

**Research Article**

## **FLUORIDE LEVEL OF DRINKING WATER OF KERMANSHAH PROVINCE WITH (WHO) GUIDELINES FROM 2006 TO 2011**

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### **ABSTRACT**

Fluoride is a natural element, different values of which are almost in all drinking waters and soil. Its shortage causes tooth caries and its abundance causes dental Fluorosis. According to the WHO instruction, the minimum and the maximum amount of Fluoride ions for drinking water are 0.50 PPM and 1.5 PPM, respectively. This study aimed to compare Fluoride concentration in Kermanshah's drinking water with its lowest concentration according to WHO instructions. In this descriptive-analytical study, test results of 1131 samples of drinking water in the Central Laboratory of Kermanshah province were analyzed using SPSS software version 16 during 2006-2011. Findings of this study showed that the average water's fluoride was 0.2962 PPM and its concentration range was varied from zero to 1.10 PPM. Water's fluoride concentration was significantly less than its minimum standard, I.E 0.50 PPM ( $P < 0.001$ ). According to WHO instruction for drinking water, only 23.1 percent of samples were standard and 76.9 percent of them were less than the standard level (less than 0.5 PPM), but none of the samples were much higher than the standard level. *Kangavar* and Kermanshah had the most and the least concentration, respectively, but its average in *Kangavar* was also lower than the standard level. The status of drinking water's fluoride in village was significantly better than that in city, in winter better than summer, and in wells and springs better than reservoir. Therefore, taking necessary interventional actions such as providing mouth rinse, fluoride-therapy, putting fissure sealant cover and enriching water with fluoride in all population groups, especially children and adolescents is essential in this province. In towns such as Kermanshah, *Dalahoo*, *Paveh*, *Sarpol-e-zahab* and *Ghasr-e-Shirin* with the average fluoride concentrations less than 0.3 PPM, even fluoride supplementation seems to be essential for infants from 6 months.

**Keywords:** *Kermanshah, Water, Fluoride, Guideline, WHO*

### **INTRODUCTION**

Using high quality water has great impact on the health of all people; shortage or abundance of some of its elements - fluoride is one of them - has many undesirable consequences on the health of the individual or society (WHO, 2008). Fluoride is a natural element, different values of which are almost in all drinking waters and soil. Although this is not declared as an essential element, it is important in human nutrition due to the benefits for tooth enamel and its adequate reception amount has been identified in 1997 for the first time. The mechanism of mentioned benefits for fluoride in dental health, which is making maximum resistance of tooth enamel against dental caries is such that firstly, this element replaces hydroxyl group in the lattice structure of dental calcium phosphate salts such as dental Hydroxyl Apatite and creates Fluor Apatite being harder and less removed, Secondly, fluoride acts as an antimicrobial agent and enzyme inhibitor in the oral cavity (WHO, 2008; Mahan, 2008). The main dietary sources of fluoride include drinking water, processed foods prepared with Fluoride water, tea and seafood (Mahan, 2008; Zohouri and Rugg-Gunn, 2000). Since both shortage and abundance of drinking water's fluoride has undesirable consequences on human's health (Ekanayake, 2003; Acharya and Anuradha, 2003), its range is specified in drinking water and according to WHO standard, the minimum and the maximum amounts of water flora are 0.5 and 1.5 ml per liter, respectively (WHO, 2008).

In our country, on the one hand, high rate of dental caries among children is one of the main hygienic problems in many towns, so that according to the health plan of the Islamic Republic of Iran in the Fifth

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Plan of Economic, Social and Cultural Development, goal No. 9-2 from macro objectives is as follows: reducing the DMFT index in children under 18 to 3.5 teeth till the end of the plan (Ministry of health, treatment and medical education, 2010), and on the other hand, since 1964, drinking water's fluoride is continually being measured based on "drinking water" national standard, No. 1053, but so far no overall and comprehensive analysis is done to take interventional actions according to the fluoride concentration of water in every region (Institute of Standards and Industrial Research of Iran, 2009). Therefore, regarding the relationship between water's fluoride level and dental health in previous studies (Ekanayake, 2003; Acharya and Anuradha, 2003; Khan *et al.*, 2004) and also the availability of test results of drinking water's Fluor level, we decided to compare the level of Kermanshah's drinking water's Fluoride as one of the effective factors on dental health with standard amounts.

