Original Article

UPDCJ OPEN ACCESS

Fluoride in Drinking Water and its Correlation with Dental Caries in Northern Rural Areas of Bangladesh

Habib T[1*], Islam SMS[2*], Rahman A[3], Yasmeen W[4], Iqbal MA[5].

AUTHOR'S AFFILIATIONS

1. **Tasnia Habib**
   Assistant Professor,
   Department of Periodontology and Oral Pathology,
   Udayan Dental College, Rajshahi, Bangladesh
   https://orcid.org/0009-0002-8103-9611
2. **S. M. Shahinul Islam**
   Professor, Institute of Biological Sciences,
   University of Rajshahi, Bangladesh
   https://orcid.org/0000-0001-8122-2243
3. **Aminur Rahman**
   Department of Biomedical Sciences,
   College of Clinical Pharmacy, King Faisal University, Al-Ahsa-31982
   Saudi Arabia
   https://orcid.org/0000-0001-8326-026X
4. **Wahida Yasmeen**
   Department of Public Health,
   Rangpur Community Dental College, Rangpur, Bangladesh
   https://orcid.org/0009-0005-3129-232X
5. **Md. Ashif Iqbal**
   Associate Professor, Dept. of Periodontology & Oral Pathology,
   Update Dental College & Hospital. Dhaka, Bangladesh
   https://orcid.org/0000-0002-9490-7927

ARTICLE INFO.

Received: 2 March, 2025
Accepted: 18 March, 2025

Volume: Vol-15, Issue-1, April 2025

DOI: https://doi.org/10.3329/updcj.v15i1.80550

Publisher: Update Dental College, Dhaka, Bangladesh

Web: www.updatedentalcollege.edu.bd

E-mail: updcj@hotmail.com

Scan to access article citation and full online link

Corresponding Author*

S. M. Shahinul Islam
Professor, Institute of Biological Sciences,
University of Rajshahi, Bangladesh
Email: shahin_ibsc@ru.ac.bd
ORCID: https://orcid.org/0000-0001-8122-2243

Tasnia Habib
Assistant Professor
Department of Periodontology and Oral Pathology,
Udayan Dental College, Rajshahi, Bangladesh
Email: tasniahabibsinthia@gmail.com
ORCID: https://orcid.org/0009-0002-8103-9611
*These Authors contributed equally as corresponding authors

ABSTRACT

Objective: The aim of this study is to evaluate the prevalence of dental caries and its relationship with fluoride levels in drinking water. Fluoride concentrations were analyzed in six different Upazilas of Naogaon, located in the northern region of Bangladesh.

Methods: The study included a total of 120 dental caries patients from these six Upazilas, with 60 males and 60 females. The fluoride concentration in drinking water was evaluated by utilizing the (SPADNS) method. The findings indicated that Sapahar Upazila exhibited the lowest concentration of fluoride in drinking water at 0.118±0.12 mg/L whereas Manda Upazila exhibited the highest mean frequency of fluoride concentration in drinking water, which was recorded as 0.875±0.34 mg/L.

Results: It was found that DMFT (Decayed, Missing, Filled teeth) value gradually decreased with increasing water fluoride levels from >6.5 mg/L. Conversely, DMFT increased progressively when water fluoride levels dropped below 1.1 mg/L. Sapahar exhibited a significantly higher incidence of dental caries (94.7%) compared to other Upazilas despite having the lowest fluoride level (0.190±0.06) with the highest DMFT index (7.124±0.62).

Conclusion: The study observed that low levels of fluoride in the studied area are a major contributing factor to dental caries, necessitating increased awareness among the population. Additionally, the use of fluoride toothpaste is recommended to address the issue in areas where the fluoride concentration in drinking water falls below 0.5 mg/L.

KEY WORDS: Dental caries, Fluoride concentration, Drinking water, DMFT index, Oral health.

INTRODUCTION

Fluorides are classified as inorganic non-metallic fluorine compounds and are naturally present in water and soil. Upon absorption through the gastrointestinal tract, fluoride plays a vital role in fortifying teeth and bones, accumulating in areas with high calcium levels, such as bones and teeth [1]. Fluoride compounds are crucial for dental health, aiding in the remineralization of damaged tooth enamel, combating early signs of decay, and inhibiting the growth of harmful oral bacteria[2]. This naturally occurring element is widespread and found in varying concentrations in rocks, minerals, volcanic gases, and other materials. Optimum level of fluoride concentrations in drinking water are considered beneficial for preventing dental caries [3].

