original article

Drinking water fluoride concentration and its relationship with decayed, missing, and filled teeth index in Mianeh, Iran

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ABSTRACT

Aims: The aim of this study was to determine fluoride levels in drinking water of Mianeh city and to evaluate decayed, missing, and filled teeth (DMFT) index in children between 6 and 9 years old.

Materials and Methods: This cross-sectional research was carried out on all sources of drinking water including 14 groundwater sources in Mianeh city. A total of 56 samples were taken from all wells during four seasons of 2009 and analyzed with colorimeter "SPADNS" method with DR 2500 spectrophotometer set17.

Results: The results show that the means of source fluoride concentration in spring, summer, autumn, and winter seasons were 0.295 ± 0.039 mg/l, 0.47 ± 0.17 mg/l, 0.48 ± 0.18 mg/l, and 0.4 ± 0.06 mg/l, respectively. This means that the concentration of fluoride in all sources was below national standards, but they were in permissible range proposed by WHO. In addition, the DMFT index of the children between 6 and 9 years old in Mianeh city was higher than national mean.

Conclusions: Considering the low fluoride concentration in water sources of Mianeh, it was proposed that a chemical compound such as sodium fluoride be added to provide fluoride ion. It seems that the low fluoride levels in supplied water have a significant effect on higher DMFT index in children of the subjected community.

Key words: Dental caries, DMFT index, drinking water, fluoride concentration, Mianeh city

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INTRODUCTION

Water always contains some dissolved material, suspended solids, and dissolved gasses. The presence of some of the dissolved material is necessary for health, but over presence of them- more than permissible levels - maybe lead to health problems. The concern about chemical ingredients in drinking water is different from that of microbial agents,

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because unlike chemical agents they need more time to show adverse impacts.[1] Similar to some of natural elements, fluoride can enter the body through inhalation and ingestion of food and beverage such tea and water and influence our health.[2,3] Nearly 80% of fluoride entered into the body is excreted mainly via urine. But fluoride residue is absorbed into the body tissues.[4] Constant and frequent contact with fluoride results in a condition in the body called enamel fluorosis. The impact of fluoride in a mild discoloration of dental surfaces cause severe staining, enamel loss, and pitting. These conditions remain permanent in the body after dentification in childhood (8 years of age).[5] The prevalence of disease related to fluoride in various parts of the world is different; including 100% prevalence of Fluorosis in Senegal and Tanzania[6,7] and the 67% prevalence in Larestan Township and Lengeh port in the south of Iran.[8]. On the other hand, studies show that the fluoride concentration up to 0.5 mg/l may cause dental caries.[9] So the concentration of fluoride in drinking water resembles a two-edged knife. That is; both high and low concentrations are harmful.[10,11] There are a variety of procedures to classify dental condition. DMFT index that expresses the mean number of decayed, missing and filled teeth in a group of individuals has been widely utilized in epidemiological surveys of oral health index. This index is usually used to find the relationship between Fluoride content of drinking water and dental condition.[7]

Although there are other routes for entering the fluoride into the body, water and water-based beverages providing greatest contribution to received fluoride by the individual.[12] Depending on the age of persons, 57-90% of all received fluoride is from consumption of water with 2 mg/l concentration, and if the concentration reaches 4 mg/l, the share will get 72-94%.[5] The concentration of fluoride in most of the drinking water is due to the presence of mineral fluoride (CaF_2). So the waters that have very high concentration of sodium, potassium, chloride, and little calcium, contain very high levels of fluoride as well.[3] On the whole, because of longer contact time of groundwater with stone bed, the concentration of fluoride in groundwater is more than that in surface water.[13,14]

Many studies have been done on fluoride concentration in drinking water in many parts of the world such as Tibet, some counties of Iran such as Khaf, Dashtestan, Shush aquifer of Khuzestan county, central Rajasthan (India), and Sicily (Italy).[11,15-19] Considering the fact that all drinking water of Mianeh is provided from groundwater, the aim of this research was to measure the concentration of fluoride in Mianeh city. Finally, the DMFT index in children with 6 and 9 years was also reviewed.

MATERIALS AND METHODS

Mianeh is one of the cities in the east Azerbaijan province in Iran. According to demographic information of Iran Demography Organization, Mianeh city was populated with about 196000 people in 2010. It is located between north latitudes of 31°58′ and 34°15′, and west longitudes of 45°24′ and 48°10′ in northwest of Iran. The city is situated at an altitude of 1100 meter above sea level.

