

## DRINKING WATER FLUORIDE AND CHILD DENTAL CARIES IN KHARTOORAN, IRAN

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**SUMMARY:** The aim of this study was to determine whether a relationship exists between the concentration of groundwater fluoride (F) and dental caries of children living in the Khartooran area of the Semnan Province in Iran. A total of 1,043 children, ages 6–11, were selected for examination from seven villages of Khartooran with essentially the same socio-economic living standards and nutritional conditions. F levels in the regular drinking water measured by the SPADNS method ranged from 0.99 to 2.76 mg/L. The ranges for dental caries for permanent teeth (Dt) and deciduous teeth (dt) in boys in the region were 0–0.91 and 0–0.90, respectively. For girls, in the same villages, the ranges for Dt and dt were 0–0.81 and 0–0.84, respectively. Pearson's correlation coefficient showed there is a negative, inverse, and moderately significant linear correlation between the concentration of F in the water and dental caries of deciduous and permanent teeth of boys and girls in the region ( $p < 0.05$ ).

Keywords: Khartooran, Iran; Children; Dental caries; Groundwater fluoride; Semnan Province, Iran.

### INTRODUCTION

As the most electronegative and most reactive of all the chemical elements, fluorine is found in the environment as fluorides. All natural waters have fluoride (F) ranging from trace levels to several dozen mg/L.<sup>1-5</sup> Since drinking water is usually the main source of F intake, determination of water F concentration has been an important undertaking in many countries to investigate its potential effects on health, especially in relation to the occurrence of dental caries and dental fluorosis.<sup>6-11</sup> In this study we examined the relationship between dental caries in children and the F content of groundwater used for drinking and cooking in seven villages of the Khartooran area of Semnan Province in Iran.

### MATERIALS AND METHODS

The study was conducted between March and September 2012 in the 1460-km<sup>2</sup> Khartooran area of Semnan province in Northeastern Iran. The climate is hot and dry in summer and cold in winter. The seven villages in Khartooran that were selected for study all relied for their drinking water on local groundwater sources with varying concentrations of F and all had essentially the same socio-economic standards and nutritional conditions. The 1,043 children examined attended a total of 35 schools, with five in each of the seven villages, were aged 6–11 and included 550 boys and 493 girls. For the F analyses, the standard SPADNS method was used with a Spectrophotometer DR/5000s (HACH Company, USA). The DMFT index in the study region was determined according to the WHO standard.<sup>12</sup> Data were computerized and analyzed using the Statistical Package for the Social Sciences (SPSS version 11.5). Regression analysis was used to examine the relationship between the F concentration in the drinking water with caries in permanent (Dt) and deciduous (dt) teeth.

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## RESULTS AND DISCUSSION

The total population of students in the 35 schools in the seven villages of Zamanabad district of Khartooran and also the number of schoolchildren studied are shown in Table 1 tabulated according to age and gender. As can be seen, most of the children selected for the study were from Ahamadabad village and the fewest were from Rezaabad village.

**Table 1.** The total student population (TSP), boys (n=1,394) and girls (n=1,386), in the 35 schools in the seven villages of Zamanabad district of Khartooran and the demographic characteristics of the sample studied (n=1043)

Village	TSP boys	TSP girls	Age groups of boys in sample			Age groups of girls in sample			Total n sample
			9–10	8–9	7–8	9–10	8–9	7–8	
			Rezaabad	134	127	14	15	12	
Ahmadabad	410	400	40	45	40	30	32	30	217
Zamanabad	146	134	20	24	25	21	22	20	132
Dastjerd	158	176	20	21	24	23	21	20	129
Gazazan	176	176	23	22	25	25	24	20	139
Khankhoudi	175	182	25	25	26	21	22	24	143
Ghalebala	195	191	35	34	35	35	32	30	201
Totals	1394	1386	177	186	187	169	168	156	1043
	2780		550			493			

Table 2 shows the mean, standard deviation (SD), and other descriptive statistical indications of the association between the drinking water F concentration and dental caries of deciduous and permanent teeth of the schoolchildren in the villages (boys, girls, and all children in the villages regardless of age and gender).