However, the increasing demand for groundwater has led to the consumption of naturally fluoride-rich groundwater, causing dental fluorosis, skeletal fluorosis, and bone deformities [4]. The World Health Organization (WHO) recommends a maximum fluoride concentration of 1.5 mg/L in naturally occurring drinking water, with an intake of 2 liters per day [5,6]. The stress effects of fluoride on humans, while certain European countries maintain drinking water fluoridation concentrations within the range of 0.8 to 1.2 mg/L. The US Department of Health and Human Services suggests that 0.7 mg/L of fluoride in drinking water is required to inhibit tooth decay [7,8].

While fluoride concentrations in drinking water below 0.5 mg/L may protect adults from dental caries, there is an increased risk for caries in children. Excessive fluoride exposure can lead to adverse health effects such as dental fluorosis and skeletal fluorosis, resulting in corroded teeth and bone pain [9,10]. High fluoride concentrations in drinking water have been linked to various diseases, affecting skeletal fluorosis, and causing hard tissue deformities. Reports indicate a range of fluoride concentrations in supplied water from 0.03 to 1.10 mg/L with groundwater fluoride levels in Bangladesh typically below 1.0 mg/L [8,9].

Dental caries is a chronic and progressive disease affecting the mineralized tissue of teeth, with a multifactorial etiology involving the interaction of tooth substance, microorganisms, and dietary carbohydrates over time. This process leads to demineralization of tooth enamel, cavitation, and functional impairment, often associated with pain, infection, tooth loss, and diminished quality of life [11,12]. Bangladesh is identified as a high-risk country for dental caries [2]. The Aim and objectives of this study is assessing the fluoride level in drinking water across the northern rural areas of Bangladesh using the SPADNS method and explore the interrelationship between the fluoride levels in drinking water with the prevalence of dental of dental caries as well as the DMFT index among the local populations.

METHODS:

Study area and population

This study was completed between January 2021 to September 2022 at the Dental Unit, Rajshahi Medical College, Rajshahi & Plant Biotechnology and Genetic Engineering Lab., Institute of Biological Sciences, University of Rajshahi, Bangladesh. For this study, six Upazila, namely Naogaon Sadar, Niamatpur, Manda, Mohadevpur, Porsha and Saphar in the Naogaon district of Bangladesh, were selected. A total of 120 patients, comprising 60 males and 60 females, from these six Upazilas were identified as having severe erosion or primary lesions. Among all these cases, 20 participants were selected from each of the six studied Upazilas of Nagaon district. Among all these cases, 20 participants (10 male, 10 female) were selected from Nagaon Sadar, 20 from Niamatpur (10 male, 10 female), 20 from Manda (10 male, 10 female), 20 from Mohadevpur (10 male, 10 female), 20 from Porsha (10 male, 10 female) and 20 (10 male, 10 female) from Saphar in the Naogaon District (Table 1). The age range of the participants was 3 to 66 years, categorized into four groups: 3-18, 19-34, 35-50, and 51-66 years. A total of 120 samples were collected from respondents in each Upazila for the analysis of fluoride concentration in drinking water.

Data collections

Initially, 120 respondents were chosen at the Dental unit, Rajshahi Medical College and they examined by a licensed dentist to evaluate the presence of severity of dental caries. All of them were residents of the selected Upazilas. Patients were requested to bring samples of their drinking water (collected from tap water, and or tube well) in bottles. The collection of drinking water bottles took place from January 2021 to September 2022. Relevant information was recorded in a pre-determined datasheet and each bottle was labeled with the patient's name and ID number before being transported to the laboratory. All recipients were selected from Nagaon district because the principal researcher is permanently residing there and practicing in her own clinic. Some patients came from her clinic and she referred them to the Dental unit, Rajshahi Medical College and some patients were at RMCH but they lived in Nagaon. Furthermore, they have taken the lab facilities of Rajshahi Medical College for the clinical testing of this study and completed the entire process.

Questionaries: Data on socio-economic factors, dietary habits and oral hygiene practice were collected through structural interviews.

Laboratory assessment

The fluoride concentration in drinking water was analyzed for respondents from different Upazilas. The prevalence of dental caries among respondents was identified through observation. Caries missing teeth were employed assess the caries experience [13]. The (DMFT) index are clinical indicator that measures the number of decayed, missing or filled teeth in a person's mouth and provide a numerical score which represents the actual dental caries situations of a person's mouth. The whole research work and assessment procedures were implemented followings two steps such as first step is clinical works like patients selections along with caries and DMFT index score detection and collections were done by expert dentists in the Outdoor Department of Rajshahi Medical College and Hospital and second step is laboratory works such as detection of fluoride concentrations in water were measured by SPADNS method at Plant Biotechnology and Genetic Engineering Lab., Institute of Biological Sciences, University of Rajshahi, Bangladesh.

There is a stronger Association between DMFT index and dental caries progression along with fluoride concentration in drinking water.

