

Assessing the association of Naturally Occurring Water Fluoride Concentration, geology of the area with the Prevalence of Dental Fluorosis: A Cross-Sectional Investigation from North India

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This study aimed at assessing the association of water fluoride concentration and type of geological rocks with prevalence of dental fluorosis amongst children (6-14 years) in 30 selected villages of a north Indian province in Himalayan Region.

1. The overall prevalence of dental fluorosis was 19.1%. 3.4% children were severely affected (Dean's Index-5).
2. Dental fluorosis showed significant association with rising level of fluoride in water, however dental fluorosis was reported even at water fluoride concentration as low as 0.6 ppm
3. Higher Fluoride level were observed (more than 1.5 ppm) where granite was the main soil-forming parent rock and around 93% of the dependent population was affected.

BACKGROUND

- Fluorine acts as a double-edged sword- Dental Fluorosis and Dental caries.
- WHO has recommended fluorine intake- levels 0.5 to 1.5 mg/l in drinking water, Bureau of Indian Standards (BIS) -1mg/l.
- Excess of fluoride in water is major reason for dental fluorosis. Other sources of exposure of fluorine intake include milk, meat, fluoride containing toothpaste, tobacco, tea, fluoridated salt etc. Its prevalence is higher with certain rock type like granite.
- Dental fluorosis is endemic in at least 25 countries globally.
- India is among the worst affected countries. Two-thirds states are affected influencing around 60 million people- 10% being children below 14 years.
- Uttarakhand is a hilly state in northern India with difficult geographic terrain and climatic conditions. Fluorosis was not been reported before this study.



