

Assessment of Fluoride and Total Dissolved Solids (TDS) Levels in Government School Drinking Water Sources Across Hingoli District, Maharashtra

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ABSTRACT

Background: Fluoride and total dissolved solids (TDS) are important indicators of drinking water quality and have significant effects on oral and systemic health. Excess fluoride exposure during childhood may lead to dental fluorosis. However, district level data on fluoride and TDS levels in government school drinking water sources in Hingoli district are limited.

Materials and Methods: A cross-sectional observational study was conducted among 50 government schools selected through stratified random sampling across five talukas of Hingoli district. Fluoride estimation was performed using the SPADNS colorimetric method according to APHA guidelines, while TDS was measured using a calibrated digital TDS meter. Descriptive statistics and Pearson's correlation analysis were performed.

Results: Fluoride levels ranged from 1.46–2.21 mg/L, with 96% of samples exceeding the BIS permissible limit of 1.5 mg/L. Mean fluoride concentrations across all talukas exceeded 1.9 mg/L. TDS levels ranged from 28–771 mg/L and remained within the acceptable BIS limit in all samples, although 38% exceeded the desirable limit of 500 mg/L. A weak positive correlation was observed between fluoride and TDS ($r = 0.20$).

Conclusion: Most government school drinking water sources in Hingoli district showed elevated fluoride levels, indicating a potential risk of dental fluorosis among schoolchildren. Regular water quality surveillance and appropriate defluoridation measures are recommended to reduce the risk of fluorosis among schoolchildren.

Keywords: Fluoride, Total dissolved solids, Drinking water, Schoolchildren, Dental fluorosis.

INTRODUCTION

Safe drinking water is essential for maintaining oral and systemic health. Fluoride is naturally present in groundwater and has both beneficial and harmful effects depending on its concentration.¹ Excess fluoride exposure above 1.5 mg/L may result in dental and skeletal fluorosis, particularly among children during enamel development.² Total dissolved solids (TDS) influence water quality and

palatability, with BIS recommending desirable levels below 500 mg/L.³ Hingoli district predominantly depends on groundwater obtained from borewells and hand pumps; however, limited data are available regarding fluoride and TDS levels in school drinking water. Assessment of these parameters is important because schoolchildren are particularly vulnerable to the effects of chronic

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fluoride exposure during the years of tooth development. Therefore, the present study was conducted to assess fluoride and TDS levels in government school drinking water sources across Hingoli district, Maharashtra.

MATERIALS AND METHODS

A cross-sectional observational study was conducted among government schools across five talukas of Hingoli district, Maharashtra, namely Hingoli, Sengaon, Kalamnuri, Aundha Nagnath, and Basmath, between August 2025 and October 2025. A total of 50 government schools were selected using stratified random sampling, with 10 schools included from each taluka. Government schools with functional drinking water sources were included in the study, while schools without active water supply or those undergoing water treatment or repair during sampling were excluded.

Water samples were collected in sterile labelled plastic containers and transported under refrigerated conditions to the laboratory within 24 hours. Fluoride estimation was performed using the SPADNS colorimetric method according to APHA 4500-F D guidelines. All water samples were analyzed at the Government Drug and Scientific Analysis (GDSA) Laboratory. TDS values were measured on-site using a calibrated digital TDS meter. Data were entered into Microsoft Excel 2021 for statistical analysis. Descriptive statistics including mean, standard deviation, and range were calculated, and Pearson's correlation coefficient was used to determine the relationship between fluoride and TDS levels.

RESULTS

Table 1 shows the taluka-wise mean fluoride and TDS levels in drinking water samples collected from government schools across Hingoli district. Mean fluoride concentrations ranged from 1.97 ± 0.25 mg/L in Aundha Nagnath to 2.09 ± 0.09 mg/L in Kalamnuri, while mean TDS values ranged from 313.90 ± 194.18 mg/L to 454.00 ± 131.41 mg/L across different talukas. Figure 1 illustrates the distribution of fluoride and TDS levels among the

DISCUSSION

The present study evaluated fluoride and total dissolved solids (TDS) levels in drinking water sources of government schools across Hingoli

studied water samples. Fluoride concentrations ranged from 1.46 mg/L to 2.21 mg/L. Out of 50 samples analyzed, 48 samples (96%) exceeded the BIS permissible fluoride limit of 1.5 mg/L, while only two samples demonstrated fluoride levels marginally below the permissible limit. All talukas showed mean fluoride concentrations above 1.9 mg/L, indicating widespread fluoride contamination across Hingoli district. TDS values ranged from 28 mg/L to 771 mg/L. Although 38% of samples exceeded the desirable BIS TDS limit of 500 mg/L, all samples remained within the maximum permissible limit of 2000 mg/L. Pearson's correlation analysis demonstrated a weak positive correlation between fluoride and TDS levels ($r = 0.20$).

Table 1: Taluka-wise Mean Fluoride and TDS Levels.

