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The Relation Between Drinking Water Fluoride Concentration and DMFT Index: A Case Study on Elementary School Students in Sarayan County, Iran

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Abstract

Background: Dental caries can lead to loss of tooth tissue, microbial infiltration to the pulp, pain and eventually tooth loss. WHO has set DMFT (Decayed, Missing, and Filled Teeth) index for measuring oral health. The aim of this research was studying the relation between drinking water fluoride concentration and DMFT index in the elementary schools of Sarayan County.

Methods: This study was conducted on 420 students in the cities of Saryan, Ayask, and Seh Qaleh in Sarayan County, South Khorasan Province, Iran. Data of DMFT were collected through observation and completion of a questionnaire. Fluoride concentration in well water samples was measured by SPADNS spectrophotometric method.

Results: The average of fluoride concentration in 9 wells of drinking water samples was 0.34 mg/L. The amount of DMFT in 12-year old students was (2.21±0.1) which was higher than that 7-year olds (0.24±0.02). The average value of DMFT index was 1.34±0.08 and 1.29±0.06 for male and female students, respectively. No dental fluorosis was detected among studied students. Analysis showed a significant reverse relation between fluoride concentration and DMFT index (P-Value=0.02).

Conclusion: Fluoride concentration in the water of Sarayan County was less than the minimum acceptable level of 0.5 mg/L. Although, DMFT values of less than 1 are acceptable by WHO, the measured values at Sarayan were higher than 1. Therefore, it is necessary to plan for oral and dental care and pay more attention to the regulations of fluoride in drinking water.

Keywords: DMFT Index, Drinking Water, Fluorides, Dental caries

Background

One of the most important priorities of each society is providing healthy drinking water [1]. Supplying drinking water with desirable quality and quantity will have a significant impact on public health [2]. Dental caries is one of the most commonly observed problems among the elementary school students. It is closely related to the fluoride content of drinking water [3-5], and has a growing trend in developing countries like Iran. Therefore, it can impose a lot of expenses on families that the concentration of fluoride in their drinking waters is less than the standard level (0.5 mg/L) [6].

According to the health office reports of Iranian Ministry of Health and Medical Education, 68% of elementary school students in the country have dental problems [7-9]. Decayed, Missing, Filled Teeth (DMFT) is the most important indicator of dental decay rate [7, 10]. In order to calculate the index of DMFT in a society, the number of filled teeth and missing teeth by each individual is counted. Then a total average is calculated. DMFT average is an applicable, simple, and fast index which has been used for decades in dentistry [6].

Fluoride ion presence in drinking water is an important factor for prevention of dental decay problems [11, 12]. Fluoride belongs to the halogen group elements that are found abundantly in the earth's crust. It plays a vital role in the structure and composition of human teeth and bones. Drinking water is the most important route to get fluoride for humans. Although fluoride can be supplied from other sources, such as pills, drops, toothpastes, gels and mouthwashes containing fluoride, but the best and cost-effective approach to supply fluoride is consumption of drinking water, and in the absence of sufficient fluoride in drinking water fluorination is essential [9, 13]. Several studies report that age, geographical location (ambient temperature), fluoride concentration in drinking water and dietary habit are the most effective parameters in intake of fluoride from drinking water [11, 14]. Since, the greatest need of body to fluorine is supplied from drinking water, therefore it is important to determine its amount in drinking water [15].

To reduce dental caries, WHO has determined the optimum level of fluoride in drinking water equal to 0.7 and 1.2 mg/L in tropical and cold regions, respectively [16]. The standard level of fluoride in drinking water has also been set by the *Institute* of Standards and *Industrial Research* of *Iran* in the limit of 1.4 to 2.4 mg/L [7]. In general, the standard level of fluoride in drinking water depends on the ambient temperature of the area. The lower standard level belongs to the area with warmer weather, and vice versa [17].

