Assessment of Fluoride Level in Drinking Water Sources of Jumla, Nepal

Kabiraj Poudel,[1] Sudeep Subedi,[2] Merika Banskota,[3] Bishow Raj Timalsina,[4] Kushal Bhattarai,[5] Nabin Thapa[6]

[1,4,6]Lecturer, [2]Consultant, [3]Dental Surgeon, [5]Associate Professor

[1,3]Department of Dental Surgery, [4]Department of Opthalmology, [5]Department of Biochemistry, [6]Department of Anaesthesiology and Critical Care, Karnali Academy of Health Sciences, Jumla, Nepal

[2]Private Practitioner.

ABSTRACT

Introduction: Dental caries is one of the most prevalent chronic diseases. Though, preventable recent trend shows an increase in the prevalence of dental caries in developing country like Nepal. Optimal level of Fluoride in drinking water has a proven effect of preventing dental caries.

Objective: The objective of this study was to estimate the amount of fluoride in drinking water of Jumla, Nepal.

Methods: This study was an observational cross-sectional study conducted from August to September 2022 during which 78 drinking water samples were collected from different randomly selected wards of one municipality and seven rural municipality of Jumla district using simple random sampling technique. The drinking water sample for fluoride level of different area was analyzed and interpreted using SPADNS colorimetric method which is set as standard by American Public Health Association.

Results: A total of 78 samples were collected from distinctive drinking water sources of randomly selected wards of 7 rural municipality and a municipality. Out of 78 samples collected, only 5 samples (6.41%) had a fluoride concentration of more than 0.5mg/L. The highest fluoride concentration was 1.31mg/L. The overall mean (±SD) fluoride concentration of Jumla district was 0.20(±0.24). The median (Q1-Q3) concentration of fluoride in drinking water of Jumla district was estimated to be 0.11mg/L (0.05-0.29).

Conclusions: This study estimated the fluoride level in drinking water of Jumla district to be below the optimal level and shows the importance of water fluoridation in order to prevent dental caries.

Keywords: Dental caries, drinking water, fluoride concentration, Jumla, Nepal.

INTRODUCTION

Fluoride is present in various forms in soil, air, water, plants and other sources in a trace amount.[1] The ingestion of fluoride in optimal quantity have shown to prevent dental caries. Fluoride acts in teeth by topical and systemic mechanisms. Fluoride prevents demineralization and facilitates remineralization.[2] Fluoride acts as a double-edged sword, if present in optimal quantity helps decrease dental decay while excess can cause dental and skeletal fluorosis.[3]

Dental caries is one of the most prevalent diseases throughout the world.[4] The prevalence of dental caries in Nepal among 5-6 year old children and mean decayed missing and filled (dmft) index of teeth is 67% and 3.3 respectively.[5] Though preventable, studies have shown an increasing trend of dental caries in Nepal in recent years.[6,-8] Community water fluoridation has made a significant impact in prevention of dental caries.[9,10] The fluoride content in drinking water and other sources of fluoride intake by an individual makes a difference in the fluoride based preventive program.[11]

The data on the fluoride level of Jumla, one of the remotest parts of Nepal is not available. Thus, the aim of this study was to estimate fluoride level in drinking water sources of Jumla.

Correspondence

Dr. Kabiraj Poudel,
Lecturer, Department of Dental Surgery,
Karnali Academy of Health Sciences, Jumla, Nepal.
Email: drpoudelkabiraj@gmail.com.

METHODS

The study was a laboratory based observational cross-sectional study conducted in Jumla, Nepal from August to September 2022. Ethical approval was obtained from Institutional Review Committee of Karnali Academy of Health Sciences, Teaching hospital (KAHS) - Ref: IRC/ 2078/2079/45.

Jumla is administratively divided into seven rural municipalities; Guthichaur, Patarasi, Tatopani, Tila, Hima, Sinja and Kanakasundari and a municipality; Chandannath. Samples were collected using simple random sampling technique. Drinking water samples were collected from three randomly selected wards of each rural municipalities and five wards of Chandannath municipality using lottery method. Three drinking water samples were collected from the most populated and commonly used drinking water facilities of each ward. The drinking water samples of 125ml were collected in sterile polypropylene bottles. Samples from the municipal/communal/public drinking water sources were included in the study while water source with the contamination like fecal matter were excluded from the study. Each bottle was coded uniquely identifying the ward and the drinking water source. It was stored in room temperature and was transported to the laboratory within 15 days of collection. Before sending the sample, it was coded specially to blind the laboratory personnel. The sample was analyzed at environment and public health organization (EPHO) laboratory, Kathmandu using SPADNS colorimetric method set as standard by American Public Health Association. SPADNS colorimetric test uses inverse colorimetric reaction in which fluoride is made to react with zirconium dye lake causing dissociation of a portion of it turning it into a colorless complex anion and the dye, with increase in fluoride content the color is progressively lighter and is compared to standard fluoride solution.[12] Spectrophotometer and filter photometer were the instrument along with Standard fluoride solution, SPADNS solution, zirconyl-acid reagent, acid zirconyl-SPADNS reagent, reference solution, sodium arsenite solution were the reagents used during the analysis.[13]

RESULTS

From different drinking water sources of randomly selected wards of seven rural municipalities and a municipality 78 samples were collected. Out of 78 samples collected, only 5 samples (6.41%) had a fluoride concentration of more than 0.5mg/L. Three samples (3.84%) had fluoride concentration of more than 1mg/L while two samples (2.56%) had fluoride level of more than 0.5mg/L.

