

Naturally fluoride contained of drinking water and the prevalence of dental fluorosis in Ninevah Governorate, Iraq

Tarik Y KHAMRICO*

May Gh AL-AJRAB**

ABSTRACT

The purpose of the study was to determine the prevalence of dental fluorosis in a group of school students lived in area with high and low natural fluoride contained drinking water in Ninevah Governorate.

The study was conducted among (1724) school's students aged (11-16) years from randomly selected schools (primary and intermediate) in two provinces in Ninevah Governorate. Eight hundred and thirteen students who had lived since birth in high natural fluoride level area (Sinjar province) (2.05-2.22 ppm) and (911) students lived continuously from birth in low natural fluoride level area in their drinking water (Talkaif province) (0.11-0.19 ppm).

Dean index has been used to assess the dental fluorosis. The results show that the prevalence of dental fluorosis in Sinjar province is (97.3%) within individual and (62.9%) within teeth, ranging from very mild to mild form of dental fluorosis, with no significant sex difference, but the percentage of severity has been found to be increasing with age, while the prevalence of dental fluorosis in Talkaif province was (5.5%) within individual and (1.2%) within teeth, with no significant sex difference.

The community fluorosis indices for Sinjar and Talkaif provinces are (1.7 and 0.1) respectively. This difference is due to the difference in level of natural fluoride in both provinces' drinking water supplies.

Key Words: Dental fluorosis, community fluorosis index, mottled enamel, natural water fluoridation.

الخلاصة

إن الهدف من هذه الدراسة هو لمعرفة مدى انتشار تبقع ميناء السن (Dental Fluorosis) عند طلاب المدارس الذين يعيشون في منطقتين: الأولى تحتوي على نسبة عالية من الفلورايد، والثانية تحتوي على نسبة ضئيلة من الفلورايد في ماء الشرب في محافظة نينوى.

تم إجراء الدراسة على عينة مكونة من (1724) طالب في مدارس مختارة بصورة عشوائية (ابتدائية وثانوية) وبأعمار تتراوح بين (11-16) سنة في قضاءين تابعين لمحافظة نينوى هما: قضاء سنجار بعينة مكونة من (813) طالب، ولدوا وعاشوا في هذا القضاء الذي يستقي الماء من عين سنجار الحاوية على نسبة عالية من عنصر الفلور (2.05-2.22 جزء من المليون)؛ والعينة الأخرى مكونة من (911) طالب ولدوا وعاشوا في قضاء تلكيف الذي يستقي الماء من نهر دجلة الحاوي على نسبة منخفضة من عنصر الفلور (0.11-0.19 جزء من المليون).

*Tarik Yousif KHAMRICO; BDS, DDPH (RCS), MSc: Prof.

**May Ghanim AL-AJRAB; BDS, MSc: Assistant Lecturer.

Department of Pedodontics, Orthodontics, and Preventive Dentistry, College of Dentistry, University of Mosul, Mosul, IRAQ.

استُخدمت دلالة 'دين' (Dean Index) لقياس مدى انتشار تبقع ميناء السن. أظهرت النتائج أن نسبة انتشار تبقع ميناء السن في قضاء سنجار كانت (٩٧,٣%) للأشخاص و (٦٢,٩%) للأسنان وبمقدار يتراوح بين بسيط جداً إلى بسيط وبدون اختلاف للجنس، كما لوحظ أن مقدار شدة هذا المرض يزداد مع العمر. أما بالنسبة لقضاء تلعكبر فقد وُجدَ أن نسبة انتشار تبقع ميناء السن هي (٥٥,٥%) بالنسبة للأشخاص و (١,٢%) بالنسبة للأسنان مع عدم وجود اختلاف للجنس. إن نسبة انتشار تبقع الأسنان للمجتمع (Community Fluorosis Index) للقضاءين كانت (١,٧%) و (٠,١%) على التوالي، وهذا الاختلاف في مؤشر تبقع الأسنان يعكس الفرق بين مستوى الفلور الطبيعي الموجود في ماء الشرب لكلا القضاءين.