Mild Fluorosis



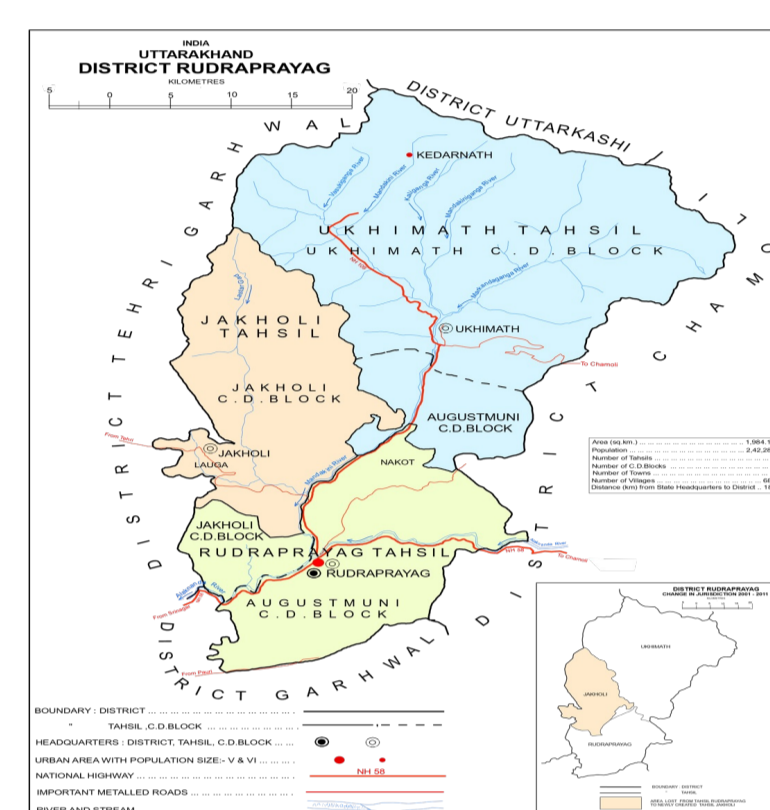
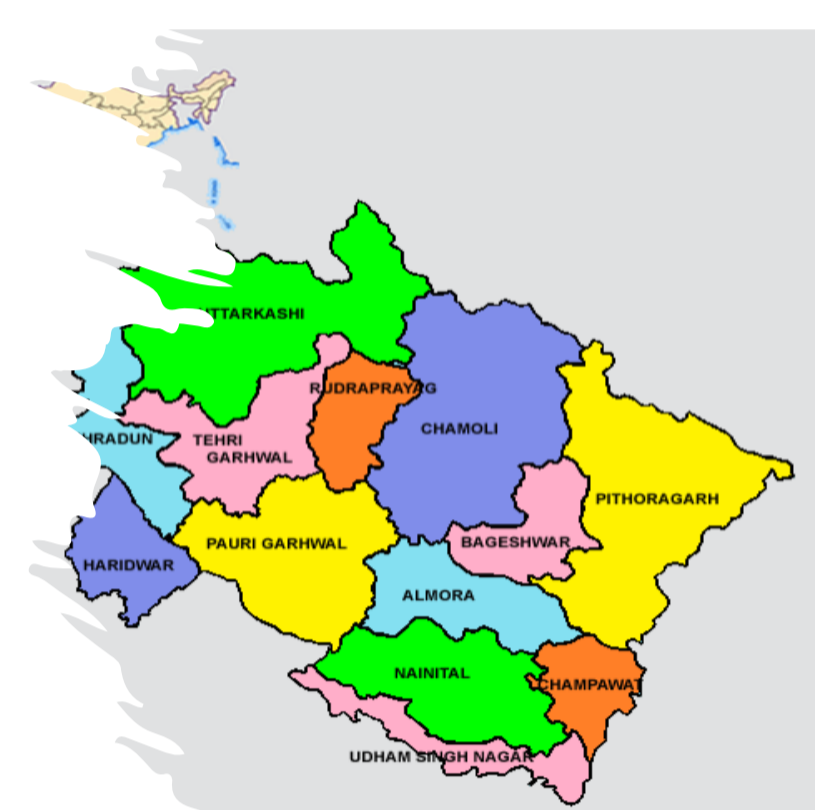
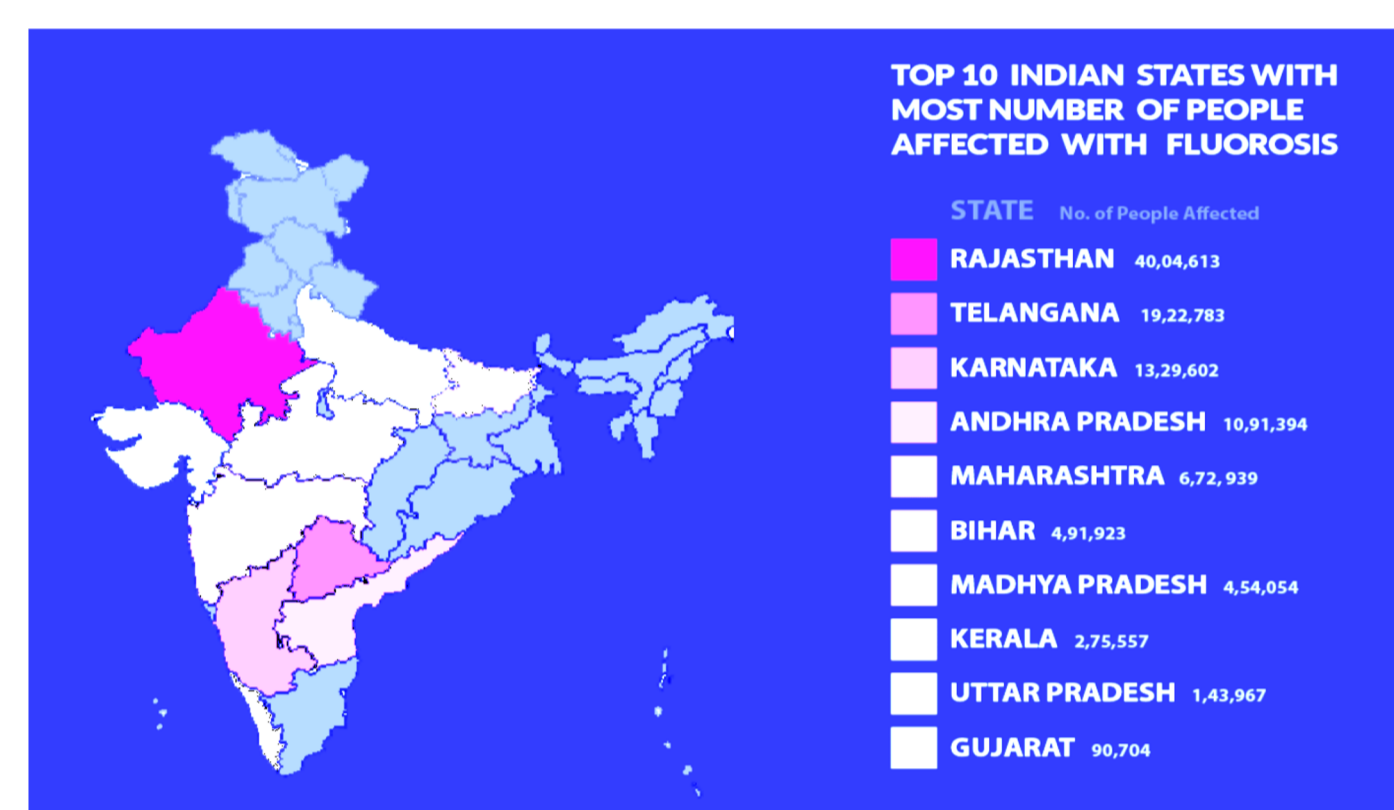
Moderate Fluorosis