Fluoride assessment method

The fluoride concentration in drinking water was determined using the SPANDS ($C_{16}H_9N_2Na_3O_{11}S_3$) method. The SPANDS method refers to a particular analytical technique used in the measurement of certain types of analytes, typically involving SPANDS (sodium 3-amino-7-nitro-2,1,3-benzoxadiazole-4-sulfonate), which is a reagent. This reagent, $C_{16}H_9N_2Na_3O_{11}S_3$, is often used in spectrophotometric or fluorescence detection methods to measure specific ions or compounds in solution. SPADNS is typically used in assays, such as those involving the analysis of amine or amine-containing compounds [13,14]. The method is based on the ability of SPADNS to form fluorescent complexes with certain analytes, allowing for sensitive and selective detection. The specific chemistry involves a reaction between the amine groups and SPADNS, forming a colored or fluorescent product that can be quantified with appropriate instrumentation, such as a spectrophotometer or fluorometer. The use of the SPADNS method is the most preferable as it does not involve sophisticated instruments and expensive chemicals. In the SPADNS method, zirconium reacts with SPADNS to form a red-colored complex. The reaction between fluoride and the SPADNS reagent is rapid and hence the samples can be tested within 10 min after adding them to the reagent. SPADNS reacts with zirconyl chloride to give a wine-red-colored complex which further reacts with fluoride to give a new complex [1,15]. When the bright red solution of SPADNS is mixed with colorless zirconyl acid solution, a dark red complex of zirconyl acid–SPADNS is formed. When zirconyl acid–SPADNS solution is added to water containing fluoride, the fluoride ions react with the complex and bonds with zirconium. The concentration of the complex decreases in approximate proportion to the concentration of fluoride in the water and the color of the reagent-mixture becomes brighter [4,16].

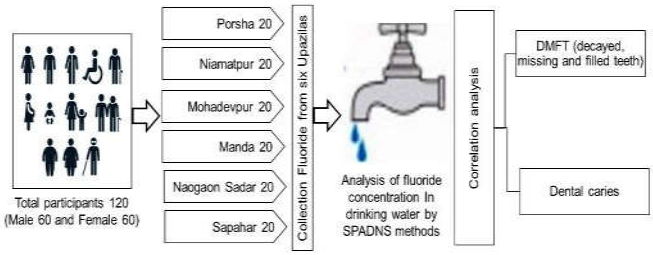

Fig. 1: Flow diagram of the study design.

Table 1: Dental caries and DMFT status of six Upazila of Nagaon district under different age groups in Northern part of Bangladesh.

