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Fluoride Levels of Urban Water in Western Azerbaijan Province in 2017

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ABSTRACT

Introduction: Fluoride is one of the naturally occurring mineral elements which has an effective role in preventing dental caries and its consolidation. Fluoridation of water is a simple technique and the most effective method approved for preventing dental caries. Accordingly, this research was carried out with the aim of investigating the level of fluoride in the urban water of cities in Western Azerbaijan province in 2017. **Materials and Methods:** In this descriptive-cross-sectional study, the level of fluoride in urban water reservoirs of 17 towns of Western Azerbaijan province was examined in different reservoirs. The information of the reservoirs was collected from water and wastewater organization of the province, where a 250-cc water sample was collected from each reservoir. The prepared samples were thenT sent to the laboratory to measure the level of fluoride. Determination of the concentration of fluoride ion in water samples was carried out using spectrophotometric method. Eventually, the data obtained from this study were examined by statistical-descriptive methods using SPSS 17. P <0.05 was considered as statistically significant. **Results:** The results obtained from the study indicate that the level of fluoride in the samples investigated in Shooth and Poldasht town was larger than the optimum level, while the rest of towns had a level lesser than the optimum value. Furthermore, the median of the investigated population (the median fluoride of the towns of Western Azerbaijan province) was 0.227 ppm, when based on statistical tests, it had a significant difference with the optimal fluoride value (1 ppm) (p-value<0.05). **Conclusion:** Considering the median of fluoride concentration in towns of Western Azerbaijan province (0.227 ppm), it can be stated that the level of fluoride in drinking water of this province is low, elucidating the addition of supplementary fluoride to the drinking water of reservoirs.

INTRODUCTION

Fluoride is one of the naturally occurring elements and one of the most electronegative chemical elements, which does not occur as free ion in the nature. Naturally, in all water resources, some degree of fluoride can be seen at different concentrations. Absorption of fluoride occurs through digestive system, while its discharge is mainly done by the kidneys. Given that dental caries, is the most common disease among children, research has shown that fluoride is very effective in preventing dental caries, particularly, when minor amounts of it are constantly present in the oral cavity. Constant but minor usage of fluoride regarding the prevention of caries is better than its professional use. Fluoride controls caries effectively (1).

Fluoride exerts its anti-caries effects via different processes:

1. Presence of fluoride ion in dental tissues causes sedimentation of fluoroappatite from calcium and phosphate ions. This insoluble sediment replaces soluble salts containing manganese and carbonate. This substitution process causes further resistance of the enamel against caries (2).
2. Primary carious lesions are remineralized via a similar procedure without formation of cavity (2).
3. Fluoride has antimicrobial properties. Fluoride is used in different ways (topical use, mouthwash, addition to foods, and fluoridation of water, etc).
4. It is effective in glycolysis (1).
5. It accelerates the formation of mineral compounds required by the dental enamel and changes in the form and size of teeth (1).

The relationship between fluoride and diminished caries was first proposed by Dr Trendley Dean in 1930 (3). To benefit from the anti-Dickey properties of fluoride, it can be added to drinking water or commonly consumed foods (milk, salt, etc.) (4).

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A study has demonstrated that addition of fluoride to milk in eight-year-old children after three years has been effective in reducing caries by as much as 78%(5). The study by Do et al (2009) showed that in the group who used sufficient fluoride-containing drinking water, the extent of caries was significantly lower than that of the control group (6). The study by Bailie et al (2009) indicated that addition of fluoride to drinking water of regions with low fluoride in their water is effective in decreasing caries (7). Fluoridation of water is a simple technique and the most effective method approved to prevent dental caries (8). Although fluoride is effective in diminishing caries, if the level of fluoride of water exceeds the normal level, it causes fluorosis in children (9). For societies who intend to implement fluoridation plan, knowing the suitable level of fluoride is important and essential. Moreover, for societies who enjoy a high natural level of fluoride, fluoride separation plan (defluoridation of water) is needed (1). Knowing the suitable level of fluoride is essential, but before prescribing fluoride, the fluoride level of the regional water should be determined. Optimal fluoride or the concentration of fluoride that has anti-caries properties with minimum risk of development of fluorosis has been determined as 1 ppm. The most suitable concentration of fluoride in drinking water is determined based on the temperature of the region. Given that people in tropical regions consume more water than those living in regions with a moderate climate, this level is variable. The higher the mean air temperature in societies, the lower the level of fluoride determined for drinking water (10).

