ISSN: 2383-2568 *Quarterly of International Archives of Health Sciences 2016;3(1):19-22*

Fluoride Concentration in Drinking Water Resources; North of Iran

ARTICLE INFO

Article Type
Short Communication

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How to cite this article
Amouei A.I, Faraji H, Khalilpour A, Fallah S.H, Asgharnia H.A. Fluoride Concentration in Drinking Water Resources; North of Iran. International Archives of Health Sciences. 2016;3(1):19-22.

ABSTRACT

Aims Fluoride is one of the anions present in soil and water, and determining its level in drinking water is vital for preventing dental and bone diseases in societies. This research aimed to determine fluoride concentrations in drinking water sources of rural and urban areas of Babol City, Iran.

Instrument & Methods This descriptive cross-sectional study was conducted in Babol City, Iran, in 2014. 384 water samples were taken from 43 wells and 3 springs in the rural areas, and from 20 wells, 3 water reservoirs, and the water distribution system in the urban areas. Fluoride concentrations of water samples were measured with a model DR2000 spectrophotometer using the standard SPADNS method. Data were entered to SPSS 16 software and were analyzed by ANOVA test.

Findings The mean fluoride concentrations in the water samples of the deep wells were higher compared to those of the springs (p=0.01). The mean fluoride concentrations in the plains areas were higher compared to the mountainous regions (p=0.02). The mean fluoride concentrations in the wells of the urban areas, in the urban reservoirs, and in the urban water distribution system were 0.40±0.14, 0.39±0.15, and 0.40±0.15mg/l, respectively (p=0.07). Fluoride concentrations in water in urban areas during various seasons varied from 0.31 to 0.45mg/l (p=0.06).

Conclusion Fluoride concentrations in all drinking water sources in urban and rural areas of Babol are less than the ranges recommended by WHO and Iranian national standards.

Keywords Fluorides; Drinking Water; Rural Health; Urban Health; Water Resources

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Article History
Received: October 26, 2015
Accepted: February 7, 2016
ePublished: March 10, 2016

CITATION LINKS

[1] luoride level in drinking water resources of Gorgan rural regions [2] Fluoride in drinking water and its removal [3] Guidelines for drinking water quality [4] Fluoride in drinking water and human urine in southern Haryana, India [5] Fluoride content of drinking waters in Kerman/ Iran [6] Fluoride in drinking water [7] Fluoride in food and water consumed in Koohbanan, Iran [8] Mapping of fluoride endemic areas and assessment of fluoride exposure [9] Monitoring of fluoride in ground water resources of Iran [10] Dental fluorosis and caries experience in relation to three different drinking water fluoride levels in South Africa [11] The effect of water fluoride concentration on dental caries and fluorosis in five Iran provinces: A multi-center two-phase study [12] Fluoride contamination in drinking water in rural habitations of northern Rajastan, India [13] Effect of high-fluoride water on intelligence in children [14] Fluoride contamination in groundwater in parts of Nalgonda District, Andhra Pradesh, Indiag [15] Fluoride and environmental health: A review [16] Determine the concentration of Nitrate and Nitrite in drinking water in rural and urban areas (2012) [17] Fluoride concentration in potable groundwater in rural areas of Khaf city, Razavi Khorasan Province, northeastern Iran [18] Fluorine concentration in drinking water resources in rural areas [19] Flouride concentration in drinking water in Shahroud (Northern Iran) and determination of DMF index in 7 years old children [20] Standard methods for the examination of water and wastewater [21] Histopathological investigation of fluoride induced neurotoxicity in rabbits [22] Fluoride in drinking water and dental fluorosis [23] Evaluation of fluoride concentration in drinking water sources in south Khorasan [24] Fluoride content of drinking waters in Kerman, Iran [25] Study of Ardabil drinking water physicochemical parameters [26] The concentration of Fluoride in drinking water of Hamadan and Bahar cities in 1998-99 [27] Study of chemical and bacterial quality of potable ground water sources in Urmia in 2000 [28] Chemical quality of drinking water in Bandar Abbas

Introduction

Fluorine is one of the essential elements for humans and animals and it is present in measurable quantities in body tissues and fluids of living organisms [1]. Fluorine is among the important elements in human health and nutrition and its role in the health of teeth and bones has been proven [2-4] which is found in the forms of fluorite, cryolite, and fluorapatite. Fluorine is used in extracting metals such as aluminum and materials needed for making tile, ceramic, and brick, and in the pharmaceutical industry [3]. This element is the most active non-metal substance and combines with almost all other organic and inorganic elements [5].

