

Relationship of Dental Caries at Different Concentrations of Fluoride in Endemic Areas: An Epidemiological Study

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Objective: Fluoride has been an effective tool to prevent dental caries but efforts have been on to establish optimal level of fluoride in drinking water in different communities. The present study seeks to establish the safe and acceptable concentration of fluoride in drinking water which would lead to maximum caries protection with least amount of clinically observable dental fluorosis. **Study Design:** 30 villages from 2 districts of Haryana were classified according to differing levels of fluoride in the drinking water. 3007 school children (1558 males & 1449 female) were examined and the DMFT score was related to the level of fluoride in drinking water. **Results:** The caries prevalence was maximum (48.02%) in the area having 0.50 ppm fluoride in drinking water. The children from area having the 1.13 ppm fluoride level had the least caries prevalence i.e. 28.07%. **Conclusion:** The results of the present study did not suggest any additional anticaries benefit beyond 1.13ppm fluoride level. The present investigation showed that the optimal fluoride levels for drinking water for our conditions were near 1.13ppm (1-1.2 ppm) as there was maximum caries protection with least amount of esthetically objectionable fluorosis at that level.

Keywords: Coronal; Caries; Epidemiology; Fluorosis; India.

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INTRODUCTION

Today, the greater means exist to prevent major oral diseases. The dental professional has a fundamental obligation to prevent the initial development of diseases, and to conservatively and economically check incipient conditions, using all clinical and community means available.¹

Dental caries remain one of the most common diseases in the world, affecting substantial number of children and adults of all ages. The consequence of tooth decay includes pain, infection, compromised appearance and chewing ability, the need for costly dental restorative treatment, loss of tooth and absence from work or school.

Dental caries called as scourge of modern civilization is no more confined to the west but has spread even to the

developing countries.² Due to implementation of organized community preventive measures in the developed countries, dental caries is on the decline, but in the developing countries like India as well as in the underdeveloped ones it is increasing rapidly.³⁻⁵

Fluorine is the 14th essential trace element. About 96% of the fluoride in the body is found in bones and teeth and it is essential for the normal mineralization of bones and formation of dental enamel. Fluorine is often called a two-edged sword because of its beneficial effects in optimal doses and harmful effects due to overdosage.⁶ It can be considered a nutrient, a drug, or a poison, entirely on the basis of dosage used.⁷

The relation between concentration of fluoride and the development of dental caries was established from numerous epidemiological studies beginning in the mid 1930's, and specially from the classic 21-city study reported by Dean.^{8,9} On January 25, 1945 Grand Rapids, Michigan became the first city in the world to adjust its water fluoride concentration to a level expected to promote dental health.¹⁰

The cariostatic effect of fluoride was well established from studies in the past¹¹⁻²³ and hence fluoride became most potent and effective anti-caries agent. Galagan and Vermillion recommended a range of optimal concentration of fluoride from 0.7 ppm in water of the warmest temperature zones of the United States to 1.2 ppm in the coldest zones.²⁴

Most reports²⁵⁻²⁷ show that the caries prevalence tends to diminish with increasing fluoride level in the drinking water, thus indicating an inverse relationship between fluoride and caries. However, some studies indicate no relationship,²⁸ or even a positive association between the fluoride concentration in drinking water and the prevalence of dental caries in

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the permanent dentition.^{20,29}

The aim of this study is to determine safe and acceptable level of fluoride in drinking water for maximum caries protection with least amount of clinically observable dental fluorosis.

MATERIAL AND METHODS

Two districts of Haryana (Dist. Gurgaon and Hissar) having varying fluoride levels in drinking water as established by Public Health Department Haryana were selected for the study. 30 villages out of these two districts having fluoride levels ranging from 0.30 to 8.50 ppm in the drinking water were selected randomly. Villages having single source of water supply only were selected for this study, to eliminate the discrepancy in consumption of fluoride in drinking water from different sources. One village (Hayatpur) with two sources of water supply was also selected because the difference in the fluoride content in two sources was quite marked i.e. 2.20 and 8.5 ppm. The group wise distribution of fluoride content in drinking water of these villages was recorded. The groups made were <0.50 (sub optimally), <1.00 (near optimum), and over 1.51, 2.45, 5.27 and 8.50 (more than optimum) ppm fluoride levels. Environmental factors like eating habits, nutritional status, consumption of water, living conditions were almost found uniform in all seven groups studied.

