

**Research Article** 

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# Estimation of Fluoride Concentration in Drinking Water and Associated Health Risk Assessment in Children's of Higher Secondary Schools of Sheopur District, Madhya Pradesh, India

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# Abstract

Sheopur is one of the tribal districts among the 21 tribal districts of Madhya Pradesh. It is small tribal towns and Sehariya tribe population lives here. Therefore, present investigation was carried out for 24 Higher Secondary Schools of the Sheopur district to delineated fluoride concentration in groundwater drinking water used by school children's. The calculation of the water quality index has shown that 62 % of groundwater is of low quality and is not suitable according to BIS and WHO requirements for domestic purposes. As groundwater is the only source of drinking water in the region. A total 22 tube bell, hand pump and dug bell samples were collected from 17 villages of Sheopur. Dug and tube wells are used by the municipal water delivery system. Fluoride toxicant was quantifying by ion selective electrode method. The maximum fluoride range recorded in Karhal is 1.63 ppm and minimum fluoride range recorded in Vijyapur (Raghunathpur village) was 0.12 ppm and other physicochemical parameter was screened like pH, TDS, EC, turbidity, Na, Ca, and K. The ranges of these parameters are pH 6 to 7.5, TDS 150 to 1960 in ppm, EC 0.1 to 2.2 µS/cm, turbidity 0.2 to 11.10 NTU, Na 9.25 to 437 ppm, Ca 29.96 to 60.75 ppm and K 0.2 to 88.07 ppm. This study was carried out first time which revealed the fluoride range as a systematical presented in maximum high secondary schools of Sheopur district which confined to a big area in the Sheopur district region. This was in accordance with WHO guidelines explaining that at an optimal fluoride level (1 ppm), about 20% of the population demonstrates fluorosis.

**Keywords:** Fluoride; Fluorosis (dental, skeletal); Tribe population; Sheopur; Saharia tribe

# Introduction

The main source of intermediate of fluoride is the water, which is taken by humans in very high quantities [1,2]. Fluoride is a natural substance and an essential micronutrient for all human beings who are providing to strengthen the apatite matrix of bone tissues and teeth [3]. The acceptable limit of fluoride in drinking water is according to the WHO 1.5mg/l and 1.2 mg/l is according to BIS. Taking a high level of fluoride from a fixed level by human, it is a major cause for dental and skeletal fluorosis [4]. In rural and tribal areas are distribution system of water is dug well, tube wells and hand pumps for drinking purposes but excess fluoride and excess salinity present in the water sources [5]. Groundwater is the major source of drinking water and rural population its only depends on groundwater for domestic and agriculture purposes [6]. Low or high concentration of fluoride in ground water it's depends on the rock's nature and present of fluoride bearing mineral in bedrocks [7].

Fluorosis is a very big public health problem in India and all over the world [8]. Approximately 62 million people and 6 million children have become victims of fluorosis by consuming of fluoride containing water [9]. Fluorosis is major health problems caused by high fluoride value in drinking water and when it is exceeding the value are dental fluorosis, abnormal teeth formation and deformation of bones in children as well as in adults [10]. Fluoride is showing the beneficial effect on teeth and bone at present in low concentration in drinking water but present in excessive rate of fluoride in water can expose the major health problems like as dental fluorosis and skeletal fluorosis [11]. Fluoride concentration is over 2.0mg/l it is responsible for dental fluorosis and above 4.0 mg/l responsible for skeletal fluorosis. Fluorosis is a chronic condition caused by excessive intake of high limit fluoride marked by mottling of the teeth and calcification of the ligaments. Fluorosis is mainly two types' skeletal fluorosis and dental fluorosis. Toxic levels of fluoride have been coupled with a weakening of bones and increase in hip and fractures.

Main objective of this investigation describes the fluoride toxicant on the tribal population basically school going children's of Sheopur district. In this study, we have presented the systematic investigation and mapping of fluoride Sheopur district using their concentration and cover the 23 higher secondary school of this tribe district of Madhya Pradesh.