Water supplying in Mianeh (like many communities in Iran) is relying on groundwater sources. Around 25 wells had been allocated to supply drinking water in Mianeh. Nevertheless, 11 wells were exploited in 2009 and 14 wells were being used to supply the drinking water of the city. Figure 1 shows the location of Mianeh and its wells.

This descriptive and cross-sectional study was done on drinking water resources of Mianeh. In this research the concentration of fluoride in all drinking water resources were analyzed seasonally. Since any single well serves a part of the city, the method of 'census' was used in this research and all water resources were sampled using one-liter plastic bottles. Therefore a total of 56 samples were collected over the 2009. Following sampling, the fluoride concentration was measured with colorimeter "SPANDA" method with DR 2500 spectrophotometer set17.

RESULTS

The main purpose of this research was to determine the fluoride concentration in drinking water resources of Mianeh. Figures 2 and 5 show the fluoride concentration of groundwater sources in spring, summer, autumn, and winter. As it is shown in the figures, the maximum fluoride concentration relates to source No.3 during summer [Figure 3], and the minimum concentration was related to source No.13 during autumn [Figure 4].

Table 1 shows the descriptive results of fluoride levels in drinking water of Mianeh in each seasons of the year. According to this table the concentration ranges of fluoride

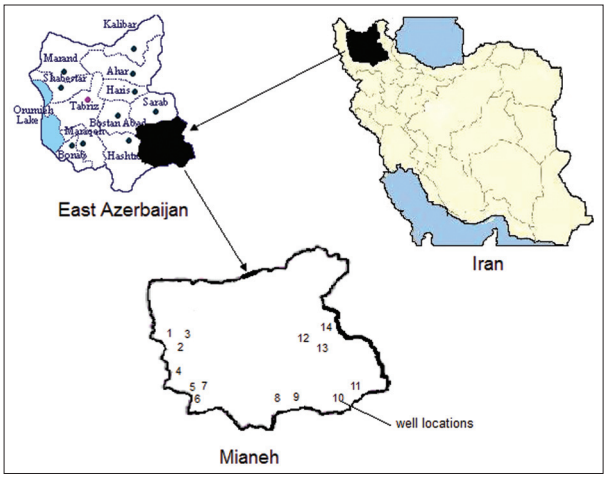

Figure 1: Location of Mianeh and its drinking water resources (wells)

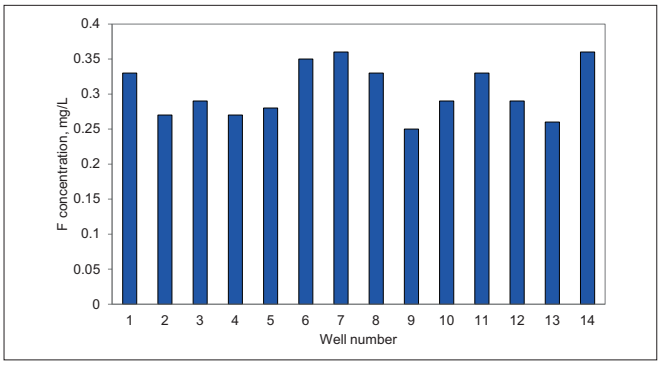

Figure 2: Variation of fluoride concentration in water of wells during spring season

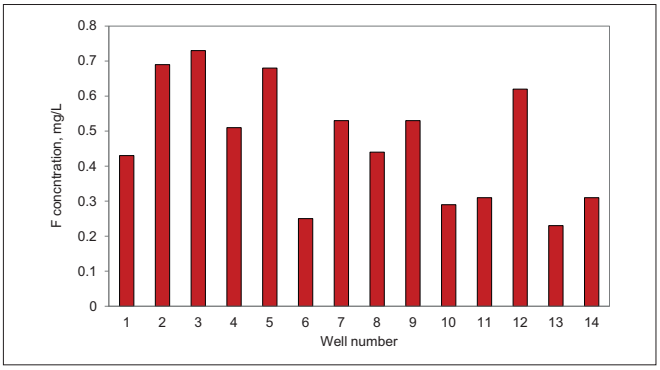

Figure 3: Variation of Fluoride concentration in water of wells during summer season