Severe Fluorosis

RESULTS CONTINUED...

- Eating habits and source of water were found to be significantly associated with the presence of fluorosis ($p < 0.001$). Stunting [27.7% (74)].
- From the regression analysis of factors statistically significantly associated with the prevalence of dental fluorosis it was observed that the children belonging to higher socioeconomic status, class 2 and above, had 1.78 times more chances of being affected by fluorosis as compared to children of lower socioeconomic status [$p = 0.015$, 1.78 (1.12 - 2.83)]. (Table 2)
- Stunting was commonly observed in fluorosis-endemic areas, and stunted children had two times more chances of being affected by dental fluorosis [$p = 0.011$, 2.08 (1.16 - 3.73)].
- Fluoride concentration in water samples (90) ranged from fluoride level 0.03 to 2.03mg/l (average 1.1mg/l (Table 3)
- 12 samples had fluoride concentration above permissible limit (>1 ppm).



India

Uttarakhand

Rudraprayag

In 2009 Central Ground Water Board has reported high fluoride level (>1.5 mg/l) in few villages of Rudraprayag, and there have been some complaints from villagers that their children are facing frequent dental problems, although there has been no previous report of dental fluorosis from the area. Therefore, this study was planned to assess the prevalence of dental fluorosis along with its association with ground water fluoride level, types of geological rocks and other epidemiological determinants.

Table 3- Categorization of Water Samples and villages as per Fluoride Concentrations in Drinking Water from 30 villages (3 Samples/village)

Fluoride level (ppm)	Number of samples (N=90) n (%)	Number of villages (N=30) n (%)
<0.5	57 (63.3)	19 (63.3)
0.5 - 1	21 (23.3)	7 (23.3)
>1	12 (13.3)	4 (13.4)
Total	90 (100.0)	30 (100.0)