The overall mean (±SD) fluoride concentration of Jumla district was 0.20 (±0.24). The median (Q1-Q3) concentration of fluoride in drinking water of Jumla district was estimated to be 0.11mg/L (0.05-0.29). Five out of eight municipalities did not have any sample of drinking water containing optimal level of fluoride in drinking water. Three samples from Tatopani rural municipality, one sample each from Chandannath municipality and Gutichaur rural municipality had optimal fluoride concentration. The maximum fluoride concentration was 1.32mg/L and the minimum being less than 0.05mg/L. The maximum fluoride concentration was present in one of the drinking water samples in Tatopani rural municipality ward number one.

All the samples were divided into four quartiles of fluoride concentration. The coefficient of variance (CV) was the highest (166%) in the first quartile and the lowest (21%) in

Table 1: Fluoride concentration in mg/L in different sources.

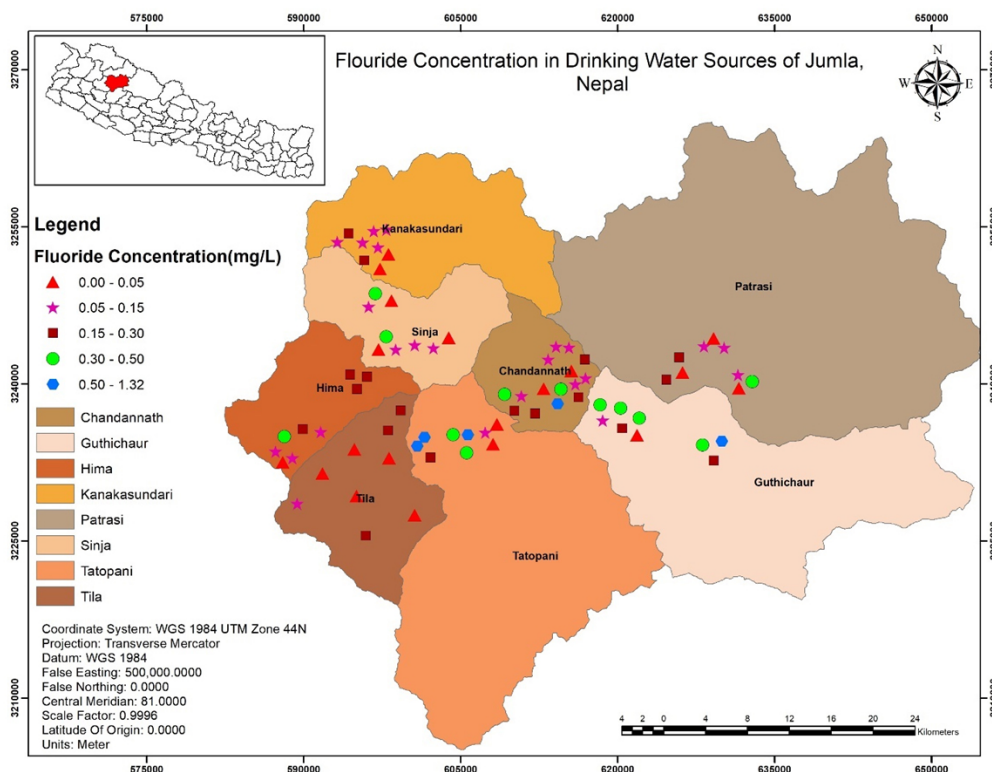| Municipality	Mean	SD	Median	Q1-Q3	Minimum	Maximum
Chandannath	0.22	0.26	0.13	0.08-0.29	<0.05	1.09
Guthichaur	0.32	0.18	0.37	0.15-0.46	<0.05	0.52
Hima	0.17	0.11	0.16	0.05-0.24	0.05	0.4
Kanakasundari	0.10	0.09	0.08	0.04-0.15	<0.05	0.29
Patarasi	0.12	0.11	0.11	0.02-0.18	<0.05	0.35
Sinja	0.12	0.14	0.79	0.01-0.22	<0.05	0.37
Tatopani	0.45	0.47	0.40	0.03-0.82	<0.05	1.32
Tila	0.07	0.09	0.03	0.0-0.19	<0.05	0.22
Overall	0.20	0.24	0.11	0.05-0.29	0.05	1.32

Figure1: Fluoride mapping of Jumla, Nepal.

third quartile. On dividing the samples, municipality wise, the coefficient of variance was the highest (125%) in Tila rural municipality while the lowest (57%) in Guthichaur rural municipality. The overall coefficient of variance of fluoride concentration of Jumla district was 122%.

