

## Enamel mottling in a group of Iraqi students in a high and low fluoride community

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### ABSTRACT

The purpose of the study was to determine the prevalence of mottled enamel in a group of school students lived in area with high and low natural fluoride contained drinking water in Iraq.

The study was conducted among (874) school's students aged (13–16) years from randomly selected intermediate schools in two provinces in Ninevah Governorate. Four hundred and eight students who had lived since birth in high natural fluoride level area (Sinjar province) (2.05–2.22 ppm fluoride) and (466) students lived continuously from birth in low natural fluoride level area in their drinking water (Talkaif province) (0.11–0.19 ppm fluoride).

Al-Alousi index has been used to assess mottled enamel. The results show that the prevalence of mottled enamel in Sinjar province is (95.8%) within individuals and (65.3%) within teeth, with significant difference between the sex; while the prevalence of mottled enamel in Talkaif province was (18.1%) within individuals and (3.6%) within teeth, with no significant sex difference.

The high percentage of mottled enamel was of type "A", followed by types "B" and "E" in high fluoride area, while in low fluoride area also type "A" reported the high prevalence, followed by types "B" and "C".

**Key Words:** Mottled enamel, natural water fluoridation, dental fluorosis, Al-Alousi index.

### الخلاصة

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

تم إجراء الدراسة على عينة مكونة من (٨٧٤) طالب وطالبة في مدارس ثانوية تم اختيارهم بصورة عشوائية وبأعمار تتراوح بين (١٣-١٦) سنة في قضاءين تابعين لمحافظة نينوى هما: قضاء سنجار بعينة مكونة من (٤٠٨) طالب وطالبة ولدوا وعاشوا في هذا القضاء الذي يستقي الماء من عين سنجار الحاوية على نسبة عالية من عنصر الفلور (٢.٠٥-٢.٢٢ جزء من المليون)؛ والعينة الأخرى مكونة من (٤٦٦) طالب وطالبة ولدوا وعاشوا في قضاء تلكيف الذي يستقي الماء من نهر دجلة الحاوي على نسبة منخفضة من عنصر الفلور (٠.١١-٠.١٩ جزء من المليون). استخدمت دلالة الألووسي وجماعته لقياس مدى انتشار تبقع ميناء السن.

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أظهرت النتائج أن نسبة انتشار تبقع ميناء السن في قضاء سنجار كانت (٩٥,٨%) للأشخاص و(٦٥,٣%) للأسنان مع وجود اختلاف معنوي بين الجنسين. أما بالنسبة لقضاء تلكيف فقد وجد أن نسبة انتشار تبقع ميناء السن هي (١٨,١%) للأشخاص و(٣,٦%) للأسنان مع عدم وجود اختلاف بين الجنسين. إن أعلى نسبة سُجِّلَتْ لأنواع تبقع ميناء السن كانت نوع "A" يليه "B"، "E" عند طلاب سنجار، بينما في تلكيف كذلك سُجِّلَ نوع "A" أعلى النسب يليه "B" و "C".

## INTRODUCTION

Enamel defects may be localized to a single tooth or affect the whole dentition. They can vary in severity from a mild defect of calcification to almost complete failure of enamel formation. Many terms have been used to describe these defects including "mottled enamel", "developmental opacities", "dental fluorosis", "enamel hypocalcification" and "internal enamel hypoplasia" <sup>(1)</sup>.

The aetiological factors associated with enamel defects may be divided into two main groups, those which cause localized defects limited to one or a few teeth, and those which cause generalized defects affecting most or all teeth. Over ninety different factors may be responsible for enamel defects <sup>(1)</sup>. It is generally accepted that enamel developmental defects can result from a wide spectrum of systemic, local and possibly genetic factors <sup>(1-3)</sup>, including increased exposure to fluoride <sup>(4-5)</sup>. The occurrence of enamel mottling has been observed in optimum and low fluoride areas, and numerous aetiological factors, apart from fluoride, have been implicated. The optimum exposure to fluoride greatly improved dental health, while excessive ingestion of it results in defective and unsightly dental enamel <sup>(6-8)</sup>.

So the aim of the study was to determine the prevalence and severity of mottled enamel in a group of school students lived in areas with high and low natural fluoride contained water in Ninevah Governorate, Iraq.

## 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 (13-16) years. They have been examined for estimation the prevalence of enamel mottling. The students have been examined on secondary schools, and the selection of schools has been done randomly. Two secondary schools for boys and two secondary schools for girls have been selected for each province and the classes selected are from 1<sup>st</sup> up to 4<sup>th</sup>



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 mottled enamel:

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 mottled enamel has been performed according to criteria of Al-Alousi *et al.*<sup>(9)</sup> for determining the degree of mottled enamel within the teeth and individual.