The present study was conducted among 3007 school

children (1558 males and 1449 females) in the age group of 12-16 years who were continuous residents of their respective areas if he/she had been born and lived permanently in that area. It was also ensured that the selected individuals had all their permanent teeth (except third molars) erupted.

Subject examination was done by one investigator. Classroom with maximum light and ventilation was selected to carry out the Type III examination (Inspection using a mouth mirror and explorer in adequate illumination). Each individual was asked to rinse their mouths thoroughly with plain water and teeth were cleaned using gauze before being subjected to examination. A straight chair with tall back on which individual's head could rest was used for examination of Dental caries according to WHO Index.³⁰

Caries was recorded as being present when a lesion in a pit or fissure or on a smooth tooth surface had a detectable softened floor and undermined enamel. A tooth with a temporary filling was also included in this category. If any doubt existed, caries was not recorded.

Informed consent and official permission to carry out the survey was obtained from the parents of children and all the concerned authorities respectively.

RESULTS

The sample

The results of the study as regards to the prevalence and

Table 1. Distribution of the sample according to fluoride level in drinking water

Group No.	Village	District	Fluoride Content (In ppm)	Average Fluoride Content Of The Group	No. Of Children Examined (in years)					TOTAL
					12	13	14	15	16	
1	KIRMARA	HISSAR	0.34	0.50	119	132	119	81	30	481
	BADSHAHPUR	GURGAON	0.38							
	SINGHWAKHAS	HISSAR	0.62							
	KHOR	GURGAON	0.65							
2	SARBASIRPUR	GURGAON	0.70	0.87	45	102	123	83	40	393
	RAINWALA	HISSAR	0.74							
	GAWAR	HISSAR	0.91							
	KURTHALA	GURGAON	1.00							
	MOHAMMADPUR	GURGAON	1.00							
3	RAIPUR	GURGAON	1.00	1.13	48	87	126	117	46	424
	PILCHIYAN	HISSAR	1.11							
	TIGHRA	GURGAON	1.14							
	BAPAS	GURGAON	1.20							
	RAHANWA	GURGAON	1.20							
4	BANDHAULI	GURGAON	1.26	1.51	29	95	130	107	78	439
	AGROHA	HISSAR	1.59							
	TARAKPUR	GURGAON	1.60							
	CHULIKHURD	HISSAR	1.60							
5	KAIMRI	HISSAR	2.10	2.45	139	181	194	190	67	771
	HAYATPUR(1)	GURGAON	2.20							
	CHAHALKA	GURGAON	2.25							
	DAULTAWAS	GURGAON	2.25							
	SALEMGARH	HISSAR	2.50							
	MOHAMMADPUR	HISSAR	2.50							
	LALUWAL	HISSAR	2.58							
	LADHUWAS	HISSAR	3.25							
6	SAWKA	GURGAON	4.05	5.27	70	98	99	111	49	427
	GHIRAI	HISSAR	5.15							
	GURANA	HISSAR	6.60							
7	HAYATPUR(2)	GURGAON	8.50	8.50	18	22	18	8	6	72
TOTAL					468	717	809	697	316	3007

NOTE: HAYATPUR(1)-SOURCE OF WATER IS WELL; HAYATPUR(2)-SOURCE OF WATER IS HAND PUMP; ppm-PARTS PER MILLION

Table 2. Prevalence of dental caries at various fluoride levels

Fluoride level (in ppm)	No. of children examined			No. of children with caries			Mean DMFT			Standard deviation
	M	F	T	M	F	T	M	F	T	
0.5	253	228	481	116(45.85)	115(50.44)	231(48.02)	1.06	1.27	1.16	1.6248
0.87	208	185	393	69(33.17)	69(37.30)	138(35.11)	0.55	0.62	0.58	1.3856
1.13	221	203	424	63(28.51)	56(27.59)	119(28.07)	0.48	0.40	0.44	0.8062
1.51	226	213	439	64(28.32)	68(31.92)	132(30.07)	0.48	0.56	0.52	0.9055
2.45	409	362	771	143(34.96)	141(38.95)	284(36.84)	0.58	0.59	0.59	0.8775
5.27	207	220	427	81(39.13)	102(46.36)	183(42.86)	0.61	0.69	0.65	0.8775
8.5	34	38	72	18(52.94)	16(42.11)	34(47.22)	0.82	0.74	0.78	1.0817

Note: The figures in brackets indicate percentages

severity of dental caries were tabulated in accordance with the different fluoride level group areas.