**Table 2.** Description of schoolchildren dental caries and water F concentration parameters in seven villages of Zamanabad district of Khartooran

Parameter	Range	Minimum	Maximum	Mean	Std. Deviation
F (mg/L)	1.77	0.99	2.76	1.70	0.56
Dt <sup>a</sup> boys	0.91	0.00	0.91	0.32	0.26
dt <sup>b</sup> boys	0.90	0.00	0.90	0.33	0.27
Dt girls	0.81	0.00	0.81	0.31	0.29
dt girls	0.84	0.00	0.84	0.31	0.27
Dt all in villages	0.91	0.00	0.91	0.35	0.25
dt all in villages	0.90	0.00	0.90	0.35	0.23

<sup>a</sup>Caries in permanent teeth (Dt), <sup>b</sup>Caries in deciduous (dt) teeth.

The fluoride concentration of drinking water in the region varied from 0.99 to 2.76 mg/L. In two other studies, from different parts of Iran, the groundwater F ranges were 0.12–2.17 mg/L<sup>13</sup> and 0.12–0.39 mg/L.<sup>11</sup>

The ranges for dental caries for permanent teeth (Dt) and deciduous teeth (dt) in boys in the Zamanabad district of Khartooran were 0–0.91 and 0–0.90, respectively. For girls, the ranges for Dt and dt were 0–0.81 and 0–0.84, respectively.

As seen in Table 3, Pearson's correlation coefficient indicated there is a negative, inverse, and moderately significant ( $p < 0.05$ ) linear correlation between the drinking water F concentration and dental caries of deciduous and permanent teeth of boys and girls in the seven villages of the Zamanabad district. Overall, this inverse linear correlation remained relatively strong ( $p < 0.001$ ) between drinking water F concentration the seven villages the Zamanabad, district, regardless of the age and gender groups.

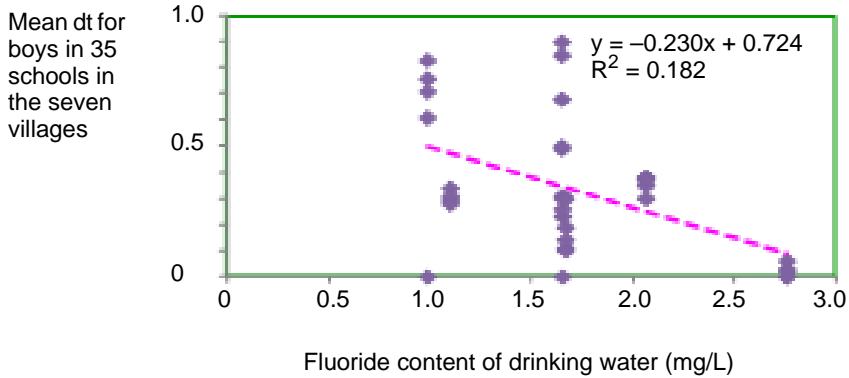
**Table 3.** Pearson's correlation coefficient (r) between F concentration in drinking water and dental caries in schoolchildren of all 7 villages in the Zamanabad district of Khartooran

Parameters	Dt (boys)	dt (boys)	Dt (girls)	dt (girls)	Dt (villages)	dt (villages)
F (mg/L)	-0.43	-0.50	-0.40	-0.42	-0.57	-0.63
p-value	0.009	0.003	0.016	0.010	<0.001	<0.001