In a study conducted on underground wells of Iran in 2008, the fluoride concentration of Kermanshah's drinking water has been the least. In cities such as *Shiraz, Sari, Zanjan, Kashan, Urmia, Ardabil* and ..., Cross-sectional studies are conducted on the level of drinking water's fluoride, which in most cases have indicated its improper conditions, But no study is conducted for Kermanshah, or otherwise its information is not available (Ramezani *et al.*, 2009; Sadeghi and RouhElahi, 2007).

Kermanshah province is located in the western part of Iran and has 14 towns based on national divisions. Geographical and climate conditions of its towns are very different. Towns of Kermanshah province include Kermanshah, *Eslamabad-e-gharb, Kangavar, Sahneh, Dalahoo, Harsin, Ravansar, Songher Kelyayi, Gilan-e-gharb, Sarpol-e-zahab, Salas-e-babajani, Javanrood, Paveh and Qasr-e-Shirin* (Sadeghi and RouhElahi, 2007). This study aims to identify and compare fluoride concentration of Kermanshah's drinking water with the minimum acceptable concentration of national standard No 1053 in study towns, different years of study (2006-2011), and the place of Sampling, season and source of water supplying.

## **MATERIALS AND METHODS**

This was a descriptive-analytical study. The data were collected from the water quality assessments of 1131 water samples in the reference water laboratory of Kermanshah (Kermanshah, Iran). Water test results were related to drinking water samples of different towns of Kermanshah province, all of which have been sent to the reference water laboratory of Kermanshah by trained experts and technicians of environmental health from Health Centers of related districts (towns) for continuously monitoring during 2006-2011.

According to duties, experts and technicians of environmental health sampling any source of drinking water 1-2 times annually for chemical analysis. This sampling is conducted based on the national standard No. 2347 entitled "Water sampling method" (Institute of Standards and Industrial Research of Iran, 2005). It should be noted that fluoride ion concentration of the samples sent to the reference water laboratory is measured in accordance with national standard No. 2351 entitled "Method of identifying fluorine ion in water" and the amount of fluoride ion in water was based on the potentiometric determination technique (Institute of Standards and Industrial Research of Iran, 2009).

Findings of the results of 1131 were analyzed using SPSS software version 19. One-sample T-test, T-test and Chi-2 statistical test were used to compare the fluoride concentration of province's drinking water with the lowest standard level (0.50 PPM), to compare the average fluoride concentration in province's water with the lowest standard level (0.50 PPM) and to compare independent qualitative variables (e.g. different towns, seasons and source of water supplying) with the water's fluoride status, respectively. Since water resources should be chemically tested 1-2 times annually according to 1053 standard, the results of studied water tests cover 100 percent of urban population but this coverage is less in rural areas due to resources' dispersion and shortage of trained experts and technicians of environmental health.

## **RESULTS AND DISCUSSION**

### **Results**

The average level of fluoride ion in water was 0.30 PPM(0.2962 PPM) during 5 years ago and its concentration range was varied from zero to 1.1 PPM which was significantly less compared to the least

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standard level using T-test (P value). As shown in Table 1, the average water's fluoride was not more than standard level. The average water's fluoride varied from the maximum level at the beginning of 2006 (0.33 PPM 0.33) to the minimum level at the end of 2011 (0.25 PPM 0.25).

The highest to the lowest mean fluoride concentration in towns is as follows: 1) *Kangavar*, 2) *Gilan-e-gharb* 3) *Harsin*, 4) *Sangher\_Kelyayi*, 5) *Ravansar*, 6) *Eslamabad-e-gharb*, 7) *Javanrood*, 8) *Salas-e-babajani* 9) *Sahneh* 10) *Qasr-e-Shirin*, 11) *Sarpol-e-zahab*, 12), *Paveh*, 13) *Dalahoo* and 14) *Kermanshah*.