If fluoride concentration in drinking water is less than 0.5 mg/L, the decay rate will be significantly higher. Also, if the fluoride content in drinking water is greater than 1.5 mg/L, it causes dental and skeletal fluorosis which can create permanent deformation of the bones and joints [18], as well as tooth staining, endocrine damage, thyroid and liver disorders, softening of bones, bone-like shaping of tendons and ligaments, and reduction of spinal space inside the vertebrae, especially the neck vertebrae [19, 20].

Considering that our country has a great variety of climate, therefore the appropriate fluoride concentration for drinking water in a province or city might be different from other. Hence, setting a given value of fluoride concentration for the whole country cannot be logical and economical. Regarding the health effect of drinking water fluoride concentration, particularly on teeth, WHO suggests that both fluoride concentration and the DMFT index should be periodically examined and compared with national and international standards in order to propose the best solution [6].

The objectives of the current study were (a) determining fluoride concentration in the drinking water of Sarayan, Ayask and Seh Qaleh, (b) determination of DMFT index in 7-12 years old students, (c) studying the relation between DMFT index and fluoride concentration, and (d) providing the appropriate solutions.

Methods

This cross-sectional study was carried out on 7-12 years old elementary school students of Sarayan, Ayask and Seh Qaleh cities in 2018. The Sarayan county has 3 main cities including Sarayan, Ayask and Seh Qaleh (Figure 1). Sarayan is the capital and the most important city of Sarayan County and located in the

northwest of South Khorasan province at longitude of 33.8597° N and latitude of 58.5144° E with a hot and dry climate. The altitude of city is 1484 meters above sea level. The distance of this city from Birjand, the capital of province, is 160 km. In 2015, the city's population was 33.312. [21]

The present study was carried out in line with the "Caries-free Dental National Program for Primary School Students" of the Ministry of Health. To determine the DMFT index, after determining the total number of elementary schools, 70 students per age group were randomly selected. In total, 420 students were selected. In this study, caries was detected using a sickle scaler, flat mirror and natural light, and

decayed, or missed teeth as well as filled teeth were counted. Determination of DMFT was based on the method of case observation and completion of the questionnaire.

To determine the concentration of fluoride in drinking water, samples were collected from 9 wells (Sarayan; 5, Ayask:2, and Seh Qaleh:2 wells) and analyzed according to SPADNZ method by the DR-5000 spectrophotometer.

Finally, data were analyzed through SPSS 20. Descriptive statistics were reported and linear regression was done.

This work has been reviewed and approved by the Ethical Review board of Birjand University of Medical Sciences (Ethic Code No: 4791).
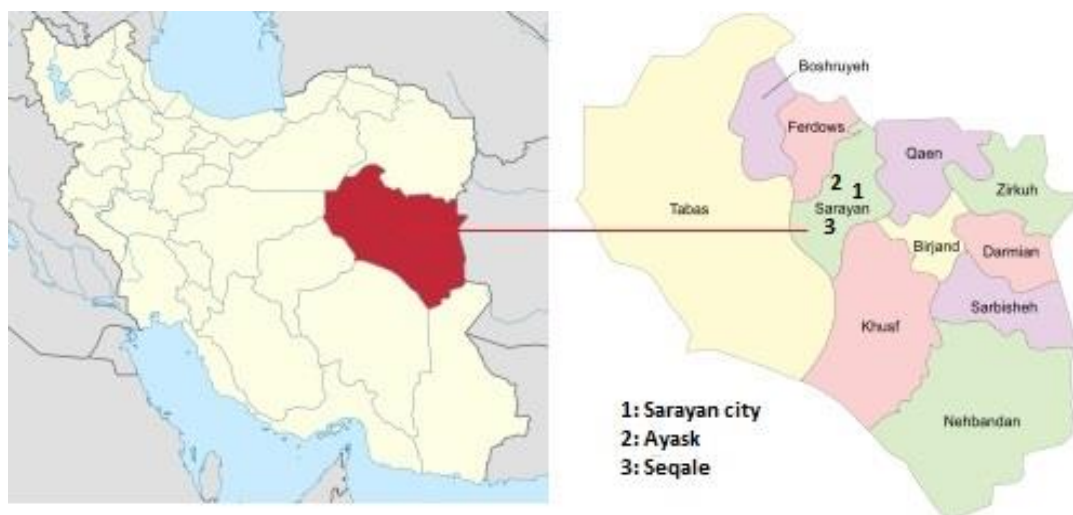