INTRODUCTION

Endemic dental fluorosis is a specific disturbance of tooth formation caused by excessive intake of fluoride during formative period of the dentition and the manifestation of this form of chronic fluoride intoxication depend upon the amount ingested of fluoride, the duration of exposure, and the age of the subject⁽¹⁾. The recommended level of fluoride in water supplies is (1) ppm⁽²⁾, and the excess of fluoride ion caused dental fluorosis or mottled enamel^(3,4). It is widely accepted that dental fluorosis is only important when it becomes of cosmetic concern. To address this distinction, many authors have arbitrarily designated some types of defect as statistically objectionable^(5,6).

In studies undertaken in population without fluoridated drinking water, the estimation of the prevalence of dental fluorosis, or diffuse opacities, have been varied widely. Some of this variability undoubtedly results from the use of different indices, interpretation of criteria or teeth examined⁽⁷⁾. However, a number of studies using standardized procedure have reported differences in the prevalence of dental fluorosis between countries⁽⁸⁾ and cities⁽⁹⁾, and even between adjacent country districts⁽⁷⁾. They suggested that these differences might be associated with differences in social deprivation.

So, the aim of this study was to determine the prevalence and severity of dental fluorosis in a group of school children lived in areas with high and low natural fluoride contained water in Ninevah Governorate.

MATERIALS AND METHODS

The study was conducted in two district areas in Ninevah Governorate: one with drinking water containing high natural fluoride, and the second area with drinking water containing naturally low level of fluoride.

The first area is Sinjar province with drinking water used containing (2.05-2.22 ppm) fluoride and the source of water is tap water from borehole. The second

area is Talkaif province with its drinking water containing (0.11-0.19 ppm) fluoride and the source of water is public water supplies from Tigris River.

Many samples of water have been taken from both provinces for determining the concentration of fluoride within them, in a plastic container with a good cover. Samples are taken directly from the source of water like borehole in Sinjar and Tigris River in Talkaif and the other sample is taken from tap water in schools and houses in both provinces.

The two areas are nearly of the same socio-economic and educational status. The population of the study is students (girls and boys) aged from (11-16) years. They have been examined for estimation the prevalence of dental fluorosis. The students have been examined either at primary or secondary schools, and the selection of schools has been done randomly. Four primary schools and two secondary schools for boys, and two secondary schools for girls have been selected for each province and the classes selected are from 5th primary up to 4th intermediate classes. All the students examined have lived continuously from birth on the district area which they have been examined.

The students have been examined in a suitable room, and before examination any student that does not meet the age qualification or subject not born and lived in those areas has been excluded from the examination and also information regarding name, age, and sex of the student has been registered prior to examination on a special form which contained the assessment of dental fluorosis. This form contains also some questionnaires that the students have to answer them before examination. These questionnaires are about the students' born area; also the students asked about using any form of fluoride supplements and if the answer is "yes", the students excluded from the study.

The examination, then, is done during the light hours in good natural light, using plane mirror with the students sitting in a chair in front of the examiner.

The criteria to select for diagnosis of dental fluorosis:

1. All the examined teeth must be dried with cotton wool.
2. The examination has included all fully erupted permanent teeth.
3. The tooth is considered a fully erupted when at least 2/3 of the crown erupted with no gingiva covering it.
4. All the primary teeth are excluded from the examination.
5. Also the permanent teeth with crown, or labial veneer or retained root, are excluded from the examination.

The diagnosis of dental fluorosis has been performed according to criteria of Dean index ⁽¹⁰⁾ for determining the degree of dental fluorosis within the individual. Each tooth has been graded as normal or one of the following degrees of fluorosis (questionable, very mild, mild, moderate, and severe). Each tooth has been graded as one of these categories and for assessment of prevalence of dental fluorosis within individual has been given a grading equivalent to that attached to most two severely affected teeth, and if the assessment differs the rating is the lesser of the two ⁽¹¹⁾.

In addition to assessing the degree of dental fluorosis within individual, Dean devised means of calculating the degree of fluorosis within a community by the use of community fluorosis index ⁽¹²⁾.

$$\text{Community Fluorosis Index} = \frac{\sum \text{number of individual} \times \text{statistical weight}}{\text{Total number of individual examined}}$$

The statistical analysis of the data, which was conducted using SPSS (for Windows version 9.0), include the followings:

1. Classification of data and calculation of frequencies.
2. Chi square test has been used for determining sex significant difference for all forms of dental fluorosis within individual and teeth.

The differences were considered significant when the probability was less than 5% level ($p < 0.05$).