The fluoride level of water differs from region to region and even season to season. In Kerman province, water fluoride ranges between 0.17 ppm in Kerman city to 0.44 ppm in Kahnuj city (11). The fluoride of water in Karaj River in November and December 2000 was 0.19 mg/L, while in May and June, it was 0.335 mg/L (12). Nasehinia studied the level of drinking water fluoride and DMFT index in Damghan city in 2000-2001 and found that fluoride level in low-rainfall seasons was 0.37 mg/L, while in high rainfall seasons, it was obtained as 0.6 mg/L. DMFT index among 12-year-old students was 2. The above-mentioned value, given the classification by health organization regarding DMFT index stood in the second level, and extent of caries in Damghan city is low. Based on the information obtained above, it can be implied that the fluoride level of drinking water is closely related to extent of dental caries across different societies (13). Khademi investigated the relationship between fluorosis and dental caries with different fluoride values of drinking water in Najafabad, a city in Isfahan. The fluoride level of drinking water of four regions of Najafabad, Juzdan, Rahmatabad, and Filur was obtained as 0.23, 0.6, 1.35, and 0.78 ppm, respectively (14). The DMFT value for Najadabad, Filur, Juzdan, and Rahmatabad was obtained as 6.66, 3.37, 5.51, and 3.13, respectively. The severity of fluorosis in the studied groups was correlated with different value of drinking water fluoride. There was also a significant relationship between DMFT and drinking water fluoride (14). Nourisepehr et al investigated the level of fluoride in drinking resources of villages of Semnan province in 2006. Out of the entire drinking water resources of these villages, over 86% had fluoride resources of less than 1 mg/L. But in Reza-abad village of Shahroud, fluoride level was 4 mg/L, which should be reduced to less than 2 mg/L (15). According to the study of Basir et al, incidence of fluorosis at different degrees in branches of Maroun, Karoun, and Karkheh was obtained as 62.2, 34.9, and 57.3%, respectively, and the average DMFT was 1.37, 1.20, and 0.6, respectively. With increased fluoride level, incidence of fluorosis was also increased. In two branches of Karoun and Karkheh, elevation of drinking water fluoride and incidence of fluorosis were accompanied by diminished DMFT (16).

Based on the mentioned studies, accurate measurement of the current water fluoride content is essential not only in Western Azerbaijan province, but also throughout the entire points to modified drinking water fluoride (17,18). Therefore, due to the significance of the subject and as the level of drinking water fluoride plays an important role in controlling dental caries or at the same time development of fluorosis, decision was made to study the fluoride level of drinking water across the towns of Western Azerbaijan province. With this study, dentists, health experts, and beneficiary authorities will be aware of the fluoride level in drinking water of the towns of Western Azerbaijan province.

MATERIALS AND METHODS

In this descriptive-cross-sectional study, the fluoride level of urban water reservoirs of Western Azerbaijan province towns was examined. In this research, samples were collected from all of the water reservoirs of the towns of Western Azerbaijan province. Based on the information received from water and wastewater organization of Western Azerbaijan province, the drinking water of these 17 towns is supplied by a total of 98 reservoirs. A 250-cc water sample was collected from each reservoir. Given the large number of the samples, the samples prepared from the reservoirs of each town were mixed with each other, and from each town, one sample was sent to the laboratory for measuring the level of fluoride.

First, water tap was opened so that some water would outflow. Then, the plastic container was washed with the water to be sampled, and a bottle was filled with water. The lid of the bottle was closed immediately and sent to the laboratory. Before measuring the level of fluoride, the water temperature of all samples was adjusted by regulation device, which was constant across all stages for all of the samples.

Experiments on the determination of fluoride level on the studied samples was performed in physiochemical laboratory of water and wastewater organization of Western Azerbaijan province. This laboratory is the reference laboratory for determination of biochemical markers of water samples in the Northwest of the country.

To determine the concentration of fluoride ion in the water samples, spectrophotometer method was used, which is a standard calorimetry method, already used in previous studies. This method is based on zirconium, eriochrome cyanine R with a high accuracy with fluoride ion, which develops a red color. The intensity of red color is in accordance with the concentration of fluoride ion, and can be measured using visible region spectrophotometer (19-22).

RESULTS

The results associated with fluoride level experiment of 17 towns of Western Azerbaijan province are presented in Table 1. These findings show that in the studied samples, except for Shouth and Poldasht towns, the fluoride level of other towns is lower than the optimal value, while the fluoride level of the two mentioned towns is above the optimal value.

The variable statistical indices of fluoride in the studied samples suggested that the lowest fluoride value was 0.001, the largest was 1.430, and the median was reported to be 0.227 ppm (Diagram 1).

To investigate the existence of any significant difference between the median of fluoride variable with optimal value of 1 ppm, binomial sign test was employed, and the significance level of the test was 0.05, according to the results presented in Table 2. The results in this table indicate that there is a significant difference between the median of the studied population (the median fluoride of the towns of Western Azerbaijan province) and the optimal level of 1. Also, the median of fluoride of these towns is less than the optimal level of 1 (P-value<0.05).