Figure 1. The studied areas

Results

In this study, at first, the concentration of fluoride was determined in well water samples of Sarayan, Ayask and Seh Qaleh cities. Table 1 summarizes the average value of fluoride

concentration in each of the cities and the whole county. As seen in the Table 1, the minimum concentration of fluoride (0.21 mg/L) belonged to the Ayask and the maximum was for Sarayan (0.43 mg/L). Also, total average fluoride concentration for Sarayan County was 0.34 mg/L.

Table 1. The fluoride concentration (mg/L) in drinking water of studied areas

Sampling site	Sample number	Well (1)	Well (2)	Well (3)	Well (4)	Well (5)	Fluoride average in city (mg/L)
Sarayan	Sample 1	0.45	0.48	0.5	0.34	0.41	
	Sample 2	0.40	0.45	0.52	0.38	0.43	0.43±0.049
	Sample 3	0.35	0.46	0.48	0.42	0.39	
	Average	0.4±0.05	0.46±0.01	0.5±0.02	0.38±0.04	0.41±0.02	
Ayask		0.17	0.26				
		0.17	0.23	-	-	-	0.21±0.041
		0.18	0.25				
Seh Qaleh		0.36	0.42				
		0.40	0.45	-	-	-	0.4±0.031
		0.38	0.39				
Total number of wells in Sarayan county							9

DMFT index was studied in a total number of 420 students (210 females and 210 males) by a mirror and sickle scaler. Tables 2 shows the results of DMFT index among students at different ages. The DMFT index value by gender and different cities are given in Table 3 and 4 respectively.

Table 2. The prevalence of DMFT index among all students studied at Sarayan County (grouped by age)

Age	N	Decayed	Missing	Filled	DMFT
7	70	13	0	4	0.24±0.02
8	70	27	0	17	0.62±0.05
9	70	36	1	18	0.78±0.04
10	70	40	2	59	1.44±0.06
11	70	63	6	77	2.08±0.08
12	70	82	5	68	2.21±0.1
Total	420				

Table 3. The prevalence of DMFT index among all students studied at Sarayan County (grouped by gender)

DMFT	Filled	Missing	Decayed	Amount	Gender
1.29±0.06	132	4	133	210	Female
1.34±0.08	112	9	148	210	Male
				420	Total

Table 4. The DMFT index among all students studied in different cities of Sarayan County

City	DMFT for male	DMFT for female	DMFT average in city
Sarayan	1.28	1.2	1.24±0.04
Ayask	1.63	1.46	1.54±0.08
Seh Qaleh	1.13	1.23	1.18±0.05

The results revealed that the concentration of fluoride in all water wells of studied cities was below the minimum standard level. Although, the values of DMFT index were close to the targets set by the WHO in 2015. According to the results of this study and with regard to P-value= 0.02, there was a significant negative relation between the concentration of fluoride in drinking water and DMFT index. Figure 2 shows the relation between cities DMFT and fluoride concentration in Sarayan County.