RESULTS

The distribution of the sample by age and sex is shown in table (1). The total sample is divided into two main groups. The first group consisted of [813 (47.15%)] students lived continuously from birth in high level natural fluoride area (Sinjar province), and the second group consisted of [911 (52.85%)] students lived continuously from birth in low level of natural fluoride area (Tarkaif province). The total sample consisted of (1724) students, [969 (56.2%)] males and [755 (43.8%)] females. Each group is subdivided into three age groups (11-12, 13-14, and 15-16) years.

Table (1): Distribution of the sample by age and sex

Age (year)	Area	Males		Females	
		No.	%	No.	%
11-12	Sinjar	190	49.00	198	51.00
	Tarkaif	185	45.12	228	54.80
13-14	Sinjar	194	70.50	81	29.50
	Tarkaif	195	61.50	122	38.50
15-16	Sinjar	94	62.70	56	37.30
	Tarkaif	111	60.00	70	40.00
Total	Sinjar	478	58.79	335	41.21
	Tarkaif	491	53.89	420	46.11
Total Sample		969	56.20	755	43.80

Table (2) shows the number and percentage of students who suffer from dental fluorosis in Sinjar province. The results indicated that only (2.7%) of individuals have normal teeth, which means that (97.3%) of the individuals have dental fluorosis. The percentage of normal individuals decreased with increase the age of the students. The results show that the very mild and mild forms of dental fluorosis have the higher percentage in all age groups and for the total sample. The results revealed that the severity of dental fluorosis increased with age of students. The total males reported

more severe dental fluorosis than the females in categories (moderate and severe), and these sex differences were found to be not significant.

Table (2): Number and percentage of Sinjar students distributed according to Dean index of fluorosis by age and sex

Age (year)	Sex	No.	Dean Index											
			Normal		Questionable		Very Mild		Mild		Moderate		Severe	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11-12	M	190	6	3.2	24	12.6	65	34.2	70	36.8	22	11.6	3	1.6
	F	198	8	4.0	24	12.1	77	38.9	74	37.4	10	5.1	8	4.0
Total		388	14	3.6	48	12.4	139	35.8	144	37.1	32	8.2	11	2.8
13-14	M	194	7	3.6	24	12.4	58	29.9	49	25.3	29	14.9	27	13.9
	F	81	0	0.0	12	14.8	33	40.7	20	24.7	14	17.3	2	2.5
Total		275	7	2.5	36	13.1	91	33.1	69	25.1	43	15.6	29	10.5
15-16	M	94	1	1.1	14	14.8	19	20.2	28	29.8	13	13.8	19	20.2
	F	56	1	1.8	4	7.1	19	33.9	19	33.9	6	10.7	7	12.5
Total		150	2	1.3	18	12.0	38	25.3	47	31.3	19	12.7	26	17.3
Total Males		478	148*	3.1	62*	13.0	142*	29.7	147*	30.8	64*	13.4	49*	10.2
Total Females		335	9*	2.7	40*	11.9	126*	37.6	113*	33.7	30*	9.0	17*	5.1
Total Sample		813	23	2.8	102	12.5	268	33.0	260	32.1	94	11.6	66	8.1

* No significant difference between males and females using χ^2 at 0.05 level.

Table (3) showed the number and percentage of student's teeth affected by dental fluorosis. The results showed that questionable form of dental fluorosis has a higher percentage for the total sample (23.5%) and for all age groups followed by other forms of dental fluorosis as decreased the percentage with the decrease of the severity. The study revealed that the severity of dental fluorosis increases with age. The total males reported more severe dental fluorosis than females in categories (very mild, mild, moderate, and severe), with no significant difference between them, except for mild type.

Table (3): Number and percentage of Sinjar students' teeth distributed according to Dean index of fluorosis by age and sex