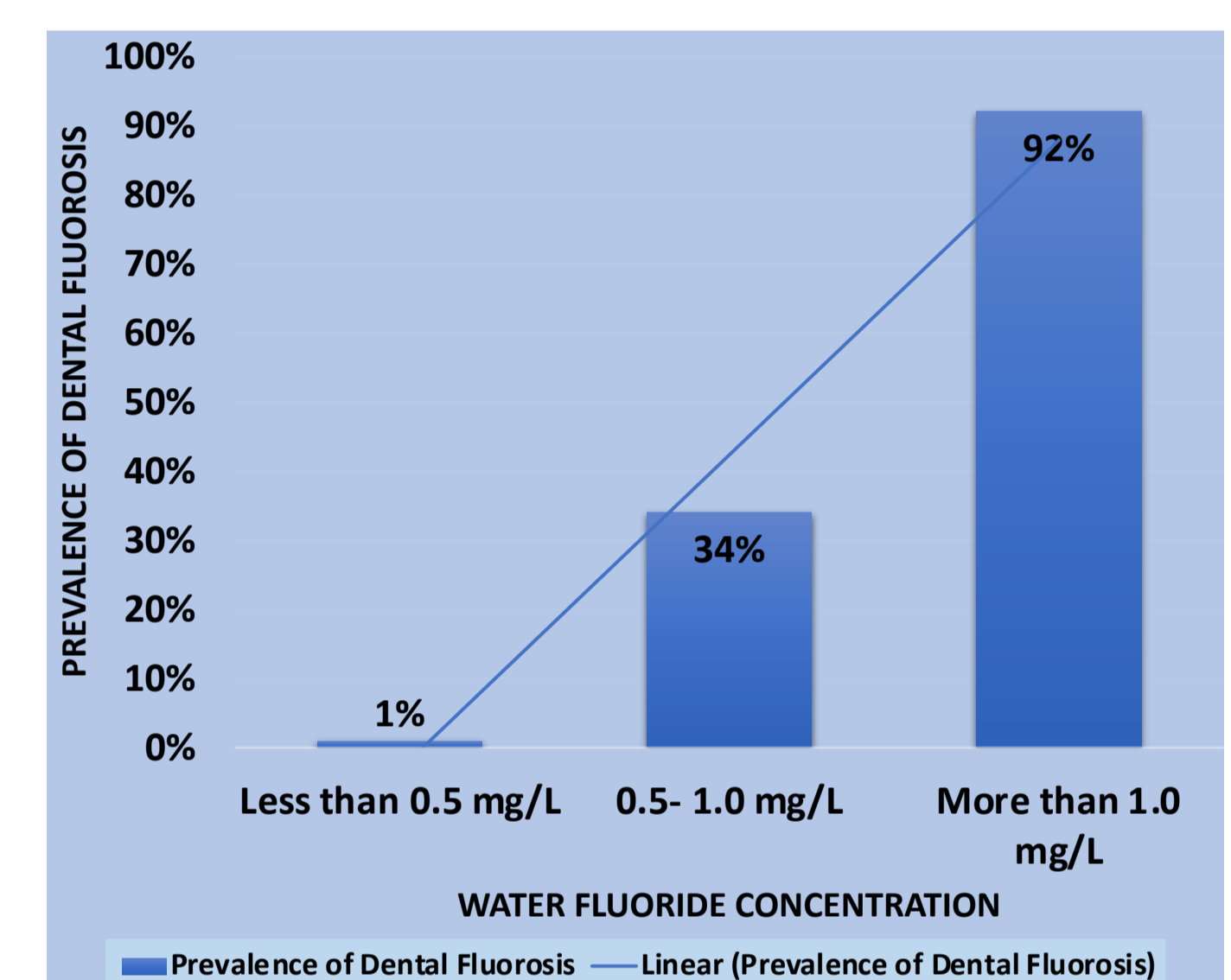
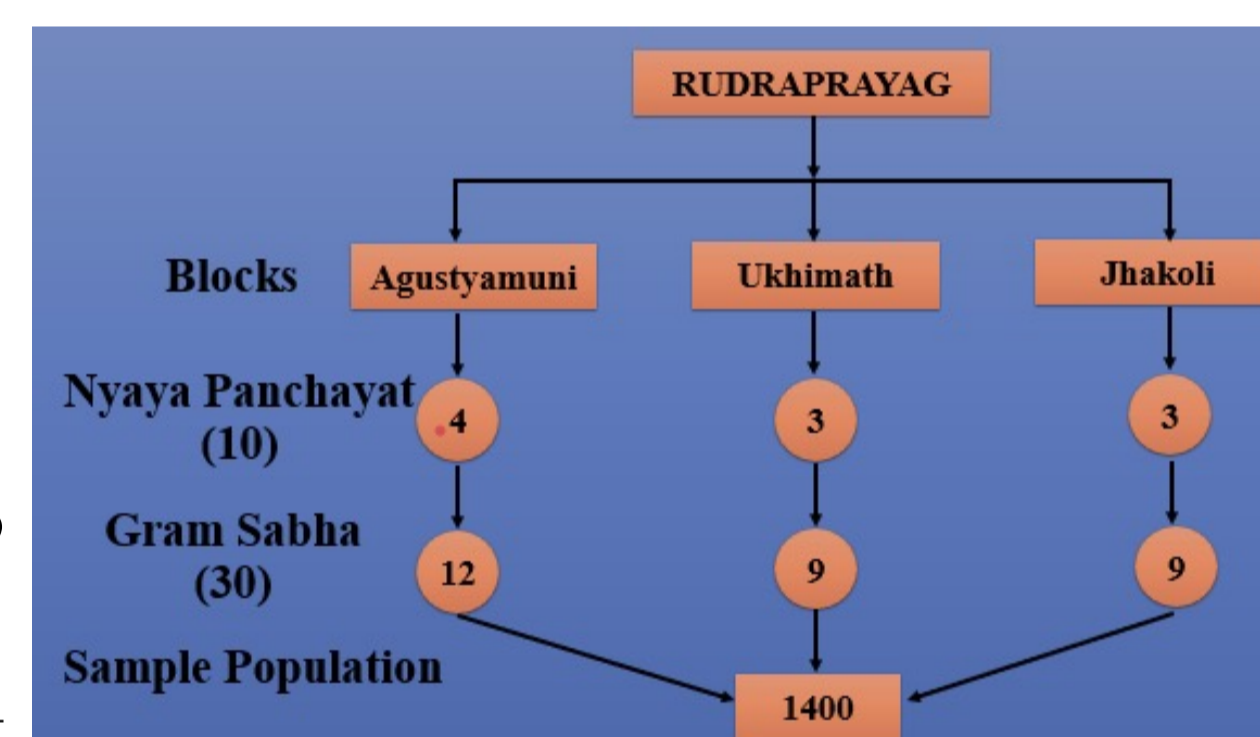