# Materials and Methods

#### Study area

The research investigation was carried out on selected higher secondary schools of Sheopur district of Madhya Pradesh. The district is located north western corner of Madhya Pradesh which is border by Rajasthan on the west and Utter Pradesh on the north. It is bounded by latitude 25.67° north and longitude 76.7° east. The adjacent districts are Morena, Gwalior and Bhind in the east and Shivpuri in the south. Total 21 districts of M.P. are tribal districts. Sheopur is one of tribal district of Madhya Pradesh (Figure 1). Karahal, Baroda and Vijaypur three block includes in Sheopur district and five Tehsil Sheopur, Baroda, Vijyapur, Veerpur and Karahal cover the all over Sheopur district (Figure 2). In

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Received: 02-Oct-2023, Manuscript No. jescc-23-117185; Editor assigned: 04-Oct-2023, PreQC No. jescc-23-117185 (PQ); Reviewed: 18-Oct-2023, QC No. jescc-23-117185; Revised: 23-Oct-2023, Manuscript No. jescc-23-117185 (R); Published: 30-Oct-2023, DOI: 10.4172/2157-7617.1000739

**Citation:** Garg RK, Vishwakarma M (2023) Estimation of Fluoride Concentration in Drinking Water and Associated Health Risk Assessment in Children's of Higher Secondary Schools of Sheopur District, Madhya Pradesh, India. J Earth Sci Clim Change, 14: 739.

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Figure 1: Map showing tribal districts of the Madhya Pradesh.



Figure 2: Five Tehsils of Sheopur district of Madhya Pradesh.

Madhya Pradesh Sahariya tribe population mainly live in the Sheopur district but some Sahariya tribes found in Morena, Bhind, Gwalior, Datia, Shivpuri, Vidisha and Guna districts of Madhya Pradesh. These tribe populations only depend on the ground water for domestic and agriculture use.

# Sample collection

Total 138 water samples have been collected from different sources like hand pump, bore well and wells of the different primary and higher secondary schools of Sheopur district. Each sample was collected in plastic bottles and stored in the laboratory at room temperature. The samples were collected, during November, 2017 to October 2018 from manually operated bore wells, hand pump and open wells.

## Fluoride estimation using ion selective electrode

We have used ion selective electrode for measurement of fluoride range in water sample. This method detects the accurate reading of fluoride in water sample. The ion selective electrode was calibrated by using three fluoride standard solution 1.0 ppm, 10.0 ppm & 100.0 ppm. We had prepared 1.0 ppm & 10.0 ppm from 100.0 ppm fluoride standard solution and then taken a 25.0 ml of standard solution and added 25.0 ml of TISAB-II solution in each of the standard solution. Calibration was carried out as per the manual provided with the ion meter. After three step calibration, we have analyzed the 138 water sample on the same procedures using Multimeter (Make Hanna Model: HI 9829). Initially, we checked the pH of all water samples with the help of pH meter and after that analyzed fluoride concentration in all collected water sample and different water quality parameters like turbidity, TDS, EC, Na, Ca and K.

# **Results and Discussion**

This research study was performed on fluoride concentration in the schools of Sheopur district of Madhya Pradesh, India. Consequently, we also made survey among schools going children's by considering various physiological parameters. We have been covered all over higher

Table 1: Fluoride concentration in drinking water of various Higher Secondary Schools of Sheopur district, Madhya Pradesh.