Age (year)	Sex	No.	Dean Index											
			Normal		Questionable		Very Mild		Mild		Moderate		Severe	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11-12	M	190	1661	45.3	612	16.7	740	20.2	559	25.2	84	2.3	12	0.3
	F	198	1774	44.1	867	21.5	802	19.9	516	12.8	41	1.0	24	0.6
Total		388	3435	44.7	1479	19.2	1542	20.0	1075	14	125	1.6	36	0.5
13-14	M	194	1690	33.2	1300	25.5	1045	20.5	800	15.7	151	3.0	110	2.2
	F	81	818	38.4	670	31.5	400	18.8	193	9.1	40	1.9	7	0.3
Total		275	2508	34.7	1970	27.3	1445	20.0	993	13.7	191	2.6	117	1.6
15-16	M	94	1118	27.0	1025	24.8	832	20.1	831	10.6	218	5.3	94	2.3
	F	56	526	35.1	341	22.9	298	20.1	248	16.7	49	3.3	24	1.6
Total		150	1644	31.95	1366	23.85	1130	20.1	1079	18.65	267	4.3	118	1.95
Total Males		478	4469*	34.7	2937*	22.8	2617*	20.1	2190**	17.0	433*	3.5	216*	1.7
Total Females		335	3118*	40.5	1878*	24.5	1500*	19.7	957**	12.8	130*	1.7	55*	0.7
Total Sample		813	7587	37.1	4815	23.5	4117	20.0	3147	15.3	583	2.8	271	1.3

* No significant difference between males and females using χ^2 at 0.05 level. ** Significant difference.

Table (4) showed the number and percentage of students suffered from dental fluorosis in Tarkaif province. The results indicated that more than (94.5%) of the total individuals in Tarkaif province have normal teeth, while only (5.5%) of the individuals were affected by dental fluorosis. The study found that the severity of dental fluorosis increases with age (moderate and severe forms). The distribution of different forms of dental fluorosis for total sample almost is the same. The total males reported more severe dental fluorosis than total females (mild, moderate, and severe). This difference was found to be not significant, except in mild form.

Table (4): Number and percentage of Tarkaif students distributed according to Dean index of fluorosis by age and sex

Age (year)	Sex	No.	Dean Index											
			Normal		Questionable		Very Mild		Mild		Moderate		Severe	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11-12	M	185	174	97.2	1	0.5	1	0.5	2	0.8	1	0.5	1	0.5
	F	228	223	97.4	1	0.5	3	1.5	0	0.0	1	0.5	0	0.0
Total		413	402	97.3	2	0.5	4	1.0	2	0.5	2	0.5	1	0.2
13-14	M	195	178	91.3	2	1.0	2	1.0	7	3.6	4	2.1	2	1.0
	F	122	112	91.8	2	1.6	5	4.1	2	1.6	1	0.8	0	0.0
Total		317	290	91.5	4	1.3	7	2.2	9	2.8	5	1.6	2	0.6
15-16	M	111	104	93.7	1	0.9	0	0.0	2	1.8	3	2.7	1	0.9
	F	70	65	92.9	1	1.4	2	2.9	0	0.0	2	2.9	0	0.0
Total		181	169	93.4	2	1.1	2	1.1	2	1.1	5	2.8	1	0.6
Total Males		491	461*	94.2	4*	0.8	3*	0.6	11**	2.1	8*	1.5	4*	0.8
Total Females		420	400*	94.8	4*	1.0	10*	2.7	2**	0.5	4*	1.0	0*	0.0
Total Sample		911	861	94.5	8	0.9	13	1.4	13	1.4	12	1.3	4	0.9

* No significant difference between males and females using χ^2 at 0.05 level. ** Significant difference.

Table (5) showed the numbers and percentage of student's teeth distributed according to Dean index categories of fluorosis. The study reported that (98.8%) of all teeth in Tarkaif province is normal. On the other hand, only (1.2%) of teeth is affected by dental fluorosis. The higher percentage for the total sample is for very mild form (0.4%), followed by questionable (0.3%).

The total males reported slightly more severe dental fluorosis than total females (mild, moderate, and severe forms), with no significant difference between them, except in mild form of dental fluorosis.

Table (5): Number and percentage of Talkaif students' teeth distributed according to Dean index of fluorosis by age and sex