Figure 1- Variation in the Prevalence of Dental Fluorosis with increasing water fluoride concentration in the district

METHODS

- Study design-** Cross Sectional Study
- Study setting-** Rudraprayag district, Uttarakhand
- Study Duration-** Period of 12 months from March 2019 to February 2020
- Study population-** Age 6-19 years, residents of the district in their first 5 years of life. Children with a history of chronic medical illness (example- renal, hepatic, and endocrine disorders) were excluded.
- Ethical Approval by-** Institutional Ethics Committee (IEC), AIIMS Rishikesh
- Sample size-** 1400
- Sampling technique-** Multi-stage random sampling
- Data collection-**
 - Pre-designed, pretested, semi-structured questionnaire by personal interview method
 - Questionnaires elicited information on participants' sociodemographic status, lifestyle, and food habits
 - Oral examination of children was done in the presence of parents/guardians
 - Dental fluorosis was evaluated using the Dean's index,
 - Anthropometric assessment (Height, Weight) was done as per standard procedures.
 - Fluoride estimation in water sample by the ion-selective electrode (Orion company A324 pH benchtop model) using the EPA - approved ISE test procedures. (3 different water sources / village = 90 samples)



RESULTS

- Among the total 1400 participants, 52.3% (732) were girls. 40.4% children were in age group of 10-14 years. Most of the families belonged to lower socioeconomic status, constituting a significant proportion (44%).
- In the present study the overall prevalence of dental fluorosis (as per Dean's Index) was found to be 19.1% (267), of which 18% of children were affected by severe dental fluorosis. (Table 1)
- Fluorosis was frequently observed among children 12-16 years of age. There were no significant differences in the prevalence and severity of dental fluorosis among the boys and girls ($p = 0.68$).
- The children belonging to higher socioeconomic status, class 2, were more frequently affected by fluorosis [25.5% (35)] than the children of lower socioeconomic status [14.8% (132)]. (Table 2)

Table 1- Distribution of participants as per different grades of Dental Fluorosis (as per Dean's Index)

Dental Fluorosis	n (%)	95% CI
Normal	1133 (80.9)	78.8 - 83.0
Questionable	27 (1.9)	1.2 - 2.6
Very Mild	57 (4.1)	3.1 - 5.1
Mild	83 (5.9)	4.7 - 7.1
Moderate	53 (3.8)	2.8 - 4.8
Severe	47 (3.4)	2.5 - 4.3

Table 2- Multinomial logistic regression analysis of factors associated with the prevalence of dental fluorosis

Population Characteristics	p-value	Odds Ratio [95% CI]
Age of the participants		
≤11 years	0.814	0.95 (0.59 - 1.50)
>11 years		1
Water fluoride level		
Above 0.5 ppm	0.000	118.52 (59.0 - 238.11)
0 - 0.5 ppm		1
Socioeconomic Status (B G Prasad Classification)		
Class 2 and 1	0.013	1.78 (1.13 - 2.87)
Class 3, 4 and 5		1
Weight for age of participants		
Underweight	0.376	0.829 (0.55 - 1.25)
Normal		1
Height for age of the participants		
Stunted and severely stunted	0.015	2.08 (1.16 - 3.73)
Normal		1