Pt. Sl.	*Age (yrs)*	*Sex*	*Caries status*	*DMFT status*	*Name of Upazila*	*Pt. Sl.*	*Age (yrs)*	*Sex*	*Caries status*	*DMFT status*	*Name of Upazila*
1	3	Male	SC	High	Porsha	61	30	Male	EC	High	Porsha
2	13	Female	EC	High	Porsha	62	28	Female	SC	High	Porsha
3	25	Male	SC	High	Porsha	63	27	Male	SC	High	Sapahar
4	6	Female	GCML	Moderate	Niamatpur	64	25	Female	LCTD	Very High	Sapahar
5	4	Male	GCML	Moderate	Mohadevpur	65	12	Male	LCTD	Very High	Sapahar
6	3	Female	ESC	Very Low	Manda	66	10	Female	LCTD	Very High	Sapahar
7	5	Male	NCL	Low	N. Sadar	67	11	Male	LCTD	Very High	Sapahar
8	36	Female	LCTD	Very High	Sapahar	68	9	Female	LCTD	Very High	Sapahar
9	8	Male	LCTD	Very High	Sapahar	69	10	Male	LCTD	Very High	Manda
10	10	Female	EC	High	Porsha	70	12	Female	ESC	Very Low	Manda
11	7	Male	GCML	Moderate	Niamatpur	71	11	Male	ESC	Very Low	Manda
12	6	Female	GCML	Moderate	Mohadevpur	72	18	Female	ESC	Very Low	Manda
13	10	Male	NCL	Low	N. Sadar	73	30	Male	ESC	Very Low	Manda
14	12	Female	NCL	Low	Mohadevpur	74	29	Male	SC	High	Porsha
15	11	Male	NCL	Low	Manda	75	60	Female	EC	High	Porsha
16	22	Female	NCL	Low	N. Sadar	76	21	Male	GCML	Moderate	Niamatpur
17	3	Male	SC	High	Porsha	77	23	Female	GCML	Moderate	Niamatpur
18	12	Female	EC	High	Porsha	78	22	Male	NCL	Low	Niamatpur
19	11	Male	EC	High	Porsha	79	25	Female	LCTD	Very High	Sapahar
20	10	Female	SC	High	Porsha	80	26	Male	LCTD	Very High	Sapahar
21	7	Male	NCL	Low	N. Sadar	81	27	Female	LCTD	Very High	Sapahar
22	12	Female	SC	High	N. Sadar	82	22	Male	GCML	Moderate	Mohadevpur
23	10	Male	NCL	Low	N. Sadar	83	12	Female	GCML	Moderate	Mohadevpur
24	9	Female	SC	High	N. Sadar	84	12	Male	LCTD	Very High	Mohadevpur
25	7	Male	NCL	Low	Niamatpur	85	10	Female	ESC	Very Low	Manda
26	6	Female	NCL	Low	Niamatpur	86	9	Male	ESC	Very Low	Manda
27	12	Male	NCL	Low	Niamatpur	87	3	Male	ESC	Very Low	Manda
28	10	Female	NCL	Low	Niamatpur	88	4	Female	SC	High	Niamatpur
29	15	Male	NCL	Low	Mohadevpur	89	5	Male	NCL	Low	Niamatpur
30	16	Female	GCML	Moderate	Mohadevpur	90	7	Female	SC	High	N. Sadar
31	12	Male	GCML	Moderate	Mohadevpur	91	42	Male	ESC	Very Low	Manda
32	10	Female	GCML	Moderate	Mohadevpur	92	10	Female	ESC	Very Low	Manda
33	11	Male	GCML	Moderate	Sapahar	93	12	Male	ESC	Very Low	Manda
34	9	Female	LCTD	Very High	Sapahar	94	51	Female	LCTD	Very High	Niamatpur
35	33	Male	LCTD	Very High	Sapahar	95	19	Male	ESC	Very Low	Manda
36	44	Female	LCTD	Very High	Sapahar	96	31	Female	ESC	Very Low	Manda
37	48	Male	LCTD	Very High	Niamatpur	97	10	Male	ESC	Very Low	Manda
38	5	Female	SC	High	Niamatpur	98	22	Female	EC	High	Porsha
39	12	Male	GCML	Moderate	Niamatpur	99	25	Male	GCML	Moderate	Mohadevpur
40	11	Female	GCML	Moderate	Niamatpur	100	28	Male	NCL	Low	Mohadevpur
41	28	Male	GCML	Moderate	Niamatpur	101	30	Female	GCML	Moderate	Mohadevpur
42	9	Female	GCML	Moderate	N. Sadar	102	22	Male	GCML	Moderate	Mohadevpur
43	10	Male	NCL	Low	N. Sadar	103	24	Female	LCTD	Very High	Sapahar
44	11	Female	NCL	Low	N. Sadar	104	25	Male	LCTD	Very High	Sapahar
45	12	Male	NCL	Low	N. Sadar	105	12	Female	EC	High	Sapahar
46	13	Female	NCL	Low	Porsha	106	26	Male	NCL	Low	Mohadevpur
47	15	Male	SC	High	Porsha	107	11	Female	GCML	Moderate	Mohadevpur
48	66	Female	EC	High	Porsha	108	12	Male	GCML	Moderate	Mohadevpur
49	20	Male	SC	High	Porsha	109	63	Female	ESC	Very Low	Manda
50	22	Female	SC	High	Porsha	110	12	Male	ESC	Very Low	Manda
51	12	Male	EC	High	Porsha	111	11	Female	ESC	Very Low	Manda
52	25	Female	SC	High	N. Sadar	112	10	Male	ESC	Very Low	Manda
53	11	Male	NCL	Low	N. Sadar	113	7	Male	EC	High	Niamatpur
54	37	Female	NCL	Low	N. Sadar	114	12	Female	SC	High	Niamatpur
55	13	Male	SC	High	N. Sadar	115	26	Male	NCL	Low	Niamatpur
56	11	Female	NCL	Low	N. Sadar	116	27	Female	GCML	Moderate	Mohadevpur
57	42	Male	NCL	Low	N. Sadar	117	22	Male	GCML	Moderate	Mohadevpur
58	12	Female	SC	High	N. Sadar	118	12	Female	LCTD	Very High	Sapahar
59	35	Male	SC	High	N. Sadar	119	41	Male	LCTD	Very High	Sapahar
60	21	Female	EC	High	Porsha	120	23	Female	NCL	Low	Mohadevpur

NCL= Non cavitated lesion, GCML= Gross cavity with mild lesion, LCTD= Large cavity tooth destruction, ESC= Early stage of caries, SC= Severe caries, EC= Extensive cavity, N. Sadar= Naogaon Sadar.

