926	1360	32.1	680	63	8	100.2	104.87	80	582.2	33.21	3	1
R-3	6.6	1460	1040	32.3	680	67	32	104.2	85.35	120	312.4	27.43	1.8	0.3
S-1	7.0	3120	2120	31.8	420	66	6	64.12	63.41	80	724.2	35.62	2.8	0.5
S-2	7.2	1612	1260	32.1	380	51	14	44.08	46.34	140	383.4	45.10	1.3	0.7
S-3	6.9	3240	2145	32.0	530	43	38	64.12	63.41	120	355	33.21	1.8	0.4
T-1	7.1	1490	1350	32.2	610	72	57	104.2	85.35	100	440.2	46.70	4.6	0.6
T-2	7.6	1610	1230	32.4	360	62	19	44.08	46.34	80	291.1	35.10	2	0.3

Table 2. Continued

Sample	pH	EC	TDS	TEMP	TH	Na	K	Ca	Mg	HCO3	Cl	SO4	NO3	F
T-3	7.3	2420	1800	31.8	800	76	13	130.14	115.91	120	241.4	30.87	2.2	0.6
U-1	7.3	3710	2670	32.3	520	49	7	76.15	104.88	200	454.4	38.02	1.7	1
U-2	7.2	1075	890	32.1	400	49	6	50.1	71.95	60	284	34.08	2.8	0.8
U-3	6.9	3200	2167	32.0	370	29	27	44.08	46.34	120	291.1	33.52	2	1.2
V-1	6.7	1567	1140	32.1	600	40	10	104.2	85.35	100	262.7	46.28	1.8	1.1
V-2	6.6	1485	1062	32.4	580	47	10	104.2	85.35	40	305.3	27.10	1.8	0.6
V-3	6.8	1620	1170	31.9	450	52	8	78.15	64.62	180	319.5	38.46	1.7	1.1
W-1	7.1	2642	1800	33.4	510	71	14	60.12	41.45	160	639	35.26	1.3	**1.4**
W-2	7.6	2900	2120	33.0	620	79	13	101.09	83.24	80	639	55.91	0.26	0.6
W-3	7.1	2160	1510	33.6	570	31	6	64.12	77.48	120	582.2	37.54	1	0.4
X-1	6.7	2167	1492	33.1	480	79	20	64.12	70.24	140	582.2	40.91	1.8	0.4
X-2	6.5	2270	1530	33.3	520	64	16	112.22	68.26	120	589.3	39.42	4.4	0.2
X-3	6.9	2132	1710	33.0	600	83	8	104.2	85.35	180	553.8	46.28	2.8	1.1
Y-1	7.1	2520	1820	33.6	320	83	13	60.24	41.37	80	852	40.74	1.69	**1.3**
Y-2	7.7	2910	2060	33.2	480	96	10	60.12	41.45	120	788.1	31.16	2.8	0.9
Y-3	7.0	2650	1510	33.4	360	31	32	84.16	36.56	200	759.7	33.72	2	0.7

Table 3. The correlation matrix of the groundwater samples during Pre-monsoon Season

	pH	EC	TDS	TH	Na	Ca	Mg	K	HCO3	Cl	SO4	F
pH	1.00	0.17	0.17	-0.33	0.25	-0.37	-0.27	0.05	-0.18	-0.17	0.23	0.18
EC		1.00	1.00	0.23	0.42	0.24	0.31	-0.17	-0.28	0.58	0.27	**0.40**
TDS			1.00	0.23	0.42	0.24	0.31	-0.17	-0.28	0.58	0.27	**0.40**
TH				1.00	0.13	0.62	0.69	0.12	0.00	0.66	0.11	**0.39**
Na					1.00	0.34	0.13	0.01	-0.22	0.64	0.09	**0.54**
Ca						1.00	0.51	-0.01	0.05	0.78	-0.09	0.23
Mg							1.00	-0.22	0.00	0.73	0.13	0.25
K								1.00	-0.10	-0.06	-0.20	-0.29
HCO3									1.00	-0.19	0.05	0.12
Cl										1.00	0.06	**0.39**
SO4											1.00	**0.43**
F												1.00