Table 1 shows distribution of the sample according to fluoride level in drinking water. A total of 30 villages were selected with different ppm of fluoride in drinking water. Seven groups were made of having average fluoride content 0.50, 0.87, 1.13, 1.51, 2.45, 5.27 and 8.50 ppm.

Sample Profile

Caries Prevalence At Different Fluoride Levels

Table 2 shows prevalence of dental caries at various fluoride levels. Mean DMFT scores at 0.50, 0.87, 1.13, 1.51, 2.45, 5.27 and 8.50 ppm fluoride level was 1.06, 0.55, 0.48, 0.48, 0.58, 0.61 and 0.82 respectively for males. For females at same ppm fluoride levels the mean DMFT score was 1.27, 0.62, 0.40, 0.56, 0.59, 0.69 and 0.74 respectively.

The total mean DMFT at above said ppm fluoride level

was 1.16, 0.58, 0.44, 0.52, 0.59, 0.65 & 0.78 respectively. The caries prevalence was maximum (48.02%) in the area having 0.50 ppm fluoride in drinking water. The children from the area having the 1.13 ppm fluoride level had the least caries prevalence i.e. 28.07%. At 8.50 ppm fluoride level the prevalence of dental caries was 47.22% which was comparable to that of low fluoride (0.50 ppm) area i.e. 48.02%. (Figure 1)

Table 3 gives us the value of ‘Z’ in comparing the value of mean DMFT scores for different concentration level (ppm) of fluoride. Highly significant differences are found between 0.5 ppm level and up to 5.27 ppm. Very significant difference was observed between 0.5 ppm and 8.5 ppm. No significant difference was found between 0.87 ppm level and other higher values. The value of ‘Z’ similarly can be interpreted for other levels of ppm from the table.

Figure 1. Prevalence of dental caries at varying fluoride levels

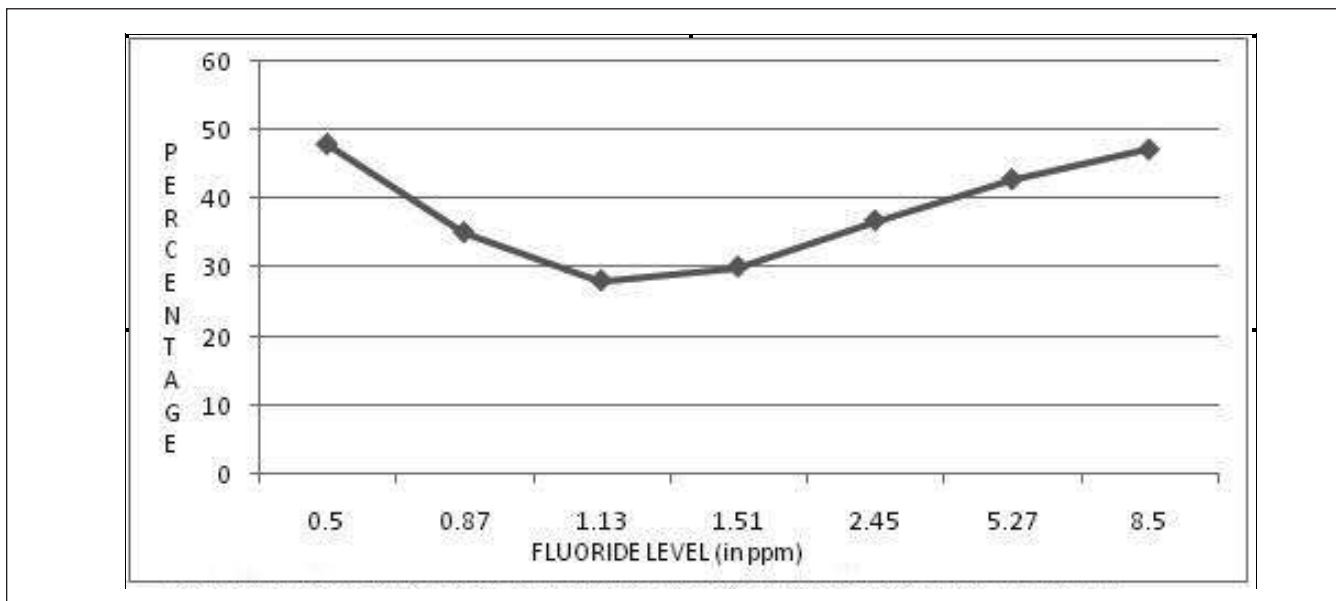


Table 3. Table Of Z Values For Prevalence Of Dental Caries [Mean Dmft] Between Various Fluoride Levels