In this study we did not use any control group. It only shows the relationship between the fluoride concentration in drinking water with the Decayed, Missing, Filled teeth and Dental caries of the study patients of six upazila of Naogaon district. Data were regularly corrected and verified to eliminate errors and inconsistencies. Statistical analysis was performed by mean ± Standard Error.

RESULTS

In this study, 120 drinking water samples were collected from 120 dental caries respondents, (60 males and 60 females) from six upazilas of Nagaon district, for analysis of fluoride concentration in drinking water. The age range of the participants was 3 to 66 years, categorized into four groups: 3-18, 19-34, 35-50 and 51-66 years. Within the group, the majority were 20 males and 20 females, aged 3-18. Then there is the 19-34 age group with 15 male and 15 female. On the other hand, there were 15 males and 10 females aged 35-50, as well as 10 males and 15 females aged 51-66 (Table 2).

After analyzing the results, no significant differences were observed in fluoride concentrations in drinking water between males and females. The analysis aimed to determine the minimum, maximum, and mean values of fluoride concentrations in the collected samples. Notably, Sapahar Upazila exhibited the lowest concentration of fluoride in drinking water at 0.118±0.12 mg/L whereas Manda Upazila exhibited the highest mean frequency of fluoride concentration in drinking water, which was recorded as 0.875±0.34 (Table 2). For Porsha Upazila, fluoride levels in drinking water ranged from 0.316±0.06 to 0.383±0.21 mg/L, for Niamatpur Upazila, ranged from 0.326±0.11 to 0.495 mg/L, for Mohadevpur Upazila, ranged from 0.326±0.11 to 0.495 mg/L, Fluoride levels in drinking water ranged from 0.601±0.28 to 0.875±0.34 mg/L for Manda Upazila, ranged from 0.428±0.35 to 0.731±0.46 mg/L for Naogaon Sadar Upazila and for Sapahar Upazila, fluoride levels in drinking water were 0.118±0.12 to 0.279±0.19 mg/L (Table 3).

Results show in Table 2, the comparison of fluoride concentration in water on DMFT index and caries status and illustrating a stronger association of the DMFT index score and dental caries along with fluoride concentration with direct correlation between fluoride concentration in drinking water and the occurrence of dental caries. This score is also used by WHO to quantify and compare the incidence of dental decay in a community. This index is commonly used in epidemiological study to assess the caries prevalence in populations. Another objective of our study is to detection of fluoride level concentration in drinking water across the Northern rural areas of Bangladesh. For this purpose, we will have some know about the Optimum fluoride level. The Optimum fluoride Refers to recommended concentration of fluoride in drinking water typically considered to be 7 ppm which provides maximum dental benefits. This level mostly cited by WHO. Relation between the Fluoride in water, DMFT Index and Dental caries: Higher Fluoride in Water = Lower DMFT Index = slower caries Progression, Lower fluoride in water = Higher DMFT Index = Faster Caries Progression.

The results showed an inverse relationship among DMFT index and dental caries status with fluoride concentration in water. When the fluoride concentration was very high (>6.5) the DMFT index was very low and there was no caries. But when the fluoride concentration was very low (0.0-1.1) the DMFT index was very high and severe caries with large cavities and tooth destruction was found. In this study, fluoride concentration in drinking water was highest in Manda Upazilla hence DMFT index was very low 0.586±0.19 and dental caries progression percentage was lowest 55.3. On the other hand, since the fluoride concentration in drinking water in Sapahar Upazila was the lowest at 0.190±0.06, the DMFT index was the highest at 7.124±0.62 and the caries progression percentage was the highest at 94.7. Moreover, Porsha Upazilla showed moderate DMFT index of 4.317±0.28 where caries progression was 78.5% (Table 4).

Table 2. Fluoride concentrations in drinking water collected from patients of different Upazila.

Age groups	Gender (No.)	(Mean ± SE) mg/L					
		Porsha	Niamatpur	Mohadevpur	Manda	Naogaon Sadar	Sapahar
3-18	Male (20)	0.325±0.04	0.461±0.15	0.419±0.22	0.604±0.19	0.494±0.41	0.118±0.12
	Female (20)	0.342±0.06	0.495±0.12	0.421±0.13	0.687±0.26	0.617±0.56	0.164±0.32
19–34	Male (15)	0.383±0.21	0.349±0.08	0.592±0.17	0.813±0.46	0.565±0.26	0.279±0.19
	Female (15)	0.359±0.07	0.326±0.11	0.608±0.32	0.875±0.34	0.731±0.46	0.258±0.23
35–50	Male (15)	0.355±0.13	0.524±0.16	0.651±0.41	0.601±0.28	0.592±0.16	0.202±0.26
	Female (10)	0.316±0.06	0.458±0.13	0.327±0.19	0.622±0.51	0.668±0.23	0.212±0.17
51–66	Male (10)	0.372±0.09	0.346±0.08	0.318±0.26	0.761±0.43	0.454±0.22	0.136±0.13
	Female (15)	0.354±0.10	0.397±0.11	0.383±0.17	0.749±0.56	0.428±0.35	0.154±0.21

Table 3: Comparison of fluoride concentration in water on DMFT index and caries status.