Therefore, *Kangavar* with the average of 0.45 PPM and *Kermanshah* with the average of 0.23 PPM have the highest and the lowest concentrations of drinking water, respectively.

These values in the village (0.37 PPM) are more than the urban (0.26 PPM), in winter (0.34 PPM) more than the summer (0.25 PPM) and in the well (0.30 PPM) more than the reservoir (0.24 PPM).

There were significant differences between the average concentration of drinking water's fluoride in study ages (P=0.001), province's towns (P<0.001), urban and rural areas (P<0.001), Four Seasons (P<0.001) and three types of sources (P=0.043=P) (Table 1).

**Table 1: Level of fluoride in different cities, villages, seasons and water reservoirs**

	Standard		Lower than standard		N samples	City	
	number	Percent	number	Percent			
P <0.001	70	14.0	431	86.0	501	Kermanshah	Township
	33	29.5	79	70.5	112	Eslamabad-e-gharb	
	33	45.8	39	54.2	72	Kangavar	
	19	34.5	36	65.5	55	Sahneh	
	4	7.4	50	92.6	54	Dalahoo	
	18	38.3	29	61.7	47	Harsin	
	8	23.5	26	76.5	34	Ravansar	
	32	43.2	42	56.8	74	<u>Sonqor</u>	
	13	52.0	12	48.0	25	Gilan-e-gharb	
	6	21.4	22	78.6	28	Sarpol-e-zahab	
	5	27.8	13	72.2	18	Salas-e-babajani	
	12	26.7	33	73.3	45	Javanrood	
	4	7.1	52	92.9	56	Paveh	
	3	30.0	7	70.0	10	Qasr-e- Shirin	
P <0.001	127	17.2	612	82.8	739	City	Region
	133	33.9	259	66.1	392	Village	
0.12	97	24.6	298	75.4	395	Spring	Season
	29	16.4	148	83.6	177	Summer	
	85	23.0	185	77.0	370	Fall	
	49	25.9	140	74.1	189	Winter	
0.053	227	24.0	717	76.0	944	Well	Source
	23	21.7	83	78.3	106	Mesh- spring	
	10	12.3	70	87.7	81	Water room	
	1131	871	77.0	260	23		Total

**Discussion**

The findings of this study showed that the average water's fluoride was 0.3 PPM from the beginning of 2006 till the end of 2010 and its concentration range was varied from zero to 1.1 PPM. According to 1053 standard of national organization for drinking water, only 23.1 percent of samples were standard and 76.9 percent of them were less than the standard level (less than 0.5 PPM), but none of the samples were much higher than the standard level.

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**Table 2: Comparison of Kermanshah's Drinking Water's Fluoride**

P value	Average fluoride in water		N sampels	City
	mean	Standard deviation		
P <0.001	0.23	0.19	501	Kermanshah
	0.33	0.22	112	Eslamabad-e-gharb
	0.45	0.18	72	Kangavar
	0.30	0.19	55	Sahneh
	0.25	0.15	54	Dalahoo
	0.43	0.26	47	Harsin
	0.34	0.15	34	Ravansar
	0.43	0.19	74	Sonqor
	0.44	0.19	25	Gilan-gharb
	0.28	0.16	28	Sarpol-e-zahab
	0.31	0.17	18	Salas-e-babajani
	0.32	0.16	45	Javanrood
	0.27	0.13	56	Paveh
	0.295	0.19	10	Qasr-e Shirin

In this study, *Kangavar* and Kermanshah had the most and the least concentration of drinking water, respectively, but its average in *Kangavar* was also lower than the standard level. It's worth to mention that Kermanshah having the minimum fluoride concentration of drinking water, have the highest population coverage of the province, which multiplies the consequences of low fluoride. Our study findings are consistent with the findings of the study conducted by Mesdaghinia *et al.*, (2009) on Iran's underground wells, because according to their findings, Kermanshah province has had the lowest mean fluoride concentration of drinking water. Their study results showed that the fluoride concentration of underground wells was  $0.48 \pm 0.28$  PPM and with a standard of less than 0.50 PPM, fluoride was less than the standard level in 69.2 percent of samples, was standard in 29.3 percent them and only in 1.4 percent of them, fluoride concentration was higher than that the standard level. Samples higher than the standard level belong to *Bushehr* province (Mesdaghinia *et al.*, 2010).