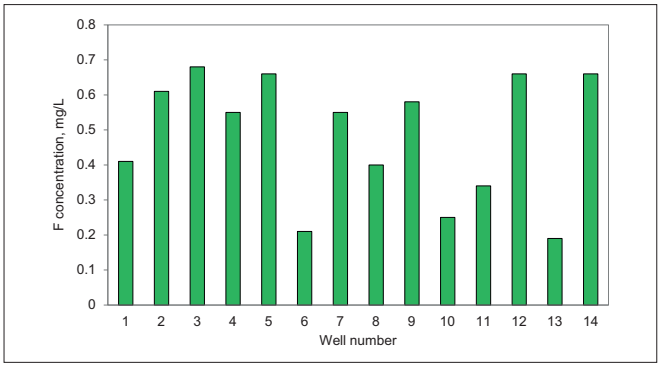

Figure 4: Variation of fluoride concentration in water of wells during autumn season

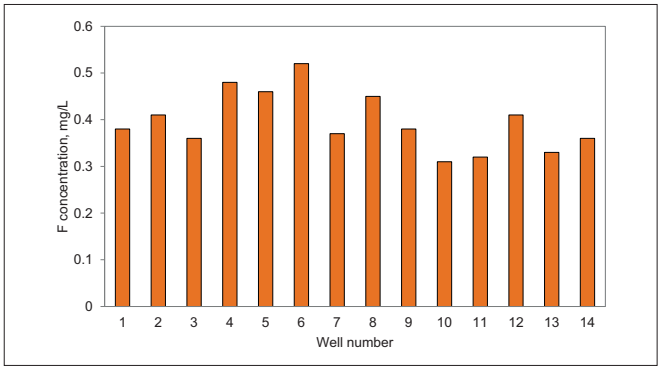

Figure 5: Variation of fluoride concentration in water of wells during winter season

Table 1: Fluoride concentration mg/l in drinking water sources of Mianeh city

Season	Mean	Maximum	Minimum	S.D
Spring	0.29	0.37	0.23	0.039
Summer	0.47	0.73	0.23	0.17
Autumn	0.48	0.68	0.19	0.18
Winter	0.40	0.52	0.31	0.06

in spring, summer, autumn, and winter seasons were 0.23-0.37 mg/l, 0.23-0.73 mg/l, 0.19-0.68 mg/l, and 0.31-0.52 mg/l, respectively. The mean concentrations and standard deviations of fluoride also in spring, summer, autumn, and winter seasons were 0.295 ± 0.039 mg/l, 0.47 ± 0.17 mg/l, 0.48 ± 0.18 mg/l, and 0.4 ± 0.06 mg/l, respectively. The annual mean of fluoride concentration was 0.41 mg/l.

The standard measures of fluoride concentration in Iran are related to the ambient temperature. Because the maximum mean temperature of Mianeh was 11.8°C, according to standards, the fluoride concentration must be within 1.1-2.4 mg/l range. WHO also recommends that the fluoride concentration in drinking water must be lower than 1.5 mg/l.[9]

According to Table 2, the fluoride concentrations in all sources were lower than the national standard range. It was also found that the fluoride concentration was not more than WHO guideline, 1.5 mg/l.

DMFT index has been reported for all age groups by Health Ministry of Iran. The mean DMFT index of groups between 6 and 9 years old for Mianeh is shown in Table 3.

DISCUSSION

The first and foremost source of drinking water supply in Mianeh is groundwater. After sampling, the fluoride concentration of these samples was measured. The mean fluoride concentration of these sources was 0.41 mg/l, whereas fluoride concentration has been reported to be 0.02-0.18 mg/l in Tibet;[15] 0.11-3.59 mg/l in potable groundwater in rural areas of Khaf, Iran;[17] 0.023-3.28 mg/l in water sources of central Rajasthan India,[11] 0.023-3.28 mg/l in Sicily, Italy;[18] and the concentration of fluoride in the village drinking water of Dashtestan, Iran was found to vary widely from 0.99 to 2.50 mg/L.[19] Therefore the fluoride concentration of drinking water of any location is linked to its site specification, depending on regional conditions, specially the geology of water sources.