Fluoride concentration in water (mg/dl)	**DMFT Index**	**Caries Status**
Optimum level (0.7 to 1.2 mg/dl)	Very Low (Score: 0.0-1.1)	No Caries
Optimum Level (0.7 to 1.2 mg/dl)	Low (Score:1.2-2.6)	Minimal caries or early demineralization
Lower fluoride concentration in water (Below 0.6 mg/dl)	Moderate (2.7-4.4)	Cavity formation with dentin involvement
Lowest fluoride concentration in water (Below 0.3 to .6 mg/dl)	High (Score: 4.5-6.5)	Extensive caries with large dentin destruction
Lowest fluoride concentration (Below .3 mg/dl in water)	Very High (Score: More than 6.5)	Severe caries with large cavity and tooth destruction

Table 4: Fluoride concentration in drinking water and its correlation with dental caries DMFT (decayed, missed and filling teeth) of the studied six Upazila.

Name of Upazila	Fluoride concentrations (mg/L)	DMFT index	Appearance of dental caries (%)
Name of Upazila	Fluoride concentrations(mg/L)	DMFT index	Appearance of dental caries(%)
Porsha	0.335±0.11	4.317±0.28	78.5
Niamatpur	0.375±0.24	2.70±0.17	75.0
Mohadevpur	0.419±0.13	2.162±0.34	71.0
Manda	0.714±0.32	0.586±0.19	55.3
NaogaonSadar	0.569±0.13	1.657±0.34	63.9
Sapahar	0.190±0.06	7.124±0.62	94.7

DMFT (decayed, missed and filled teeth).

DISCUSSION

Fluoride, a mineral that occurs naturally in many foods and water, helps prevent tooth decay. Fluoride reverses early decay and remineralizers your tooth enamel but fluoride can be harmful in large quantities. The focus of this study conducted in northern rural areas of Naogaon district, Bangladesh. The present findings revealed that Sapahar Upazila exhibited the lowest concentration of fluoride in drinking water at 0.118±0.12 mg/L whereas Manda Upazila exhibited the highest mean frequency of fluoride concentration in drinking water, which was recorded as 0.875±0.34. After analyzing the results, no significant differences were observed in fluoride concentrations in drinking water between males and females. For Porsha Upazila, fluoride levels in drinking water ranged from 0.316±0.06 to 0.383±0.21 mg/L, for Niamatpur Upazila, ranged from 0.326±0.11 to 0.495 mg/L, for Mohadevpur Upazila, ranged from 0.326±0.11 to 0.495 mg/L, Fluoride levels in drinking water ranged from 0.601±0.28 to 0.875±0.34 mg/L for Manda Upazila, ranged from 0.428±0.35 to 0.731±0.46 mg/L for Naogaon Sadar Upazila and for Sapahar Upazila, fluoride levels in drinking water were 0.118±0.12 to 0.279±0.19 mg/L. Comparisons with other studies demonstrated varying fluoride concentrations globally. For instance, Ibrahim et al. [4] reported values below the WHO standard in Khartoum and Omdurman. In contrast, some researcher found higher fluoride levels in India, with significant variability among districts [15,17].

The results show the comparison of fluoride concentration in water on DMFT index and caries status. The results showed an inverse relationship among DMFT index and dental caries status. When the fluoride concentration was very high (>6.5) the DMFT index was very low and there was no caries. But when the fluoride concentration was very low (0.0-1.1) the DMFT index was very high and severe caries with large cavities and tooth destruction was found. Furthermore, cavity formation with dentin involvement occurred when the DMFT index was moderate when the fluoride concentration in water was optimal (2.7-4.4). On the contrary, the positive effects of low concentrations (<1.0 mg/L) of fluoride in drinking water, such as preventing or reducing the risk of tooth decay, were evident [18,19]. We also got favorable result, the US Public Health Service advises optimal fluoride concentrations of 0.7 mg/L in municipal water systems to help prevent tooth decay and minimize the risk of dental fluorosis [20]. In this study, fluoride concentration in drinking water was highest in Manda Upazilla hence DMFT index was very low 0.586±0.19 and dental caries progression percentage was lowest 55.3. On the other hand, since the fluoride concentration in drinking water in Sapahar Upazila was the lowest at 0.190±0.06, the DMFT index was the highest at 7.124±0.62 and the caries progression percentage was the highest at 94.7. Moreover, Porsha Upazilla showed moderate DMFT index of 4.317±0.28 where caries progression was 78.5%. A significant negative correlation was observed between the incidence of caries and fluoride levels, with higher DMFT values associated with lower fluoride levels, suggesting a potential impact on the affected population. Some studies have assessed the impact of fluoride concentrations on caries development in children. They found that 0.25–1 mg/day supplemental fluoride for 24–55 months reduced rates of decayed, missing, and filled teeth (DMFT) surfaces by 24% [21,22]. Results concluded that fluoride concentrations were associated with a lower caries incidence rate in permanent teeth. Al most similar result described by Mir et al. (2020), they showed that 0.25–1 mg/day fluoride supplementation reduced caries incidence rates in primary teeth by 48%–72% in areas where water fluoridation levels were lower than 0.6 mg/L [23]. Al-Akwa and Al-Maweri [24] reported a significant negative correlation between caries incidence and fluoride levels, emphasizing the importance of optimal fluoride levels in preventing dental caries which is like our study.