Bold values represent significant coefficients

Table 4. Prevalence of dental fluorosis in villages with high level of fluorosis (above 1.5 mg/l) according to age group

Age Group	No. of examined student	No. of affected student	Prevalence (%)
6-7	17	3	17.64
7-8	17	5	29.41
8-9	38	11	28.94
9-10	44	13	29.54
10-11	41	16	39.02
11-12	33	7	21.21
12-13	30	8	26.66
13-14	31	8	25.80
TOTAL	251	71	28.28

Table 5. Prevalence of dental fluorosis in villages with high degree of fluoride (above 1.5 mg/l)

Villages	Fluoride in mg/L	Total Students Examined	Students affected by Fluorosis	Prevalence (%)	Moderate	Severe
Pirithi	1.7	53	18	33.96	6	12
Sirumolasi	1.7	143	37	25.87	7	30
Pudupuliyampatti	2.2	29	10	34.48	2	8
Animoor	1.6	26	6	23.07	-	6

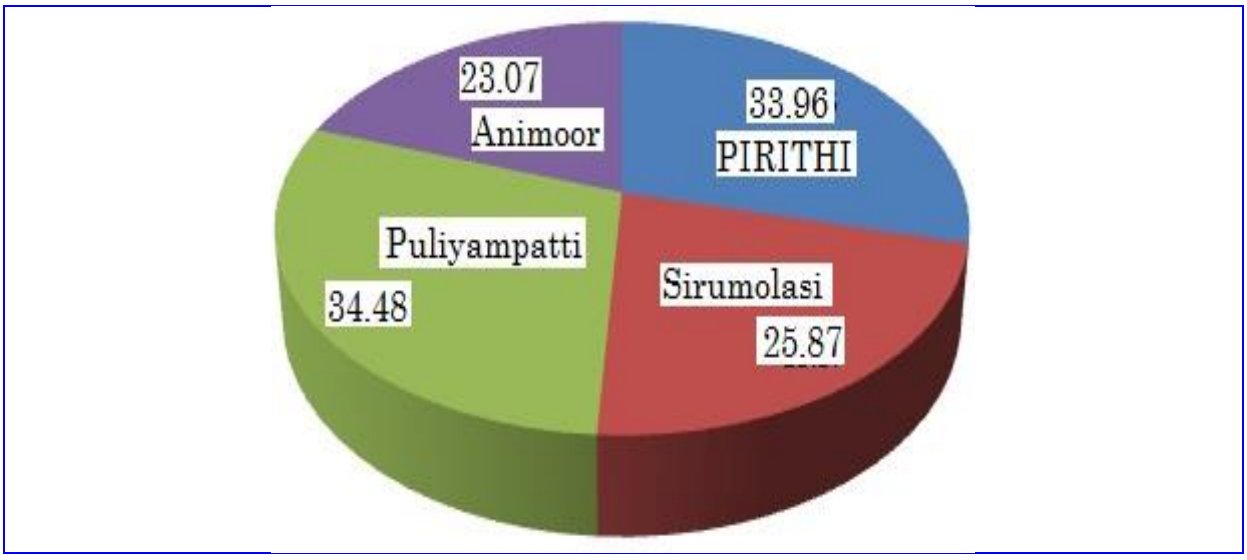

Fig. 2: Graphical representation of prevalence of Fluorosis in different villages of the study region