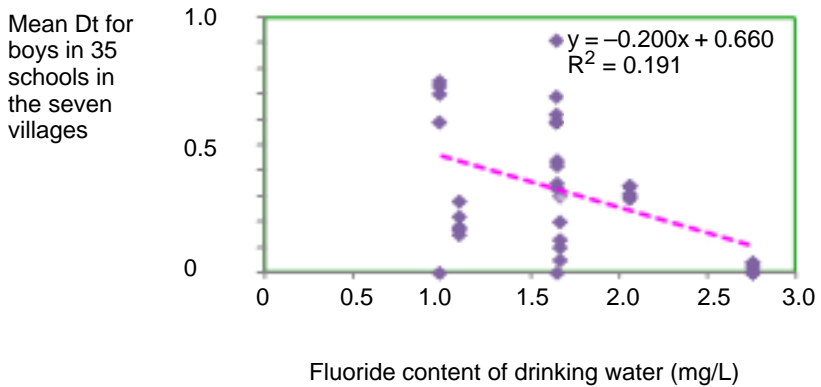
Unlike the results obtained in this study, there was no linear correlation between water F concentration and children's dental caries in investigations conducted in Saudi Arabia.<sup>8</sup> Other studies in Iran showed that drinking water F has a negligible effect on dental caries prevention, and the researchers also concluded that dental caries prevalence among children is much less, compared with other Middle-Eastern countries.<sup>13-14</sup>

Figures 1–4 shows the simple linear regression analysis of the data of our study between drinking water F concentration and tooth decay in deciduous and permanent teeth of boys and girls in different age groups. As seen from the scatter diagrams in Figures 1–4, there was an inverse correlation with increasing F concentration in drinking water and dental caries of both deciduous and permanent teeth of boys and girls in different age groups ( $r^2$  values and the simple linear regression equation are shown on the diagrams).

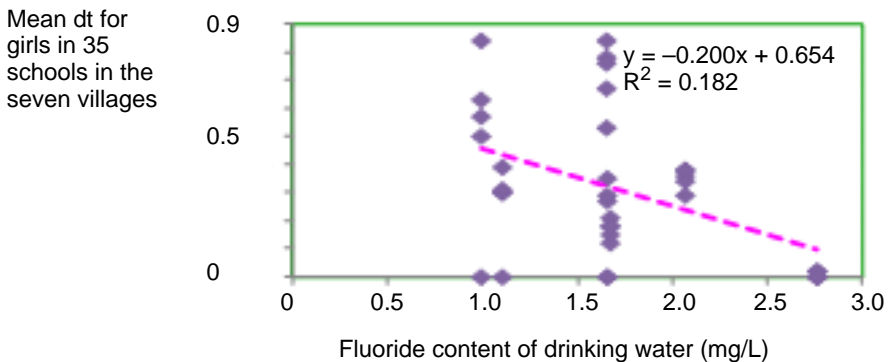
As seen in Figures 5 and 6, a similar correlation pattern is observed between drinking water F concentration and mean dental decay level for deciduous and permanent teeth in the seven villages of Zamanabad district of Khartooran, regardless of the age and gender groups. Therefore, based on the results of this research, it is concluded that there is an inverse linear correlation between drinking water fluoride content of the region and the dental caries for deciduous and permanent teeth of the children.



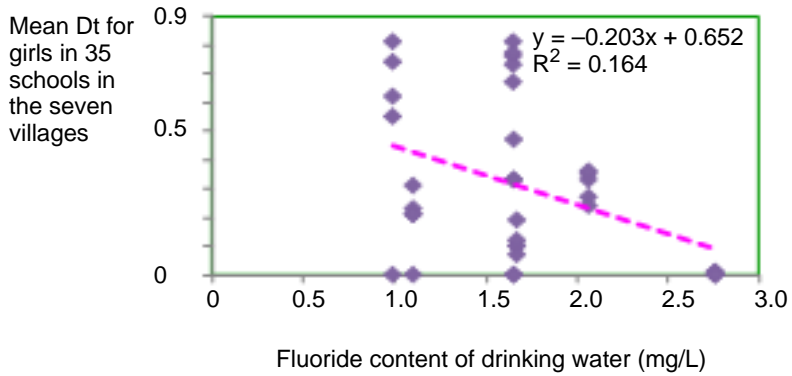
**Figure 1.** Relationship between fluoride content and mean dt for each group of boys in 35 schools in the seven villages of Zamanabad district of Khattooran.