The study contributes valuable insights into the interplay between fluoride levels in drinking water and dental caries, emphasizing the need for continued monitoring and awareness in affected regions. The observed discrepancies in fluoride concentrations among the six Upazilas underscore the significance of region-specific assessments in implementing targeted preventive measures. The present results deserve to be supplemented by additional studies with the same objectives and covering all regions of Bangladesh.

CONCLUSION

This study reveals consistently low fluoride concentrations in drinking water across six Upazilas in the Naogaon district of Bangladesh. The study also established a negative correlation between caries experience and fluoride concentrations in drinking water.

ACKNOWLEDGEMENTS

The authors express sincere gratitude to the Dental unit of Rajshahi Medical College Hospital, Rajshahi, Bangladesh, for their invaluable assistance in data collection and cooperation. Special appreciation is extended to Professor Dr. Md. Wahedul Islam, Entomology and Insect Biotechnology Laboratory, Institute of Biological Sciences, University of Rajshahi, Bangladesh, for his support and guidance.

FUNDING

The authors also extend their gratitude to the Institute of Biological Sciences, University of Rajshahi, for providing fellowship and financial support for this research work.

CONFLICTS OF INTEREST

We do not have any conflict of interest.

DATA AVAILABILITY STATEMENT

We assure that the data supporting the findings of this study will be provided upon reasonable request.

REFERENCES

1. **Federica V**, **Marco V**, **Luigi G**, **Maria EG**, **Elena M**, **Linda SB**, **Ugo C**, **Tommaso F**. Fluoride exposure and cognitive neurodevelopment: Systematic review and dose-response meta-analysis. *Environ Res*. 2023;221:115239. https://doi.org/10.1016/j.envres.2023.115239
2. **Rahman MM**, **Doza MB**, **Siddiqua MT**, **Zahid A**, **Islam MAT**. Spatiotemporal distribution of fluoride in drinking water and associated probabilistic human health risk appraisal in the coastal region, Bangladesh. *Sci Total Environ*. 2020;724:138316. https://doi.org/10.1016/j.scitotenv.2020.138316
3. **Cafasso J**. What Is Fluoride, and Is It Safe? *Healthline*. 2019. Available from: https://www.healthline.com/health/what-is-fluoride
4. **Ibrahim EM**. The relation between risk and level of chemical components in drinking water: chemical analysis of drinking water in Khartoum State. 2021. Available from: https://www.amazon.com/Relation-between-Chemical-Components-Drinking/dp/1008996009
5. **WHO/UNICEF**. WHO/UNICEF Joint Monitoring Programme. Available from: http://www.wssinfo.org/ (Accessed: 9 November 2019)
6. **FDI World Dental Federation**. Facts, Figures and Stats, Oral disease: 10 key facts. 2012. Available from: https://www.fdiworlddental.org/oral-health/ask-the-dentist/facts-figures-and-stats (Accessed: 19 March 2021)
7. **Fawell JKB**. Fluoride in Drinking-water. World Health Organization; 2024. Available from: https://www.who.int/publications/i/item/9241563192