Fluoride enters human body through drinking water and eating foods [6]. The fluoride intake from water depends on its concentration, the altitude of the region, air temperature, and diet [7]. In the tropics, since people drink more water, and due to more evaporation of water from the body and the higher mean temperature, more fluoride is received from drinking water [8]. The desirable fluoride level is 0.7mg/l in the warm months of the year, and 1.2mg/l in the cold months [9]. Increased altitude and reduced air pressure delays urination due to decreased urine pH leading to more fluoride absorption [10].

Fluoride deficiency in water causes dental decay, while its excess consumption leads to complications such as dental fluorosis and bone and kidney diseases [11]. A study conducted in Dashtestan found that fluoride at concentrations higher than 1.2mg/l had no effects on preventing tooth decay [12]. Some studies have suggested that long-term intake of large quantities of fluoride causes chronic symptoms, e.g. stomach and intestinal disorders, increased incidence of pelvic fractures, immune system disorders, low hemoglobin levels, thyroid dysfunction, increased risk of kidney stone, and reduced IQ in children [13]. Long-term exposure to high doses of fluoride during pregnancy disrupts fetal brain function [14] and newborns IQ [15].

Babol region is located in the central part of Mazandaran Province, north of Iran, with an area of more than 1578km^2 consisting of 6 counties, 8 towns, and more than 510 villages, with an urban population of 254,000 and a rural population of 250,000. Babol has a longitude from 33˚52' to 43˚51', and latitude from 36˚35' to 40˚36'. Its urban drinking water is supplied by 20 wells in Amol, and 45 wells (as individual rural wells or integrated rural water supply systems) provide drinking water for the rural areas [16].

In a study that was performed by Amouei *et al*. in rural areas of Khaf City, Iran, the fluoride concentrations in drinking water was determined in the range of 0.11 to 3.5mg/l; 31% of samples was below the limit, 4% was higher than the limit and the rest was at appropriate level between 1 and 1.5mg/l [17]. Yousefi & Taghizadeh have studied the fluoride concentrations in drinking water in rural areas of Mazandaran province, Iran. The maximum content of fluoride in drinking water belonged to spring (0.61mg/l) and the minimum concentration of fluoride related to summer (0.06mg/l) and the average contents of fluoride was 0.31mg/l [18]. In a descriptive cross-sectional study that performed by Rahimzadeh *et al*., the average of the fluoride concentration in drinking water of rural places of Gorgan City, Iran, from different water resources in all seasons was less than the permissible level of fluoride in drinking water. In that research, mean contents of fluoride in wells (0.39mg/l) was more than in springs (0.16mg/l) [1]. Nazemi & Raei have determined the concentration of fluoride in drinking water in Shahroud City, Iran and have reported the average of fluoride concentration as 0.45-0.75mg/l [19].

This research aimed to determine fluoride concentrations in drinking water sources of rural and urban areas of Babol City, Iran.

Instrument & Methods

This descriptive cross-sectional study was conducted in Babol City, Iran, 2014. 384 water samples were taken from 43 wells and 3 springs in the rural areas, and from 20 wells, 3 water reservoirs, and the water distribution system in the urban areas. Samples were collected in all seasons of the year using plastic containers under standard conditions. The samples were transferred to the water and wastewater chemistry laboratories of the Deputy of Health Services and the Rural Water and Wastewater Company in Babol.

Fluoride concentrations of water samples were measured with a model DR2000 spectrophotometer (HACH; Germany) using the standard SPADNS method [20].

Data were entered to SPSS 16 software and were analyzed by ANOVA test.

Findings

The mean fluoride concentrations in the water samples of the deep wells were higher compared to those of the springs (p=0.01). The mean fluoride concentrations in the plains areas were higher compared to the mountainous regions (p=0.02). The mean fluoride concentrations in the various water sources varied from 0.01 to 0.76mg/l in the four seasons; however, the differences were not statistically significant (p=0.1; Figure 1).