Although the fluoride concentration of drinking water of Mianeh was lower than Iran drinking water permissible standard (1.1 mg/l), it was within WHO guideline range. Since anyone must receive sufficient fluoride by various means, and since the most channel for fluoride intake is through drinking water,[5] fluoride concentration should be

Table 2: Comparison of fluoride concentration of Mianeh city drinking water with Iran standards and WHO guideline

Season	Iran standard		WHO guideline
	Lower than permissible concentration (1.1-2.4 mg/l)	Less than guideline measure(1.5 mg/l)	More than guideline measure(1.5 mg/l)
Spring	100%	100%	0
Summer	100%	100%	0
Autumn	100%	100%	0
Winter	100%	100%	0

Table 3: Values of DMFT index in age groups between 6 and 9 years old and type of tooth in Iran and Mianeh city

Age groups	Location	DMFT index	Percentile of DMFT due to dental caries %	Percentile of DMFT due to dental pull %	Percentile of DMFT due to dental filling %
Children with 6-year-old permanent teeth	Mianeh	0.347±0.09	100	0	0
	Iran	0.204±0.025	99	0	1
Children with 6-year-old milk teeth	Mianeh	6.98±0.44	90.8	8.5	0.5
	Iran	4.82±0.14	89.2	7.4	3.4
Children with 9-year-old permanent teeth	Mianeh	1.41±0.161	95.5	0.2	3.5
	Iran	0.9±0.05	89.8	1.7	7.8
Children with 9-year-old milk teeth	Mianeh	8.02±0.32	78.5	20.4	0.8
	Iran	3.35±0.1	78.6	18	3.2

at a favorable level to meet human body requirements. In the case of its shortage, fluoride must be added to drinking water so as to prevent contingent health hazards.[21] As we know, the amount of consumed water has a direct relationship with the mean temperature, and the standard of fluoride in drinking water of many countries including Iran is based on this criterion. Since Mianeh is located in mountainous region with a cold climate, it seems logical that the water consumed by its population is lower than that of regions with warmer weather conditions. For this reason, the fluoride concentration of the water sources of this city must be more than that of water sources in warmer regions. It was previously mentioned that the fluoride concentration can affect our teeth in childhood.[5] One of the methods for determining the impacts of fluoride concentration on teeth is DMFT index. According to Table 3, the DMFT indexes in both age groups 6 and 9 years old and also for both permanent and milk teeth in Mianeh were more than the mean DMFT index in Iran, and in all cases, around 78-100% of the mean DMFT index was due to dental caries. Of course this condition may not seem unexpected, because the fluoride concentration of all water sources of Mianeh in all seasons was lower than the standard concentration, and dental carries in childhood has a direct relationship with low concentration of fluoride. The DMFT of 12-year-old students of Behshahr city shown that the DMFT of girls (1.75 ± 0.19) was more than DMFT value of boys (1.21 ± 0.16), total average was equal to 1.48 ± 0.13, while the average fluoride concentration in drinking water of this city was equal 0.25 mg/l.[22] The fluoride content in the village drinking water of Arsanjan, Iran, was from 0.1 to 1.2 mg/L. Linear regression analyses showed only a weak but no significant association between small decreases of the mean overall decayed permanent teeth (Dt) and decayed deciduous teeth (dt) and increasing water fluoride levels.[20] Many public health agencies propose that the fluoride must be added to drinking waters with low fluoride levels. Other investigations have come to the conclusion that artificial addition of fluoride to drinking water has good advantages similar to the waters which contain the same level of natural fluoride. It is worth mentioning that there has not been any report which shows any adverse effect of adding fluoride-containing compounds artificially to drinking water.[23] Considering the low fluoride concentration in water sources of Mianeh, it seems necessary to consider measures of adding fluoride-containing compounds to these sources. The following compounds can be used to add fluoride to drinking water:

1) Sodium fluoride (NaF) which readily dissolved in water. Sodium fluoride, though one of the most expensive fluoride compounds, is widely used for fluoridation.
2) Sodium silicofluoride (Na_2SiF_6). It is a white, colorless, and cheap compound.
3) Fluorosilicic acid (H_2SiF_6) which is a corrosive, fuming, transparent compound and causes irritation on the skin and has a 22-30% purity degree.[1,24]

CONCLUSIONS

In this research the fluoride concentration of water sources supplying drinking water in Mianeh in all seasons was examined. The results show that the fluoride concentration of all sources was lower than the desirable value. Then to compensate fluoride concentration shortage of these sources, it was proposed that a chemical compound such as sodium fluoride be added to provide fluoride ion. In the other hand, the DMFT index in different age groups in the city was higher

than national means. It seems that the low fluoride levels in supplied water have a significant effect on higher DMFT index in children of the subjected community.