Age (year)	Sex	No.	Dean Index											
			Normal		Questionable		Very Mild		Mild		Moderate		Severe	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11-12	M	185	4496	98.9	6	0.1	17	0.4	13	0.13	8	0.2	4	0.1
	F	228	4363	99.0	21	0.5	15	0.3	1	0.0	4	0.1	1	0.0
Total		413	8859	99.0	27	0.3	32	0.4	14	0.2	12	0.1	5	0.1
13-14	M	195	5074	96.2	15	0.3	32	0.6	28	0.5	12	0.2	6	0.1
	F	122	3291	98.7	17	0.3	17	0.5	10	0.3	3	0.1	2	0.1
Total		317	8365	98.4	26	0.3	49	0.6	38	0.4	15	0.2	8	0.1
15-16	M	111	3080	99.4	2	0.1	4	0.1	4	0.1	6	0.2	4	0.4
	F	70	2049	99.3	4	0.2	4	0.2	0	0.0	5	0.2	1	0.0
Total		181	5129	99.3	6	0.1	8	0.2	4	0.1	11	0.2	5	0.1
Total Males		491	12650	98.7	23*	0.2	53*	0.4	45**	0.4	26*	0.2	14*	0.1
Total Females		420	9703	99.0	36*	0.4	36*	0.4	11**	0.1	12*	0.1	4*	0.0
Total Sample		911	22353	98.8	59	0.3	89	0.4	56	0.2	38	0.2	18	0.1

* No significant difference between males and females using χ^2 at 0.05 level. ** Significant difference.

Table (6) reported the number of individuals in Sinjar province distributed according to Dean index categories from (0) to (4). The table showed the statistical weight of each category.

$$\text{Community Fluorosis Index for Sinjar} = \frac{1385}{813} = 1.70$$

Table (6): Number of persons for each category of Dean index and its statistical weight for Sinjar province

No. of Persons	Score	Statistical Weight
23	0	0
102	0.5	51
268	1	268
260	2	520
94	3	282
66	4	664
813		1385

$$\text{Community Fluorosis Index} = \frac{1385}{813} = 1.70$$

Table (7) showed the number of individuals in Talkaif province distributed according to Dean index categories.

$$\text{Community Fluorosis Index for Talkaif} = \frac{95}{911} = 0.10$$

Table (7): Number of persons for each category of Dean index and its statistical weight for Talkaif province

No. of Persons	Score	Statistical Weight
861	0	0
8	0.5	4
13	1	13
13	2	26
12	3	36
4	4	16
911		95

$$\text{Community Fluorosis Index} = \frac{95}{911} = 0.10$$

DISCUSSION

The presence of natural fluoride in high concentration exceeding the optimal levels will reduce the dental caries⁽¹³⁻¹⁵⁾ and, unfortunately, result in unacceptable appearance of enamel of the teeth; so the study of different concentrations of fluoride and their effects on producing dental fluorosis is very important to be correlated with their effect on reducing the dental caries experience⁽¹⁶⁻¹⁸⁾.

The criteria selected for assessment of dental fluorosis in this study are Dean index⁽¹⁰⁾. These criteria depend on the clinical appearance of the teeth and not on the histological background; so it is a simple description pattern and easy to be used to identify groups of lesions that are likely to be good reflection of the prevalence and severity of dental fluorosis within students considered. Also, this index enables the user to have a clear picture about the community fluorosis score, which can be calculated in very simple equation.

The results of water investigations show that the concentration of fluoride in Sinjar province ranges between (2.05-2.22 ppm) with the highest concentration, which is from the source (borehole). Therefore, Sinjar province is considered as a high fluoride level area, and the fluoride level is twice the recommended optimum level of fluoride. On the other hand, water investigations reveal a concentration of fluoride ranges between (0.11-0.19 ppm) in Tarkaif province, which is in accordance to that concentration reported in a study carried out by Al-Alousi⁽¹⁹⁾. Therefore, Tarkaif province is considered as a low fluoride level area.

The results revealed a prevalence of dental fluorosis within Sinjar students of about (97.3%) for individual, and (62.9%) within teeth of these students. These percentages, which have been considered as a high prevalence of dental fluorosis and in contrast with other studies in areas with nearly the same level of fluoride in their drinking water, that for individual⁽²⁰⁻²³⁾, than within teeth^(7, 24), and it is nearly the same results of other studies^(12, 25).

As a conclusion of these results that the high fluoride level in drinking water, which result in high prevalence of dental fluorosis among individuals, and this agreed with most studies carried out in this field^(16, 17, 18, 20, 26, 27), but all data obtained in these studies revealed a less prevalence than that reported in this study. This may be related to climatic condition of this province: The high temperature especially in hot season (summer) leads to high attitude of the individual for consumption of high quantity of water. This leads to increasing in fluoride concentration reached to body of individual during teeth formation. Also the difference between examiner in interpretation of criteria of the index used may cause this variation in the prevalence of dental fluorosis.