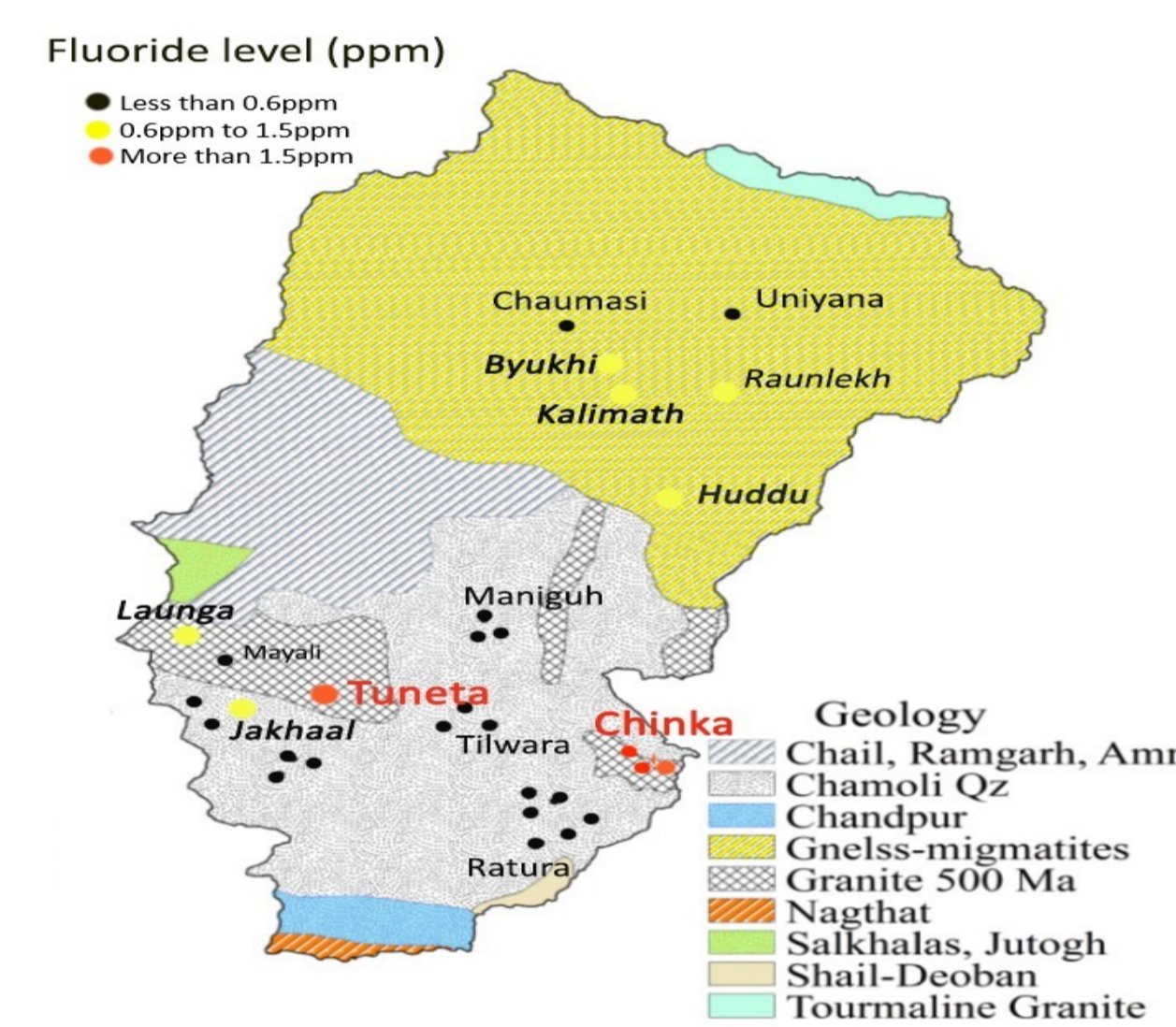


Figure 2- Map of District Rudraprayag depicting the prevalent rock type in each area and its association with fluoride content.

Rock Type	Water Fluoride	Fluorosis
Granite	Above 1.5 ppm	91-95%
Augen Gneiss and Porphyritic Gneiss Rock	0.7-1.5 ppm	20-60%
Quartz and Limestone Rock	0-0.69 ppm	0-2%

Figure 3- Prevalence of Fluorosis according to Rock Type. 4 Villages in Granite Rock Belt showed higher Fluoride content in the water content with 95% population affected with Fluorosis

CONCLUSIONS

This study gave very important conclusions -

1. The presence of dental fluorosis in Rudraprayag district got confirmed and it is a first report from State of Uttarakhand.
2. As Rudraprayag is a Himalayan district at high altitude (7000 ft.), fluorosis got reported even among those participants drinking water with normal range of fluoride content as per Bureau of Indian Standards (BIS).
3. Stunting and fluorosis were found co-existing.
4. Areas having Granite rock reported higher fluoride level in the water and the dependent population showed higher fluorosis prevalence.

ADDITIONAL KEY INFORMATION

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