It seems that, according to the current findings, fluoride concentration of Kermanshah's drinking water is higher than that in Sari (Ramezani *et al.*, 2009), towns of Zanjan province (2009), Neka and Savadkooh (2008), Urmia (2004). But are less than Kerman (2008), Ardebil (2007), Kashan (2002) and South Khorasan (2010). In the spring of 2009, Ramezani *et al.*, (2009) tested 34 water samples of all drinking water reservoirs to determine the level of drinking water's fluoride in Sari. Fluoride level obtained from each reservoir was multiplied by each reservoir's capacity and total mean and standard deviation were specified. The study results showed that the total amount of water's fluoride in Sari was  $0.25 \pm 0.031$  PPM (Aldosari *et al.*, 2003). In the spring of 2009, Ramezani *et al.*, (2009) tested 36 water samples of all drinking water reservoirs to determine the level of drinking water's fluoride in Shiraz. The study results showed that the total amount of water's fluoride in Shiraz was  $0.35 \pm 0.15$  PPM. In the summer of 2009, Ramezani *et al.*, (2010) tested 58 water samples of all drinking water reservoirs to determine the level of drinking water's fluoride in the towns of *Zanjan* province. The study results showed that the total amount of water's fluoride in *Zanjan* was  $0.06 \pm 0.09$  PPM.

In a During 1998-99, Almasi *et al.*, tested 201 water samples to determine the level of drinking water's fluorine in Kashan. The results showed that the lowest and the highest determined levels of fluorine were 0.25 ml per liter and 1.2 ml per liter, respectively. Also 50.6% of water resources were in the standard level (Almasi *et al.*, 2002). study conducted by Nunnbakhsh *et al.*, for investigating the fluorine concentration of drinking water sources in Urmia, 30 water samples were analyzed and the results showed that the fluorine concentration was 0.12 ml per liter (Nanbakhsh, 2004). In 2008, Rezaei *et al.*, (2008) tested 34 water samples to determine the fluorine concentration of drinking water sources in *Savadkooh*,

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*Neka and Jooybar*. The study results showed that the fluorine concentrations of drinking water in *Savadkooh*, *Neka and Jooybar* were  $0.06 \pm 0.01$  PPM,  $0.185 \pm 0.04$  PPM and  $0.27 \pm 0.13$  PPM, respectively and totally fluoride was less than the standard levels in all samples (Rezaei and Majidi, 2010).

*Shahriyari et al.*, tested 314 water samples of South *Khorasan* to determine the fluoride concentration of drinking water for one year (2007-2008). The study results showed that the mean water's fluoride concentration of South *Khorasan* was  $0.52 \pm 0.24$  PPM (Shahriari et al., 2010). In 2004, Sadeghi et al., (2007) tested 35 water samples to measure physical and chemical characteristics of Ardabil's drinking water. The results showed that the fluorine concentration of samples was 0.598 PPM. In a study conducted by Pooreslami et al., (2008) for measuring the fluoride level of Kerman's drinking water, 42 water samples from 16 different districts were analyzed and the results showed that the fluorine concentration of samples was 0.195 PPM.

In our study, the fluoride concentration of the village's drinking water has been significantly higher, and the status of drinking water's fluoride in rural areas has been better than city, which is consistent with the study findings of Taheri et al., in South *Khorasan* but is inconsistent with the study findings of Almasi et al., (2002) in *Kashan*. It is necessary to state that the materials and the methods of the current study more resemble the ones of the study of Taheri et al., (2005). Certainly low level of drinking water's fluoride is one of the causes of dental problems in this province and it is recommended that the Ministry of Health and Medical Education allocate more budget and facilities to Kermanshah University of Medical Science in order to overcome this problem (low level of drinking water's fluoride) and its associated consequences (tooth caries). Responsible organizations could take necessary intervention actions such as varnishing resin fluoride, providing mouthwash, fluoride-therapy and putting fissure sealants in targeted population groups, especially children and adolescents.