REFERENCES

1. Crittenden J, Harza MW. Water treatment: Principles and design. United States: John Wiley and Sons; 2005.
2. Mahvi AH, Zazoli MA, Younecian M, Esfandiari Y. Fluoride content of Iranian black tea and tea liquor. Fluoride 2006;39:266-268.
3. Dobaradaran S, Fazelinia F, Mahvi A, Hosseini SS. Particulate airborne fluoride from an aluminium production plant in Arak, Iran. Fluoride 2009;42:228-232.
4. WHO. Trace elements in human nutrition and health; Technical. Geneva: World Health Organization; 1996.
5. Doull J, Poole C, Webster T. Fluoride in drinking water: a scientific review of EPA's Standards. Washington: National Academies; 2006. p. 205-23.
6. Driscoll WS, Horowitz HS, Meyers RJ, Heifetz SB, Kingman A, Zimmerman ER. Prevalence of dental caries and dental fluorosis in areas with optimal and above-optimal water fluoride concentrations. J Am Dent Assoc 1986;113:29-33.
7. Ramezani GH, Valaei N, Eikani H. Prevalence of Dmft and fluorosis in the students of Dayer City (Iran). J Indian Soc Pedo Prev Dent 2004;22: 49-53.
8. Eftekhari M, Mazloum Z. Fluorosis prevalence study and its relation to drinking water among the 7–11 year old students in Larestan Town and its suburb. Shahid Beheshti University of Medical Sciences Dental Faculty Research Magazine 1999;17:75-79.
9. WHO. Guidelines for drinking-water quality. 4th Edition, Geneva, World Health Organization, 2011.
10. Hussain I, Hussain J, Sharma KC, Ojha KG. Fluoride in drinking water and health hazards: Some observations of fluoride distribution in Rajasthan. Environmental Scenario for 21st Century, New Delhi:APH,2002;18:355-374.
11. Hussain J, Hussain I, Sharma KC. Fluoride and health hazards: Community perception in a fluorotic area of Central Rajasthan (India): An arid environment. Environ Monit Assess 2010;162:1-14.
12. Dobaradaran S, Mahvi AH, Dehdashti S. Fluoride content of bottled drinking water available in Iran. Fluoride 2008;41:93-94.
13. Hem JD. Study and interpretation of chemical characteristics of natural water. U.S Geological Survey Water-Supply Paper 2254, 3rd Editions, United States Government Printing Office, 1985.
14. Edmunds W, Smedley PL. Groundwater geochemistry and health: An overview. Geological Society, London, Special Publications, 1996;113:91-105.
15. Cao J, Zhao Y, Liu J, Xirao R, Danzeng S. Fluoride concentrations of water sources in Tibet. Fluoride 2000;33:205-9.
16. Nouri J, Mahvi AH, Babaei AA, Ahmadpour E. Regional pattern distribution of groundwater fluoride in the Shush Aquifer of Khuzestan County, Iran. Fluoride 2006:39:321-325.
17. Amouei AI, Mahvi AH, Mohammadi AA, Asgharnia HA, Fallah SH, Kafajeh AA. Fluoride concentration in potable groundwater in rural areas of Khaf city, Razavi Khorasan province, Northeastern Iran. Int J Occup Environ Med 2012;3:201-203.
18. D'Alessandro W, Bellomo S, Parello F, Brusca L, Longo M. Survey on fluoride, bromide, chloride, nitrate and sulphate contents in public drinking water supplies in Sicily (Italy). Society of Environmental Geochemistry and Health, 26th European Conference, Athens, 2008.
19. Dobaradaran S, Mahvi AH, Dehdashti S, Abadi DRV. Drinking water fluoride and child dental caries in Dashtestan, Iran. Fluoride 2008;41: 220-226.
20. Rahmani A, Rahmani K, Dobaradaran S, Mahvi AH, Mohamadjani R, Rahmani H. Child dental caries in relation to fluoride and some inorganic constituents in drinking water in Arsanjan, Iran. Fluoride 2010;43:179-186.
21. Mazloomi S, Dehghani MH, Norouzi M, Fazlzadeh Davil M, Amarluie A, Tardast A, *et al.* Physical and chemical water quality of ilam water treatment plant. World Appl Sci J 2009;6:1660-1664.
22. Mahvi A, Zazoli MA, Younecian M, Nicpour B, Babapour A. Survey of fluoride concentration in drinking water sources and prevalence of DMFT in the 12 years old students in Behshar City. J Med Sci 2006;6:658-661.
23. IPCS, UNEP, ILO, WHO, IPCS. Fluorine and fluorides. Geneva: World Health Organization; 1984.
24. Hammer MJ. Response to "A middle range theory for generative quality of life for the elderly" Adv Nurs Sci 2007;30:92.

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