Figure 1) Mean fluoride concentrations (mg/l) in drinking water of rural areas of Babol region according to places and seasons

Spring	Summer	Autumn	Winter	Mean
Springs				
0.26±0.10	0.23±0.12	0.27±0.10	0.23±0.10	0.25±0.04
Deep Wells				
0.31±0.12	0.35±0.14	0.38±0.15	0.32±0.12	0.34±0.13
Plains sources of water				
0.41±0.16	0.23±0.12	0.36±0.14	0.35±0.15	0.34±0.14
Mountain sources of water				
0.35±0.14	0.30±0.16	0.37±0.20	0.25±0.16	0.32±0.12
Mean				
0.32±0.15	0.36±0.17	0.31±0.16	0.34±0.15	0.33±0.16

The mean fluoride concentrations in the wells of the urban areas, in the urban reservoirs, and in the urban water distribution system were 0.40±0.14, 0.39±0.15, and 0.40±0.15mg/l, respectively; however, these differences were not statistically significant (p=0.07). Fluoride concentrations in water in urban areas during various seasons varied from 0.31 to 0.45mg/l (p=0.06; Figure 2).

Figure 2) Mean fluoride concentrations (mg/l) in drinking water of urban areas of Babol region according to places and seasons

Spring	Summer	Autumn	Winter	Mean
Well water				
0.37±0.14	0.41±0.16	0.43±0.15	0.39±0.16	0.40±0.14
Water reservoir				
0.39±0.14	0.41±0.15	0.34±0.14	0.42±0.17	0.39±0.15
Water distribution system				
0.38±0.14	0.37±0.17	0.39±0.13	0.41±0.16	0.40±0.15
Mean				
0.43±0.17	0.42±0.14	0.42±0.17	0.40±0.16	0.42±0.16

Discussion

This research was conducted to determine the fluoride concentrations in drinking water sources of rural and urban areas of Babol City, Iran.

The average fluoride concentration in deep well water and springs of rural areas were 0.4 and 0.25mg/l, respectively and was 0.34mg/l in deep well water of urban areas. The average fluoride concentrations in groundwater in the plains and in the mountainous areas were 0.34 and 0.32mg/l, respectively. The mean fluoride concentration in drinking water in Azna City (located in a mountainous region), Iran, in 2006 has reported 0.5-0.7mg/l [15], whereas in Kerman (a plain area), Iran, the maximum and minimum fluoride concentrations in water are measured as 1.8 and 0.6mg/l, respectively [21] which are consistent with our study.

The reason of difference in fluoride concentrations can be that groundwater in the plains are supplied from lower levels and layers, and, higher amount of fluoride is dissolved in the water since passes through more depths in these regions [10], whereas in the mountainous regions, water is usually supplied by springs and qanats which are extracted from aquifers located at depths closer to the ground surface [15].

Mandinic *et al.* have reported higher fluoride concentrations in groundwater compared to surface waters in Canada in 2010 [22]. The average fluoride concentration in the water reservoirs in our study was 0.39, while it was 0.40 in the water distribution system. Fluoride concentrations in the various seasons ranged from 0.31 to 0.45mg/l. Shahryari *et al.* have shown that in all studied water sources of South Khorasan Province, Iran, fluoride concentrations were less than the minimum national standard of the country (0.5mg/l) and less than the levels recommended by WHO [23]. Results of our study are consistent with the studied carried out in Kerman Province, Iran [24], and Ardabil Province, Iran [25].

Rahimzadeh *et al.* have reported that fluoride concentrations in deep well water were higher compared to the springs of villages in Gorgan region, Iran [1]. Also, the mean fluoride concentration in water during all seasons of the year have reported 0.28mg/l that is lower than the levels recommended by the WHO and is consistent with our findings. Findings of studies carried out in Hamadan, Iran [26], and Orumiyeh, Iran [27], are also similar to those found in our study. Of course, in some parts of Iran, such as Bandar Abbas, fluoride

concentrations in water have reported to be higher than the standard values [28].

Evaluation of the fluoride concentration in deep wells, in terms of depth, was the limitation of this research. Considering that fluorine is an important element in the composition of teeth and bones, and its concentration must be at a balanced level in the body, and taking into account the fact that the most important source for receiving this vital element is drinking water, it is important to examine its concentration in drinking water sources in societies.

Conclusion

Fluoride concentrations in all drinking water sources in urban and rural areas of Babol are less than the ranges recommended by WHO and Iranian national standards.

Acknowledgements: We would like to express our gratitude to the Research Deputy of the Babol University of Medical Sciences and to the Rural and Urban Water and Wastewater Company of Babol.

Ethical Permission: Not needed.

Conflicts of Interests: Authors have no conflict of interests.

Funding/Support: None declared by authors.

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