The highest percentage of the type of dental fluorosis is very mild to mild form for individual, and questionable to very mild form for teeth, and this has given support to findings of many studies^(20, 21, 25, 28).

The study revealed an increase in the severity of dental fluorosis with the increasing of the age of students, and this agreed with other studies^(17, 21, 29), but it disagreed with the results of Vincent *et al.*⁽¹⁶⁾, who found that no association between the age of the subject and percent of occurrence of dental fluorosis. This increase has been found to be very little for individual but for the teeth it was (10%) increase from age group (11-12) years and age group (13-14) years, and this represented by teeth erupted at this time of age that cause this increase in prevalence of dental fluorosis within teeth, while there is no difference between age groups (13-14) years and (15-16) years, because the teeth has been already present. The difference between males

and females that has been found in this study is not significant. This finding is in agreement with other studies.

On the other hand, the percentage of dental fluorosis in Tarkaif province was (5.5%) for individual and (1.1%) within the teeth. This low prevalence reflects the low concentration of natural fluoride present in their drinking water. The individual prevalence is found to be similar to that of other studies^(21, 30, 31), and is lower than that obtained by other studies^(32, 33). However, the prevalence on the teeth is found to be less than all prevalence found for areas with the same fluoride concentration in water^(21, 30, 34), and it was nearly the same that of other studies^(18, 21, 24).

The community dental fluorosis index for Sinjar province is (1.7%); it is in coincidence with the results of other studies^(20, 21, 28), while in contrast with other studies with nearly the same fluoride concentration in their drinking water. It was higher than that of Dean *et al.*⁽³⁴⁾ for Coalesburg City (USA) and that of Segretto *et al.*⁽²¹⁾ for both cities (Fl-Stukton and Littke Field) and Forrest⁽²⁵⁾. This high community fluorosis index for Sinjar province indicated that the high consumption of fluoride is mainly from water and increase the effect of fluoride, which is due to climate condition of province. However, the community fluorosis index for Tarkaif province is (0.1%), which is in comparison with the results of other studies having the same concentration^(31, 34).

From the results of this study, we can easily recognize that there is a great difference observed between the two provinces in prevalence of dental fluorosis and dental caries⁽¹⁵⁾ and this difference is found to be with high significance. This is due to the difference in concentration of fluoride in their drinking water supplies.

REFERENCES

1. Moller IJ. Fluoride and dental fluorosis. *Int Dent J.* 1982; 32(4): 135-147.
2. Temporate-Doherty JM. Use of dietary fluoride. *Wiscoms Med J.* 1968; 67: 599-602.
3. Murray JJ. Appropriate use of fluoride. Human Health. Geneva, World Health Organization. 1986.
4. Wahab IK, Shellis RP, Elderton E. Effects of low fluoride concentrations on formation of caries-like lesion in human enamel in a sequential-transfer bacterial system. *Archs Oral Biol.* 1993; 38(11): 985-995.
5. Heifetz SB, Driscoll WS, Horowitz HS, Kingman A. Prevalence of dental caries and dental fluorosis in areas with optimal and above optimal water fluoride concentration: A five years follow-up survey. *J Am Dent Assoc.* 1988; 116: 490-495.
6. Milson K, Mitropontes CM. Enamel defects in 8-year old children in fluoridation and non-fluoridation parts of Cheshire. *Caries Res.* 1990; 24: 286-289.
7. Ellwood RP, O'Mullane DM. The demographic and social variation in the prevalence of dental enamel opacities in North Wales. *Community Dent Health.* 1994; 11: 192-196.
8. O'Brien M. Children dental health in the United Kingdom 1993, London HMSO, 1994.