DISCUSSION

With the increments in sugar consumption, prevalence of dental caries shows an increasing trend in developing nations.[14-16] The exposure of fluoride in various form have shown to be associated with dental caries experience.[17] According to WHO, the optimal level of fluoride in drinking water is 0.7-1.2mg/L.[18] Optimal fluoride level in drinking water prevents dental caries while excessive fluoride content may lead to dental fluorosis and skeletal fluorosis with symptoms like sporadic pain, joint stiffness, headache, stomachache which may progress to osteosclerosis finally leading to muscle, joint and nerve damage.[19] Thus it is important to know the presence of fluoride in drinking water in the specific community to utilize it judiciously preventing the toxic effects as many nation are endemic to fluorosis.[19] The unavailability of fluoride data in drinking water sources of Jumla, which is one of the rural most part of Nepal with less emphasis on

preventive oral health is the initiating factor for this study to be conducted.

The result of this study shows that majority of sample had a fluoride level of <0.5mg/l. The result is in an agreement with the study done in Eastern Nepal , Kathmandu Valley and Dharan, Nepal by previous researchers.[20-22] A study done in the northern neighboring country China (Nepal-China border; Tibet) also revealed a similar finding of fluoride level in drinking water source. [23] This is in contrast to the southern neighboring country India, where the fluoride concentration is above the recommended level of WHO.[24] A study done in Jammu and Kashmir of India which has a similar geography and altitude, also showed the fluoride level to be similar to this study.[25] This does not satisfy the criteria to correlate altitude and geography with the amount of fluoride in drinking water, which needs further study.[26] The study done in the eastern Nepal showed the maximum concentration of fluoride of 0.64mg/L in the Himalayan region while the maximum concentration in our study shows it to be more than 1 mg/L, Jumla being western Himalayan region. [20] This shows the need of fluoride data of every part of Nepal to withdraw any inference.

The median fluoride concentration in drinking water sources of Jumla was 0.11mg/L similar to 0.08mg/L in the study done in eastern Nepal.[20]

The fluoride in drinking water samples of Tatopani rural municipality showed three samples that have optimal amount of fluoride concentration. Interestingly, two drinking water samples from Tatopani ward number one taken from adjacent communal taps had shown the fluoride value of more than 1.0mg/L. These drinking water taps are the only source available in that community. The dental caries status in that community could be helpful to supplement further data on the role of fluoride in prevention of dental caries.

The overall coefficient of variance of fluoride concentration in Jumla district was high suggesting the non-uniformity in the distribution of fluoride in the drinking water.

Community water fluoridation has been a safe and effective method for fluoride delivery to prevent dental caries.[27] The recent trend of increment in dental caries in Jumla district must be addressed by all the possible preventive aspect. Nepal has adopted the decentralization policy providing local government with the authority of formation and implementation of their own health policy. To prevent dental caries, water fluoridation can be the best and cheap method in combination with the use of fluoridated toothpaste. The fluoride level data from this study has shown the fluoride concentration to be below optimal in all the municipalities. Community water fluoridation can be one of the approaches adopted to prevent dental caries in Jumla.

The drinking water supply system in Jumla can be a barrier for proper implementation of water fluoridation as the water supply system are isolated in most of the municipalities. Some municipalities, wards, and community of Jumla with the provision of centralised drinking water facilities are potential candidates for water fluoridation. Keeping in mind the controversies in water fluoridation and role of fluoride,[28] this issue needs to be addressed by a higher authorities' discussion representing all the stakeholders for seeing both the pros and cons of fluoridation.

The data from this study along with the study done in eastern Nepal, Dharan and Kathmandu valley has shown that most of the drinking water sources do not contain optimal amount of fluoride in drinking water. This also necessitates further research in other part of the country to have a base line data on fluoride in drinking water nation-wide. The oral health and national health policy must define the method to prevent dental caries addressing their clear view on water fluoridation. This will help guide the local government to implement fluoridation program in their level.

The major limitation of the study is the geographical coverage, each ward of the municipalities had a large territory with multiple drinking water sources, but we were able to collect only three samples of drinking water. This may not represent the different concentration in wider location. A further study with greater coverage and more samples would address the issue.

CONCLUSIONS

The study concluded that most of the drinking water sources of Jumla contained below optimum level of fluoride. With the increasing urbanization and consumption of refined carbohydrate, dental caries incidence and prevalence are increasing in the rural part of Nepal especially in the Karnali region. Thus, this study highlights the need of water fluoridation, professional fluoride application, use of fluoridated toothpastes and other preventive measures. This study is the first of its kind to be conducted in Karnali province of Nepal and is helpful to provide insight to the policy maker in water fluoridation in this region to prevent the burden of dental caries. Nation-wide fluoride mapping of drinking water sources could be done in future that would help to develop dental caries prevention programs in Nepal.

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Conflict of Interest: None

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