$y = -1.3841x + 1.8198$

$R^2 = 0.998$
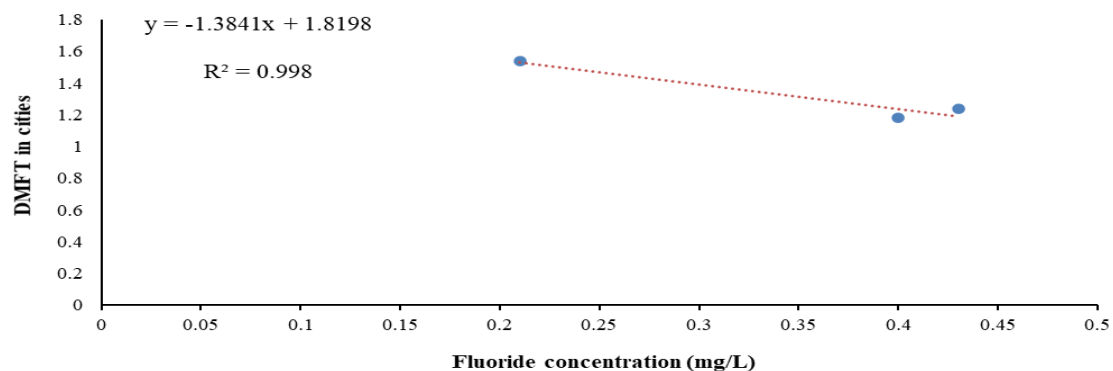
Figure 2. The relation between DMFT and fluoride concentration in Sarayan county

Discussion

Based on the results presented in Table1, the concentration of fluoride in all three cities was less than the standard limit of Iranian Ministry of Energy (IME). With respect to the dependence of water consumption on ambient temperature, this standard has been determined based on the annual average of maximum daily temperature. According to IME standard, the

maximum permissible fluoride concentration is 1.4 mg/L in very hot areas and it is equal to 2.4 mg/L in cold regions. IME has also determined the optimal range of fluoride concentration in drinking water to be 0.7-1.2 mg/L.

According to the results of this study, the average DMFT index among the students of elementary schools in Sarayan county for boys and girls were 1.34 and 1.29, respectively, which are higher than the values accepted by WHO (less than 1). On the other hand, the average concentration of fluoride in the county's water wells was 0.34 mg/L, which was lower than the WHO guidelines (0.7-1.2 mg/L) regarding fluoride concentration in drinking water. Due to the low level of fluoride in drinking water, no dental fluorosis was observed among students. The results showed a significant and negative correlation between drinking water fluoride concentration and DMFT index. In a study conducted by Khorsandi et al. on students in rural areas of northwest of Iran, researchers reported that the average content of fluoride in these areas was 0.2 mg/L and the mean DMFT index was 3.16 for boys and 3.06 for girls. Moreover, a significant negative correlation was reported in their study between drinking water fluoride concentration and DMFT index with a P-value= 0.001 [22]. Aghdasi et al. investigated the relation between drinking water fluoride concentration and DMFT index in students of elementary schools in the cities of Piranshahr and Poldasht [7]. They obtained the average fluoride concentration of 0.1 and 2.35 mg/L for Piranshahr and Poldasht, respectively. The results of this study also showed that there was a weak relation between fluoride concentration and DMFT index in Piranshahr, while the relation was more significant in Poldasht city [7]. According to the study conducted by Dehghani et al. in Shiraz, with decrease in fluoride concentration, the DMFT index increased and the relation between studied variables was meaningful [23]. The results of

the Shiraz study were in agreement with the current study. In addition, Ejlali et al. evaluated the prevalence and severity of dental fluorosis and DMFT in elementary school students in the city of Maku. They showed that the high prevalence of fluorosis was associated with high values of fluoride concentration in drinking water. In Maku, the water of some areas under study is supplied from groundwater that has accumulated in basaltic lavas. These lavas are the main source of fluoride minerals. Therefore, these researchers emphasized that appropriate control measures should be performed to remove the excess amounts of fluoride from drinking water [24].

It should be noted that since this study was coordinated and supervised by local health authorities, there were no specific restrictions for the project.

Conclusion

The results of this study showed that there was a significant and negative correlation between fluoride concentration and DMFT index. Also, the prevalence of dental decays among 7-12-year-old students in this area was slightly higher than global health standards, which necessitates planning for oral and dental health and care and paying more attention to the regulation of fluoride levels in drinking water.

Abbreviations

DMFT: Decayed, Missing, and Filled Teeth; WHO: World Health Organization; IME: Iranian Ministry of Energy.

Acknowledgments

Conflict of interest

The authors declare that they have no conflict of interest.

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