9. Downer MC, Blinkhorn ES, Host RD, Attwood D. Dental caries experience and defects of dental enamel among 12-year old children in North. *Community Dent Oral Epidemiol.* 1994; 22: 283-285.
10. Dean HT. Classification of mottled enamel diagnosis. *J Am Dent Assoc.* 1934; 20: 313-319.
11. Dean HT. Production of mottled enamel halted by a change in community water supply. *Am J Public Health.* 1939; 29: 567-575.
12. Dean HT, Arnold DF, Elvove E. Domestic water and dental caries, additional studies of the relation of fluoride domestic water to dental caries experience in 4425 white children aged 12-14 years and of 13 cities in 7 states. *Public Health Rep.* 1942; 87: 1155-1179.
13. Thylstrup A, Bill J, Brunn B. Caries experience of Danish children living in area with low and optimum levels of natural water fluoride. *Caries Res.* 1982; 166: 413-420.
14. Moola MH. Fluoridation of South Africa. *Community Dent Health.* 1995; 13(2): 51-55.
15. Khamrco TY, Al-Ajrab MG. Prevalence of dental caries (DMFT) in Iraq children and adolescent living in areas with low and high levels of natural fluoride. *Al-Rafidain Dent J.* 2001; 1(Sp Iss): 385-400.
16. Vincent A, Segeto D, Charles T. A current study of mottled enamel in Texas. *J Am Dent Assoc.* 1984; 4: 108-111.
17. Gasper MR, Pereira AC, Moreira BH. Estimation of opacities of fluoride origin from fluoride area contained (0.2 ppm) fluoride and optimal (0.7 ppm) concentration. *J Braz Dent.* 1995; 52: 13-18.
18. Pereira AC, Moreira BH. Analysis of three dental fluorosis indices used in epidemiological trial. *Br Dent J.* 1999; 10(1): 29-37.
19. Al-Alousi W. Enamel mottling in Iraqi young adult (an epidemiological study). *Iraqi Dent J.* 1998; 23: 55-66.
20. Driscoll WS, Horowitz HS, Meyers BJ, *et al.* Prevalence of dental caries and dental fluorosis in areas with optimal and above optimal water fluoride concentrations. *J Am Dent Assoc.* 1983; 107: 42-47.
21. Segretto VA, Collins FM, Camann D, Smith CT. A current study of mottled enamel in Texas. *J Am Dent Assoc.* 1984; 113: 29-33.
22. Al-Khateeb TL, Darwish SK, Bastawi AE, O'Mullane DU. Dental caries in children residence in community in Saudi Arabia with different levels of natural fluoride in the drinking water. *Community Dent Health.* 1990; 7: 165-171.
23. Riorden PJ, Bank J. Dental fluorosis and fluoride exposure in Western Australia. *J Dent Res.* 1991; 70: 1072-1082.
24. Holt RD, Morris CE, Winter GB, Downer MC. Enamel opacities and dental caries in children who used a low fluoride toothpaste between 2 and 4 years of age. *Int Dent J.* 1994; 44: 331-341.
25. Forrest JR. Caries evidences and enamel defects in area with different levels of fluoride in the drinking water. *Br Dent J.* 1956; 100(8): 195-200.
26. Kunzel V. Caries and dental fluorosis in high fluoride districts under sub-tropical condition. *J Int Assoc Dent Child.* 1980; 4: 1-6.
27. O'Mullane D, Whelton H. Efficacy of fluoride against dental caries: Fluoride in water. Oral Health Services Research Center, University Dental School, Wilton, Cork, Ireland. 1997.
28. Moller JJ, Pindborg JJ, Roed PB. The prevalence of dental fluorosis in the people of Uganda. *Archs Oral Biol.* 1970; 19: 213-225.

29. Kailis DG, Silva D. Occurrence of dental fluorosis in Carnarvon, Western Australia. *Aust Dent J*. 1970; 15: 35-43.
30. Leverett DH. Prevalence of dental fluorosis in fluoridated and non-fluoridated communities: A preliminary investigation. *J Public Health Dent*. 1986; 46: 184-187.
31. Driscoll WS, Horowitz HS, Myers RY, *et al*. Prevalence of dental caries and dental fluorosis in areas with negligible, optimal, and above optimal fluoride concentrations in drinking water. *J Am Dent Assoc*. 1986; 13: 29-33.
32. Hamdan MA, Rock WP. Dental caries experience of Jordanian and English school children. *Community Dent Health*. 1993; 10: 151-157.
33. Hawely RM, Ellwood RP, Davies RM. Dental caries, fluorosis and the cosmetics implications of different TF scores in 14-year old adolescents. *Community Dent Health*. 1996; 13: 189-192.
34. Dean HT, Jay P, Arnold FA, Elvove E. Domestic waters and dental caries. II: A study of 2832 white children ages 12-14 years of eight sub-urban Chicago communities including *Lactobacillus acidophilus* studies of 1761 children. *Public Health Rep*. 1941; 56: 761-792.