8. **Ibrahim E**, **Salem S**, **Amr A**. Evaluation of fluoride level in drinking water wells and its effects on human health. *Glob Sci J*. 2022;10(8):162-79. Available from: http://www.globalscientificjournal.com/
9. **Zhang L**, **Zhao L**, **Zeng Q**, **Fu G**, **Feng B**, **Lin X**, **Liu Z**, **Wang Y**, **Hou C**. Spatial distribution of fluoride in drinking water and health risk assessment of children in typical fluorosis areas in north China. *Chemosphere*. 2020;239:124811. https://doi.org/10.1016/j.chemosphere.2019.124811
10. **Aslani H**, **Zarei M**, **Taghipour H**, **Khashabi E**, **Ghanbari H**, **Ejlali A**. Monitoring, mapping and health risk assessment of fluoride in drinking water supplies in rural areas of Maku and Poldasht, Iran. *Environ Geochem Health*. 2019;41(5):2281-94. https://doi.org/10.1007/s10653-019-00282-x
11. **Hoque AKMF**, **Khaliquzzaman M**, **Hossain MD**, **Khan AH**. Fluoride levels in different drinking water sources in Bangladesh. *Fluoride*. 2003;36:38-44. Available from: https://www.researchgate.net/publication/286982904_Fluoride_levels_in_different_drinking_water_sources_in_Bangladesh
12. **Sheiham A**. Oral health, general health, and quality of life. *Bull World Health Organ*. 2005;83. Available from: http://www.who.int (Accessed: 19 March 2021)
13. **Otal EH**, **Kim ML**, **Hattori Y**, **Kitazawa Y**, **Hinestroza JP**, **Kimura M**. Versatile covalent post synthetic modification of metal organic frameworks via thermal condensation for fluoride sensing in waters. *Bioengineering*. 2021;8(12):196.
14. **Battaleb-Looie S**, **Moore F**, **Jacks G**, **Ketabdari MR**. Geological sources of fluoride and acceptable intake of fluoride in an endemic fluorosis area, southern Iran. *Environ Geochem Health*. 2012;34:641-50. https://doi.org/10.1007/s10653-012-9451-5
15. **Duggal V**, **Sharma S**. Fluoride contamination in drinking water and associated health risk assessment in the Malwa Belt of Punjab, India. *Environ Adv*. 2022;8:100242. https://doi.org/10.1016/j.envadv.2022.100242
16. **Wang Y**, **Yu R**, **Zhu G**. Evaluation of physicochemical characteristics in drinking water sources emphasized on fluoride: A case study of Yancheng, China. *Int J Environ Res Public Health*. 2019;16(6):1030. https://doi.org/10.3390/ijerph16061030
17. **Sharma N**, **Saxena V**, **Naithani M**. Dental caries and its association with increasing water fluoride concentration in district Rudraprayag, Uttarakhand. *Int J Community Med Public Health*. 2021;8:4005-11. https://doi.org/10.18203/2394-6040.ijcmph20213036
18. **Otal EH**, **Kim ML**, **Kimura M**. Fluoride detection and quantification, an overview from traditional to innovative material-based methods. Open Access Peer-Reviewed Chapter. 2022. https://doi.org/10.5772/intechopen.102879
19. **Fallahzadeh RA**, **Miri M**, **Taghavi M**, **Abdolmajid G**, **Anbarani R**, **Hosseini-Bandegharaei A**, **Ferrante M**, **Conti GO**. Spatial variation and probabilistic risk assessment of exposure to fluoride in drinking water. *Food Chem Toxicol*. 2018;113. https://doi.org/10.1016/j.fct.2018.02.001
20. **Ahmed I**, **Ali A**, **Zaheer M**, **Fatima I**, **Khan N**. Frequency of dental fluorosis in population drinking water with high fluoride level in Thar. *J Pak Dent Assoc*. 2020;29(4):259-63. https://doi.org/10.25301/JPDA.294.259
21. **American Dental Association**. State-of-the-science report on fluoride exposure. 2022.
22. **Davil MF**, **Mazloomi S**, **Heibati B**, **Miranzadeh MB**, **Heidari M**. Drinking water fluoride concentration and its relationship with decayed, missing, and filled teeth index in Mianeh, Iran. *Int J Environ Health Eng*. 2013;2:15. https://doi.org/10.4103/2277-9183.110163
23. **El Mir Z**, **El Osta N**, **Salameh M**, **Massoud R**, **El Haddad L**, **Mchayleh NF**. Assessment of caries index and fluoride intake in a pediatric middle eastern population. *J Contemp Dent Pract*. 2020;21(10).
24. **Al-Akwa AA**, **Al-Maweri SA**. Dental caries prevalence and its association with fluoride level in drinking water in Sana'a, Yemen. *Eur J Dent*. 2018;12(1):15-20. https://doi.org/10.4103/ejd.ejd_187_17

How to Cite

Habib T, Islam SMS, Rahman A, Yasmeen W, Iqbal MA. Fluoride in Drinking Water and its Correlation with Dental Caries in Northern Rural Areas of Bangladesh. Update Dent. Coll. j [Internet]. [cited 2025 Apr. 27];15(1):37-42. Available from: https://www.banglajol.info/index.php/UpDCJ/article/view/80550