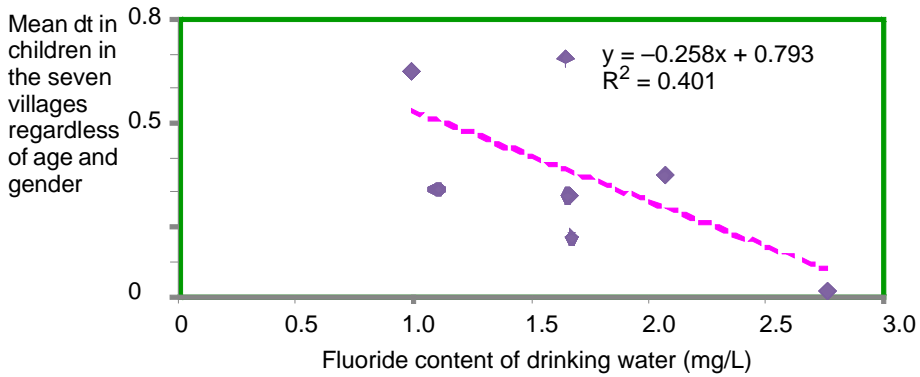
**Figure 2.** Relationship between fluoride content and mean Dt for each group of boys in 35 schools in the seven villages of Zamanabad district of Khattooran.



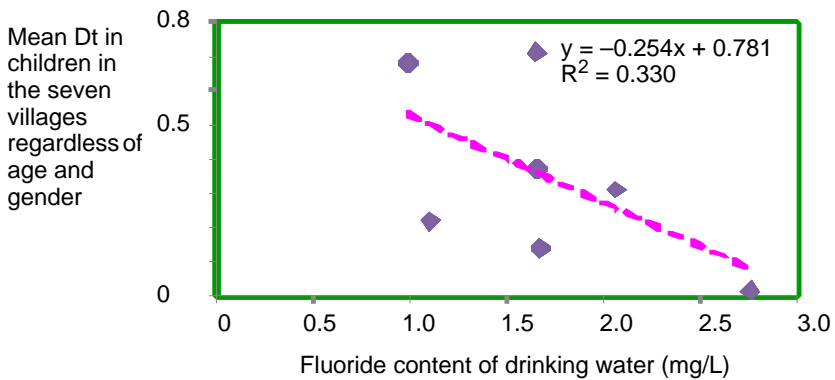
**Figure 3.** Relationship between fluoride content and mean dt for each group of girls in 35 schools in the seven villages of Zamanabad district of Khattooran.



**Figure 4.** Relationship between fluoride content and mean Dt for each group of girls in 35 schools in the seven villages of Zamanabad district of Khartooran.



**Figure 5.** Relationship between fluoride content and mean dt in children regardless of the age and gender groups in the seven villages of Zamanabad district of Khartooran.



**Figure 6.** Relationship between fluoride content and mean Dt in children regardless of the age and gender groups in the seven villages of Zamanabad district of Khartooran.

In their research in Iran, Dobaradaran et al<sup>15</sup> did not observe any significant correlation between drinking water F concentration and dental caries for deciduous and permanent teeth of children in 14 studied villages. However, when the village with the highest water F concentration and the lowest dental decay level is extracted from their study, it had a direct but weak correlation between the water F content of drinking water and dental caries.

Figures 7a,b, and c illustrate disfiguring dental fluorosis that is fairly common in some of the villages of the Khartooran area. In view of the relatively warm summer climate and the elevated level of F in much of the available drinking water, along with extensive consumption of tea with a mostly modest F content,<sup>16</sup> it is probably advisable to recommend the use low-F bottled drinking water in this part of Iran.<sup>17</sup>

**Figure 7a.** Dental fluorosis in an 8-yr-old boy from Zamanabad village (F content of the drinking water = 1.65 mg/L).



**Figure 7b.** Dental fluorosis in an 9-yr-old girl from Rezaabad village (F content of the drinking water = 1.10 mg/L).



**Figure 7c.** Dental fluorosis in an 10-yr-old girl from Ahmadabad village (F content of the drinking water = 2.06 mg/L).



**Figures 7a, b, and c.** Examples of dental fluorosis in children in three villages in the Khartooran area with drinking water F levels of 1.65, 1.10, and 2.06 mg/L respectively.

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