S. No.	Block Name	Village Name	School Name	Water Source	pН	Fluoride	TDS	EC	Turbidity	Na	Са	к
1	Karhal	Karhal	Govt. Excellence Higher Secondary School	Bore well	7.4	1.63	190	0.2	0.9	15.71	32.65	5.67
2	Vijyapur	Occhhapura	Govt. Higher Secondary School	Bore well	6.67	0.176	1160	0.3	3.5	9.14	35.56	15.5
3	Vijyapur	Occhhapura	Govt. Higher Secondary School	Hand Pump	6.67	0.176	430	0.1	0.9	58.2	59.83	87.61
4	Vijyapur	Shaympur	Govt. Higher Secondary School	Hand Pump	7	0.138	320	0.2	9.6	18.16	32.85	1.17
5	Vijyapur	Raghunathpur	Govt. Higher Secondary School	Hand Pump	6.5	0.12	110	0	11.1	6.17	30.45	15.3
6	Vijyapur	Tarra Kalan	Govt. Higher Secondary School	Hand Pump	6.6	0.133	360	0.2	3.7	17.13	34.9	88.07
7	Veerpur	Veerpur	Govt. Higher Secondary School	Bore well	6.3	0.259	1060	0.9	0.2	129	45.28	4.28
8	Vijyapur	Vijyapur	Govt. Girls Higher Secondary School	Bore well	6.89	0.235	1960	2.2	0	437	60.75	32.92
9	Vijyapur	Vijyapur	Govt. Excellence Higher Secondary School	Bore well	7.47	0.5	590	0.5	0.8	76.5	35.81	36.65
10	Vijyapur	Vijyapur	Modal Higher Secondary School	Hand Pump	7.2	0.37	440	0.3	0.1	180	30.22	11.49
11	Sheopur	Sheopur	Govt. Excellence Higher Secondary School	Bore well	6.69	0.16	370	0.2	3.3	26.75	33.59	17.26
12	Sheopur	Sheopur	Govt. Girls Higher Secondary School	Bore well	7.23	0.166	480	0.3	0.5	29.06	36.11	17.1
13	Sheopur	Sheopur	Govt. Hajareshwar Higher Secondary School	Bore well	7.13	0.13	380	0.3	1.7	45.3	35.11	12.32
14	Sheopur	Sheopurkalan	Govt. Modal Higher Secondary School	Bore well	7	0.14	230	0.1	0	23.83	31.63	7.66
15	Sheopur	Pahela	Govt. Higher Secondary School	Bore well	7.13	0.76	150	0.1	0.3	9.25	30.33	7.5
16	Karhal	Sesaipura	Govt. Higher Secondary School	Hand pump	7.2	0.42	440	0.3	1.4	26.96	34.97	26.96
17	Karhal	Karahal	Govt. Modal Higher Secondary School	Tube well	7.21	0.22	260	0.1	0.8	13.67	30.93	0.12
18	Baroda	Pandolla	Govt. Higher Secondary School	Hand pump	7.27	0.698	280	0.2	0.2	21.32	29.94	1.7
19	Baroda	Radep	Govt. Higher Secondary School	Hand pump	7.31	0.403	210	0.1	0.4	10.62	31.07	10.62
20	Baroda	Baroda	Govt. Higher Secondary School	Tube well	7.02	0.921	880	0.7	2.6	200	35.21	17.24
21	Sheopur	Saikala	Govt. Higher Secondary School	Hand pump	7.5	0.519	450	0.3	2.6	58.2	33.89	31.72
22	Sheopur	Dantrada kala	Govt. Higher secondary school	Hand pump	7.49	0.826	1360	1.2	0.8	282.7	40.33	22.48
23	Sheopur	Premsar	Govt. Higher Secondary School	Bore well	7.32	0.97	1030	0.8	0.4	240	39.03	14.63

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secondary school of Sheopur district for estimation of fluoride in various water sources used for drinking purposes in the schools which has been shown in the Table 1 including other selected water quality parameters. All the parameters ware with standard laid down limit of define by the World Health Organization (WHO) and Bureau of Indian Standards (BIS).

The different drinking water quality parameters with their variations showed as pH as 6 to 7.5, TDS as 150.00 to 1960.00 ppm, electrically conductivity as 0.1 to 2.2 in ms/cm, turbidity as 0.2 to 11.1 NTU, Sodium as 9.25 to 437.00 ppm, Calcium as 29.96 to 60.75 ppm and potassium as 0.2 to 88.07 ppm. The results of analysis of fluoride content in drinking water samples of schools located in Sheopur district are summarized in Table 2; however, Table 3 shows the different concentration of fluoride effects on human body. Fluoride concentration including other important water quality parameters of the drinking water of various higher secondary schools of Sheopur district, Madhya Pradesh have been shown in Table 1 and various levels of these water quality parameters at different study sites have been shown in Graphs 1-8.