	FLUORIDE LEVEL (in ppm)						
	0.50	0.87	1.13	1.51	2.45	5.27	8.50
0.50	—	5.6945***	8.5924***	7.4618***	7.0769***	5.9724***	2.5773**
0.87		—	1.7475 NS	0.7301 NS	0.1304 NS	0.8559 NS	1.3757 NS
1.13			—	1.3718 NS	2.9811**	3.6357***	2.5496**
1.51				—	1.3074 NS	2.1456*	1.9316 NS
2.45					—	1.0060 NS	1.4467 NS
5.27						—	0.9675 NS
8.50							—

NS -NOT SIGNIFICANT

* -SIGNIFICANT (p<0.05)

** -VERY SIGNIFICANT (p<0.01)

*** -HIGHLY SIGNIFICANT (p<0.0027)

DISCUSSION

The prevalence of dental caries at varying fluoride levels had been extensively studied during the last 50 years to know the safe and acceptable levels of fluoride in drinking water for maximum caries protection and esthetically acceptable probable dental fluorosis. In India some studies to establish the relationship between dental caries at varying fluoride levels in drinking water have been reported.³¹⁻³³

This study’s results show that minimum caries experience occurred at 1.13ppm fluoride level in drinking water which is considered to be optimal by numerous investigators.^{8,9,24,32,34,35} There was 48.02% caries at 0.5ppm level which is reduced to 28.07% at 1.13 ppm effecting a 41.5% reduction. This finding is in accordance with other various studies reported in literature.³⁶⁻⁴⁰ As fluoride level increased further there was no additional benefit for caries reduction, on the other hand there was an increase in dental caries experience.^{41,42} It was also noted in the present study that the dental caries experience remained lower at all the areas having above optimal fluoride levels than at suboptimal fluoride levels which is also supported by many earlier studies.^{32,33,43-45}

There are some reports⁴⁶⁻⁴⁸ as per studies done in USA which showed greater anticaries benefits at higher than optimal fluoride levels. Englander⁴⁹ had suggested that if epidemiological studies confirmed an enhancement of anti-caries effect provided by naturally occurring fluoride concentration of 2,3,4,5 or even 6ppm without a substantial increase in the prevalence and severity of enamel fluorosis, concentrations higher than 1 ppm could be recommended for community water fluoridation programs. Environmental Protection Agency (EPA, USA) set regulations in 1987 allowing the maximum concentration of 4ppm while suggesting that no more than 2 ppm should be the goal. Although a few exceed 2pm level.⁵⁰

The results of the present study did not suggest any additional anticaries benefit beyond 1.13ppm fluoride level. However there was slight increase in caries prevalence as fluoride levels increased further.^{41,42} Reddy and Tewari³² had also reported maximum caries reduction with minimum

amount of esthetically objectionable enamel mottling at 1.10ppm after studying the prevalence of dental caries and dental fluorosis in endemic fluoride levels of district Bhatinda, Punjab. In the present study, the caries prevalence at 8.5 ppm was almost equal to the caries prevalence at sub-optimal level i.e. 0.50ppm fluoride in drinking water. This could be due to decrease in added protection as a result of severe fluorosis, which could increase significantly caries incidence.

The difference in result of Indian studies including the present one with those of the west may be due to the differences in the climatic, environment, water diet consistency, drinking habits, nutritional status, altitude and occupational variations.^{51,52} In summary, there appears to be several factors which influence the activity of fluoride either in caries control or in the production of mottled enamel.^{24,35,53}

CONCLUSION

There was maximum dental caries experience at suboptimal fluoride level i.e. 0.50ppm as compared to the optimal and above optimal fluoride levels. Maximum caries reduction occurred at 1.13ppm fluoride level. There was no additional anti-caries benefit beyond 1.13ppm. However, there was a slight increase in the caries prevalence as fluoride levels increased further. The optimal level of fluoride in drinking water was found to be 1.13ppm at which there was maximum caries reduction with minimum amount of esthetically objectionable fluorosis.

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