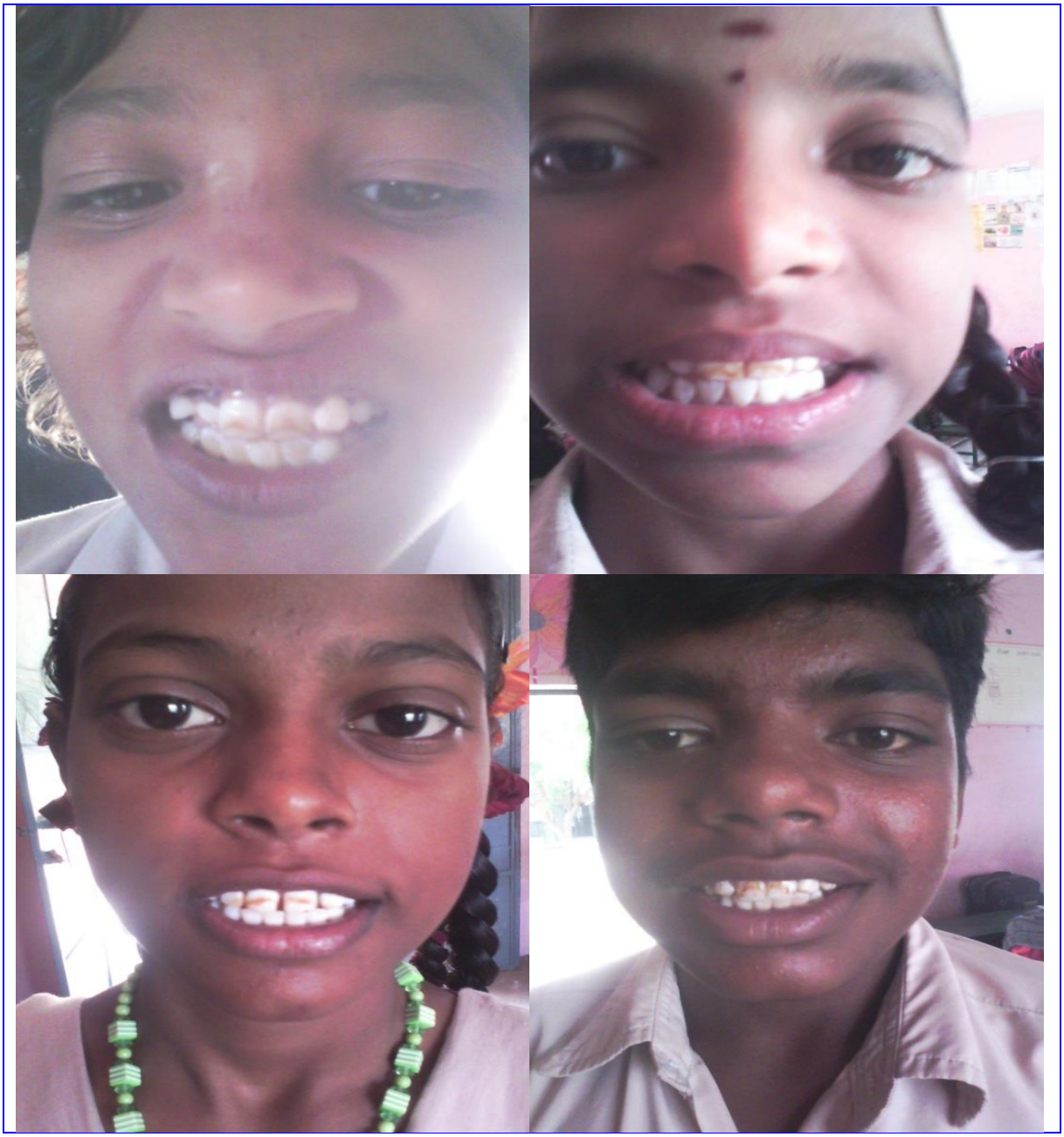

Fig. 3: The above picture highlights dental fluorosis of different grades among school children of Tiruchengode block, Namakkal district, Tamilnadu

4. CONCLUSION

The study confirms the dreaded impact of fluoride toxicity, specifically for school children. Fluoride was found nearly higher than that of recommended upper limit by WHO and ICMR in some villages. Therefore, the residents are compelled to swallow this anthropogenically and geologically polluted water since their birth. Some of the photographs, taken by us, establish the fact. Calcium and phosphorous-rich food should be taken by the population affected by fluorosis as an antidote may protect the people from further deterioration. Thus, in this region, there is an instant need to warn the people against the risk of dental fluorosis, and people are advised to adopt some techniques of defluoridation of groundwater before using it for drinking purposes.

Environmental awareness program for the health implications attributed to fluoride

contamination should be emphasized through public education and community participation.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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