Taluka	Fluoride (Mean $\pm$ SD) mg/L	TDS (Mean $\pm$ SD) mg/L
Sengaon	2.07 ± 0.03	454.00 ± 131.41
Kalamnuri	2.09 ± 0.09	414.30 ± 143.49
Aundha Nagnath	1.97 ± 0.25	313.90 ± 194.18
Hingoli	2.08 ± 0.12	391.40 ± 214.13
Basmath	2.07 ± 0.08	345.00 ± 227.67

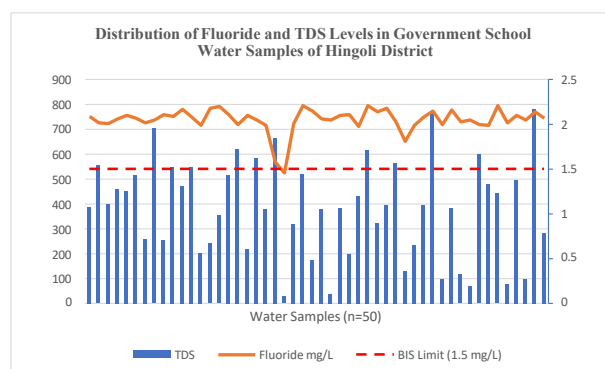


Figure 1: Distribution of fluoride and TDS levels among government school drinking water samples in Hingoli district. The dashed red line represents the BIS permissible fluoride limit (1.5 mg/L).

district, Maharashtra. The findings revealed consistently elevated fluoride concentrations in most water samples, while TDS values largely remained within acceptable limits.

The mean fluoride concentration in all talukas exceeded the BIS permissible limit of 1.5 mg/L. Out of 50 water samples analyzed, 96% demonstrated fluoride levels above recommended standards. These results indicate that schoolchildren in Hingoli district may be at increased risk of dental fluorosis due to chronic exposure to fluoride-rich drinking water.

Fluoride contamination in groundwater is generally associated with geological formations and prolonged interaction between groundwater and fluoride-bearing minerals. The elevated fluoride levels observed in the present study may be attributed to geogenic contamination associated with basaltic aquifers and groundwater characteristics of the Marathwada region.

Similar observations were reported by Rewatkar et al., who documented significant prevalence of fluorosis in rural populations of Marathwada region, Maharashtra and identified groundwater fluoride as a major contributing factor.⁴ Dhurvey and Marganwar reported high fluoride concentrations in drinking water sources of Chandrapur district, Maharashtra, along

with increased prevalence and severity of dental fluorosis among schoolchildren.⁵ Chowdhury et al. reported substantial regional variation in fluoride concentration across Karnataka and observed that areas with elevated groundwater fluoride levels demonstrated increased risk of dental and skeletal fluorosis.⁶ Comparable findings have also been documented from Rajasthan, where Choubisa et al. reported endemic dental fluorosis among children residing in fluoride-endemic regions.⁷ Teotia and Teotia described endemic fluorosis as a major public health problem in India and emphasized the role of long-term groundwater consumption in the development of dental and skeletal fluorosis.⁸ Susheela et al. further highlighted that chronic exposure to fluoride-rich groundwater continues to affect several Indian states and stressed the importance of preventive public health strategies and regular water quality monitoring.⁹

Children are particularly vulnerable to fluoride toxicity because enamel formation occurs during early developmental years. Continuous

consumption of high-fluoride water during this period may result in irreversible enamel hypomineralization and dental fluorosis. Since schoolchildren consume drinking water daily during school hours, regular monitoring of school water quality becomes critically important from a preventive dentistry perspective.

In contrast to fluoride findings, TDS levels in the present study were generally within acceptable limits. Although some samples exceeded the desirable BIS limit of 500 mg/L, none crossed the maximum permissible threshold of 2000 mg/L. These findings suggest that fluoride contamination represents a more significant concern than overall dissolved solids in the studied water sources. The weak positive correlation between fluoride and TDS ($r = 0.20$) indicates that fluoride concentration may not directly depend upon overall dissolved solids in water. Therefore, normal TDS values should not be interpreted as indicators of safe fluoride concentration. Early identification of fluoride-endemic regions may help in implementation of preventive oral health measures and reduction in fluorosis burden among children.

The findings of this study have important public health implications. Regular surveillance of drinking water quality, installation of defluoridation units, identification of alternative low-fluoride water sources, and community awareness programs are strongly recommended to minimize long-term health consequences among schoolchildren.

CONCLUSION

The present study demonstrated widespread fluoride contamination in drinking water sources of government schools across Hingoli district, Maharashtra. Nearly all samples exceeded the permissible BIS fluoride limit, indicating a potential risk of dental fluorosis among schoolchildren.

TDS levels were generally within acceptable limits, although several samples exceeded desirable standards. A weak positive correlation was observed between fluoride and TDS. The present study highlights the need for periodic water quality surveillance, preventive public health interventions, implementation of defluoridation measures in affected regions and community-based preventive

strategies to reduce the burden of fluorosis among schoolchildren.

Limitations

The present study was limited to government schools only, and seasonal variations in water quality were not evaluated. In addition, dental fluorosis assessment among schoolchildren was not performed.

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