Our country's Ministry of Health and Medical Education should oblige drinking water's control laboratories to code all drinking water's resources, enter and store the results of all tests into databases separately by code, analyze the results of tests in defined periods, and draw the country's map based on the status of drinking water's fluoride like some countries (Karthikeyan et al., 2003; Akpata et al., 2009). Then give the results to the provinces' dental health unit to take necessary interventional actions according to the water's fluoride concentrations in each area because both high and low levels of drinking water's fluoride have their own health problems (Ekanayake and DerHoek, 2003; Amini et al., 2011; Jha et al., 2011; Hernandez-Castro et al., 2011; Levy and Leclerc, 2011). The province's Water and Wastewater organization should also take the necessary measures to fluorine the water of low-fluoride provinces such as Kermanshah, Dalahoo and Paveh because the current study is conducted on all water samples of the province using census, and certainly it can be said that the status of the province's water's fluoride is undesirable.

Certainly low level of drinking water's fluoride is one of the causes of dental problems in this province and it is recommended that the Ministry of Health and Medical Education allocate more budget and facilities to Kermanshah University of Medical Science in order to overcome this problem (low level of drinking water's fluoride) and its associated consequences (tooth caries). Responsible organizations could take necessary intervention actions such as varnishing resin fluoride, providing mouthwash, fluoride-therapy, putting fissure sealants and enriching water with fluoride in targeted population groups, especially children and adolescents. Ministry of Health and Medical Education of Iran should oblige drinking water's control laboratories to code all drinking water's resources, enter and store the results of all tests into databases separately by code, analyze the results of tests in defined periods, and draw the country's map based on the status of drinking water's fluoride like some countries (Ekanayake and DerHoek, 2003; Amini et al., 2011; Jha et al., 2011; Hernandez-Castro et al., 2011; Levy and Leclerc, 2011). Then give the results to the provinces' dental health unit to take necessary interventional actions according to the water's fluoride concentrations in each area because both high and low levels of drinking water's fluoride have their own health problems (Ekanayake and DerHoek, 2003).