DISCUSSION

Fluoride is an element belonging to the group of halogens, and is abundantly found in the Earth's crust. It is found as 0.3 g/kg in the Earth's crust, with seawater containing an average of 1.4 mg/L fluoride (23). It is also found at trace amounts in groundwater resources and the wells that lie in the vicinity of appatite mines, may contain as much as 10 mg/L fluoride, yet its concentration in most groundwater resources is less than 1 mg/L. Deficiency of fluoride causes dental caries, while excess value causes incidence of dental, bone, and kidney diseases (23). The Association of American dentists in 2005 announced that water fluoridation has caused diminished dental caries by 50-60% prior to the second world war (24). It has been about 30 years since the difference in extensive studies have been carried out in order to find a relationship between cancer and fluoride in water. However, there is no evidence on carcinogenicity of fluoride in water (25). Currently, four major cities in the US use fluoride containing water. World Health Organization considers that the best way of supplying fluoride is fluoridation of drinking water. The desirable level of fluoride in drinking water is dependent on the ambient temperature, while its concentration varies between 0.5 and 1.5 mg/L (26).

Various studies have been conducted on the level of fluoride in water of different cities in Iran. In the studies carried out in 2005-2006 on fluoride in the water of Azna town, it was found that the minimum and maximum concentrations of fluoride were 0.24 and 0.98, respectively (27).

Another study carried out in Zahedan showed that the minimum and maximum concentrations were 0.75 and 2.4 mg/L, respectively (28). The water fluoride level of Nahavand Town in 2005-2006 was determined to be 0.59 and 0.3 mg/L as the maximum and minimum values, respectively (29).

At the Faculty of Dentistry of Stellenbosch University in Tygenbeny, South Africa in 2001, Grobleni SR et al examined the fluoride level in drinking water across three points of this town. They observed that the fluoride level was between 0.19 and 3 ppm (30). TSutsui A et al at the Department of Preventive Dentistry in Fukuoka University, Japan also examined fluoride concentration in drinking water in this town and stated that the average fluoride concentration ranged between 0.1 and 8.4 ppm (31).

In a study conducted by Ibrahim et al at Kharyum University, Sudan, by investigating the level of fluoride, the minimum and maximum levels were reported to be 0.25±0.04 and 2.56±0.26, respectively (32).

Fayi M et al conducted a study at Dakar University in 2007 and stated that low to medium level of fluoride of 0.03-0.09 can give rise to diminished frequency of dental caries (33).

Table 1. Fluoride content of 17 towns of western Azerbaijan province

Town	Fluoride content
Bukan	0.315
Chaldoran	0.157
Chaypareh	0.332
Khuy	0.057
Mahabad	0.137
Maku	0.361
Miandoab	0.227
Naghdeh	0.124
Urmiah	0.186
Ashnavieh	Less than 0.001
Piranshahr	Less than 0.001
Poldasht	1.430
Salmas	0350
Sardasht	0.243
Shahin Dezh	0.249
Shouth	1.118
Takab	0.074

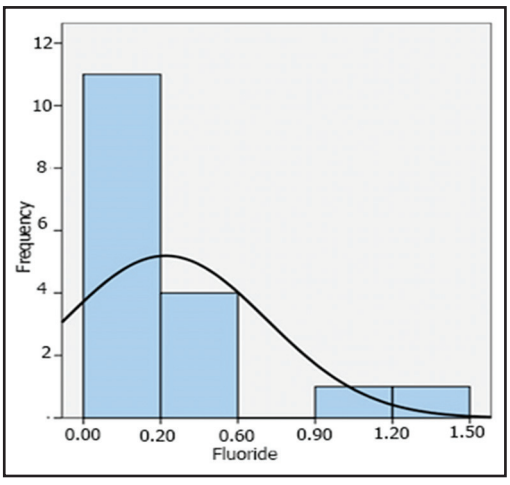

Diagram 1. The histogram of fluoride level in the towns of western Azerbaijan province

Table 2. The results of statistical investigation of the median fluoride content of the studied samples with its optimal value

Groups	Number	The observed ratio	classification	P-value
Group 1	15	0.88	Less than and equal to 1	0.002
Group 2	12	0.12	Larger than 1	

In a study, Ermis RB et al at Faculty of Dentistry of Soleyman Demirel University, Turkey (2003) stated that the fluoride concentration of drinking water in regions with low and high concentrations was 0.03-3.4 and 1.1-42.54 ppm, respectively (34). Khan AA et al in Pakistan (2004) investigated the concentration of fluoride across different regions of Pakistan and found that the drinking water fluoride concentration in these regions was 0.0-56.7 ppm (35).

In different studies conducted across different parts of Iran and the world, the drinking water fluoride level of previous studies was higher than that of this study (0.227 ppm), suggesting low level of urban water fluoride in the towns of Western Azerbaijan province.

Given the changes in the level of water fluoride with temperature, it is recommended that water fluoride level of towns be examined across different seasons. To bring the drinking water fluoride level of towns to a desirable level, fluoride should be added to water artificially, and the effect of adding fluoride to water and bringing it to a standard level in one of the regions be conducted by water and wastewater organization, and then compared with a non-fortified region in terms of DMF of residents in these regions.

CONCLUSION

Given the median concentration of fluoride across the towns of Western Azerbaijan province (0.227 ppm), it can be stated that the fluoride level of drinking water of the towns of this province is low, elucidating the need to add supplementary fluoride to the drinking water of the reservoirs.

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