The analysis revealed that the fluoride in drinking water samples ranges from 0.12 mg/l to 1.63 mg/l. Therefore, the drinking water available in the schools located in the Sheopur district is having fluoride content well within the permissible limits of WHO and there is no need of defluoridation of water samples. Only drinking water hand pump of Govt. Excellence Higher Secondary School, Karhal district Sheopur showed higher concentration of fluoride as 1.63 mg/l which is slightly higher in concentration if compared with WHO standards. Based on the recorded mean concentration, it may be inferred that exposure to fluoride from drinking water is not of much concern in the study area. However, spatial variations and observed values of 1.63 mg/l at one place indicate that the health of exposed population may be compromised at few places, particularly if the source is used for drinking water. Moreover, intake of more volume of water during early growing stage may results in fluorosis among children since most of the ingested minerals are absorbed by the body during growing state [12].

The population having more of vegetables in food is expected to

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excrete more of fluoride in urine compared to those who consume more of meat [13]. The recognition of the protective role of fluoride in drinking water against dental caries is considered as one of the major public health advances of this century [14]. It is also recognized, that fluoride levels in excess of those that provide most of the protection against dental caries can lead to dental mottling. It is a paradox that mottled enamel (dental fluorosis) was associated with the presence of fluoride in drinking water long before its relationship with lower caries prevalence was noted [15].

Previous studies in communities with similar water fluoride concentration in the water, have reported fluorosis prevalence of 2.8–8.8% [16]. This was in accordance with WHO guidelines explaining that at an optimal fluoride level (1 ppm), about 20% of the population demonstrates fluorosis [17,18].

Our findings showed that the risk of dental fluorosis is less in the areas studied at various schools of the district Sheopur, Madhya Pradesh. This study can act as a pointer to public health physicians, dentists, administrators, planners, and water supply authorities.

The information furnished can be utilized as preliminary data, and a well-designed epidemiological investigation can be undertaken at village level and district level to confirm and assess dental fluorosis. It is recommended there is no need to reduce the fluoride content of drinking water as it is accordance with WHO guidelines at various schools of the district Sheopur, Madhya Pradesh.

#### Acknowledgments

The financial support from Natural Resources Data Management System (NRDMS), Department of Science and Technology (DST), Government of India, New Delhi is highly appreciated. The Authors with thanks of Director General, M.P. Council of Science and Technology, Government of Madhya Pradesh for their help and encouragements during the research work. The Authors are also with thanking to laboratory colleagues and students for their support during the laboratory support. We wish to thank to Principals of various schools of the district Sheopur for helping us during samples collections.

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69.33

Reading/Parameter	Fluoride	pН	TDS	EC	Turbidity	Na	Ca	
Minimum	0.12	6.3	110	0	0	6.17	29.94	
Maximum	1.63	7.5	1960	2.2	11.1	437	60.75	
Mean	0.437	7.0521	571.30	0.41	1.99	84.11	36.54	
Standard Deviation	0.370	0.33	460.67	0.48	2.88	111.63	8.32	

212220.95

 Table 2: Summarized drinking water various Higher Secondary Schools of Sheopur district.

## Table 3: Different concentration of fluoride effect on human body (David 2008).

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S. No.	Fluoride concentration (ppm/lit)	Effect shows in human health
1.	<0.5	Dental caries
2.	0.5-1.5	Optimum dental health
3.	1.5-2.0	Mottling teeth, tooth decay in children's and physical damage tooth.
4.	2.0- 4.0	Discolours and disfigures the teeth, Staining of tooth enamel and possibility of skeletal Fluorosis
5.	4.0-10	Skeletal fluorosis is characterized by irregular bone deposits like as arthritis
6.	>10.0	Joint crippling, and crippling Fluorosis

CV

**K** 0.12 88.07 21.12 23.32

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Graphs 1-8: Various drinking water qualities of parameters of higher secondary schools of Sheopur.

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