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### REFERENCES

- Acharya S and Anuradha KP (2002).** Correlation between water fluoride levels and dental caries in Davangere District, India. *Indian Journal of Dental Research: Official Publication of Indian Society for Dental Research* **14**(3) 146-151.
- Akpata ES, Danfillo IS, Otoh EC and Mafeni JO (2009).** Geographical mapping of fluoride levels in drinking water sources in Nigeria. *African Health Sciences* **9**(4) 15-27.
- Aldosari AM, Akpata ES, Khan N, Wyne AH and Al-Meheithif A (2003).** Fluoride levels in drinking water in the Central Province of Saudi Arabia. *Annals of Saudi Medicine* **23** 20-3.
- Almasi H, Mostafaie GR and Iranshahi L (2002).** Fluor concentration of drinking water of Kashan in 1999. *KAUMS Journal (FEYZ)* **6**(1) 37-43.
- Amini H, Taghavi Shahri SM, Amini M, Ramezani Mehrian M, Mokhayeri Y and Yunesian M (2011).** Drinking water fluoride and blood pressure? An environmental study. *Biological Trace Element Research* **144**(1-3) 157-63.
- Ekanayake L and Hoek WVD (2003).** Prevalence and distribution of enamel defects and dental caries in a region with different concentrations of fluoride in drinking water in Sri Lanka. *International Dental Journal* **53**(4) 243-248.
- Hernández-Castro B, Vigna-Pérez M, Doníz-Padilla L, Ortiz-Pérez MD, Jiménez-Capdeville E, González-Amaro R and Baranda L (2011).** Effect of fluoride exposure on different immune parameters in humans. *Immunopharmacology and Immunotoxicology* **33**(1) 169-177.
- Ibrahim YE, Affan AA and Bjorvatn K (1995).** Prevalence of dental fluorosis in Sudanese children from two villages with 0.25 and 2.56 ppm fluoride in the drinking water. *International Journal of Paediatric Dentistry* **5**(4) 223-229.
- Institute of Standards and Industrial Research of Iran (2005).** *Water sampling*, ISIRI 2347, First revision.
- Institute of Standards and Industrial Research of Iran (2009).** Determination of fluoride- ion in water, ISIRI 2351, third revision.
- Institute of Standards and Industrial Research of Iran (2009).** *Drinking Water - Physical and Chemical Specifications*. ISIRI 1053, 5th revision.
- Jha SK, Mishra VK, Sharma DK and Damodaran T (2011).** Fluoride in the environment and its metabolism in humans. *Reviews of Environmental Contamination and Toxicology*, Springer New York **211** 121-142.
- Karthikeyan G, Sundarraj AS and Elango KP (2003).** Mapping of fluoride endemic areas and correlation studies of fluoride with other quality parameters of drinking water of Veppanapalli block of Dharmapuri district in Tamil Nadu. *Indian Journal of Environmental Health* **45**(4) 281-284.
- Khan AA, Whelton H and O'Mullane D (2004).** Is the fluoride level in drinking water a gold standard for the control of dental caries?. *International Dental Journal* **54**(5) 256-260.
- Levy M and Leclerc BS (2012).** Fluoride in drinking water and osteosarcoma incidence rates in the continental United States among children and adolescents. *Cancer Epidemiology* **36**(2) e83-e88.
- Mahan LK and Escott-Stump S (2008).** *Krause's Food & Nutrition Therapy* (St. Louis, Mo.: Saunders/Elsevier) 120-127.
- Mesdaghinia A, Vaghefi KA, Montazeri A, Mohebbi MR and Saeedi R (2010).** Monitoring of fluoride in groundwater resources of Iran. *Bulletin of Environmental Contamination and Toxicology* **84**(4) 432-437.
- Nanbakhsh H (2004).** Determination of Fluoride in Drinking Water in URMIA City (West Azarbyjan) and Its Health Importance. *Environmental Health* **4**(2) 82.
- Pooreslami H, Khazaeli P and Masoodpoor H (2008).** Fluoride Content of Drinking Waters in Kerman/Iran. *Journal of Kerman University of Medical Sciences* **15**(3) 18-29.
- Ramezani G, Saadat Mansuori S and Shahmrzadi SAK (2009).** An evaluation of level of fluoride in Shiraz drinking water during the spring of 2009. *JRDS* **6**(2) 79-83.

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**Ramezani G, Shahmrzadi S, Valaei N and Saadat Mansuori S (2009).** An evaluation on the amount of fluoride in Sari drinking water during the spring. *JRDS* 6(21) 72-6.

**Ramezani G, Valaei N and Rojhani Shirazi M (2010).** An evaluation on the amount of fluoride in the cities of Zanjan drinking water during the summer of 2009. *JRDS* 6(4) 69-73.

**Rezaei M and Majidi E (2010).** Evaluation of fluoride levels in drinking water sources of Neka, Jouybar and Savadkooh in 2008. *JRDS* 7(2) 54-8.

**Sadeghi H and RouhElahi S (2007).** Study of Ardabil drinking water physicochemical parameters. Journal o Ardaabil University of Medical Science. *JAUMS* 7(23) 52-6.

**Saliba NA, Moimaz SAS and Tiano AVP (2006).** Fluoride level in public water supplies of cities from the northwest region of São Paulo State, Brazil. *Journal of Applied Oral Science* 14(5) 346-350.

**Shahriari T, Azizi M, Sharifzadeh GR, Hajiani M, Zeraatkar V and Aliabadi R (2010).** Evaluation of fluorine concentration in drinking-water sources in South Khorasan (2008-2009). *Journal of Birjand University of Medical Sciences* 17(1) 33-41.

**World Health Organization (2008).** *Guidelines for Drinking-water Quality: Recommendations*. World Health Organization 1.

**Zohouri FV and Rugg-Gunn AJ (2000).** Sources of dietary fluoride intake in 4-year-old children residing in low, medium and high fluoride areas in Iran. *International Journal of Food Sciences and Nutrition* 51(5) 317-26.