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 mottled enamel 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 sex is shown in table (1). The total sample is divided into two main groups. The first group consisted of [408 (46.7%)] students lived continuously from birth in high level natural fluoride area (Sinjar province), and the second group consisted of [466 (53.3%)] students lived continuously from birth in low level of natural fluoride area (Talkaif province). The total sample consisted of (874) students, [563 (64.4%)] males and [311 (35.6%)] females.

Table (1): Distribution of the sample by sex

Age	Area	Males		Females		Total
		No.	%	No.	%	
Total	Sinjar	276	67.6	132	32.4	408
	Talkaif	287	61.5	179	38.5	466
Total Sample		563	64.4	311	35.6	874



Table (2) showed the number and percentage of students who suffer from mottled enamel in both provinces. The result indicated that only (4.2%) of students in Sinjar province have normal teeth, which mean that (95.8%) of the sample have mottled enamel on one tooth or more. The total males reported more prevalence of mottled enamel than females (98.2% and 90.9%), respectively, with significant difference between them. In Tarkaif province, the result indicated that (81.9%) of the total students with normal teeth, while only (18.1%) are affected by mottled enamel. The prevalence was very slightly higher in males than females (18.5% and 17.9%), respectively, with no significant difference between them.

Table (2): Number and percentage of students affected by mottled enamel

Sex	Sinjar Province				Tarkaif Province			
	Normal		Mottled		Normal		Mottled	
	No.	%	No.	%	No.	%	No.	%
Males	5	1.8	271	98.2	234	81.5	53	18.5
Females	12	9.1	120	90.9*	147	82.1	32	17.9**
Total	17	4.2	391	95.8***	382	81.4	85	18.1

\* Significant difference between males and females using  $\chi^2$  test.

\*\* No significant difference between males and females.

\*\*\* Very high significant difference between Sinjar and Tarkaif provinces at 0.001 level.

The number and percentage of students' teeth affected by mottled enamel were shown in table (3). The result reported that (65.3%) of the total teeth for Sinjar students were affected by opacities. The males recorded higher percentage than females (67.6% and 60.6%), respectively, with statistically significant difference between them; while the percentage of teeth affected in Tarkaif students were (1.9%) only. Also, the males reported very slightly higher than females with no significant difference between them.

The prevalence of the individual and teeth affected by mottled enamel between the two provinces showed very high significant difference between them.

Table (3): Number and percentage of students' teeth affected by mottled enamel

Sex	Sinjar Province				Tarkaif Province			
	Normal		Mottled		Normal		Mottled	
	No.	%	No.	%	No.	%	No.	%
Males	2462	32.4	5130	67.6	7353	96.1	293	3.9
Females	1440	39.4	2218	60.6*	4811	96.7	164	3.3**
Total	3902	34.7	7348	65.3***	12164	96.4	457	3.6

\* Significant difference between males and females using  $\chi^2$  test at 0.01 level.

\*\* No significant difference between males and females.

\*\*\* Very high significant difference between Sinjar and Tarkaif provinces at 0.001 level.

Table (4) showed the number and percentage of different types of mottled enamel distributed by sex in Sinjar students. The study revealed that type "A" reported the higher percentage for the total sample (40.4%), followed by types "B" and "E" (16.8% and 2.7%), respectively.



Table (4): The number and percentage of Sinjar students' teeth distributed according to different types of mottled enamel by sex

Type of Mottling	Males		Females		Total	
	No.	%	No.	%	No.	%
Normal	2460	32.4	1442	39.4	3902	34.7
A	3104	39.4	1599	42.6	4703	40.4
B	1353	18.9	432	12.6	1785	16.81
C	180	2.5	82	2.4	262	2.5
D	114	1.6	23	0.7	137	1.3
E	238	3.3	53	1.5	291	2.7
F	141	1.9	29	0.8	170	1.6

Table (5) showed the percentage of different types of mottled enamel distributed by sex in Talkaif students. The most prevalent type of mottled teeth was type "A", followed by types "B" and "C" for the total sample. There was very slight difference between the sexes in different types of mottled enamel with no significant difference between them.

Table (5): The number and percentage of Talkaif students' teeth distributed according to different types of mottled enamel by sex

Type of Mottling	Males		Females		Total	
	No.	%	No.	%	No.	%
Normal	7355	96.1	4805	96.7	12164	96.4
A	123	1.7	63	1.2	186	1.5
B	60	0.8	41	0.8	101	0.8
C	40	0.5	22	0.5	62	0.5
D	30	0.4	16	0.3	46	0.4
E	14	0.2	14	0.3	28	0.2
F	26	0.3	8	0.2	34	0.2

## DISCUSSION

The term "mottled enamel" was used by McKay (1916)<sup>(10)</sup> to describe the teeth of children living in Colorado Springs, but it was until (1931) that fluoride was detected in public water supplies and implicated as the causative agent by Churchill (1931)<sup>(11)</sup>. Dean (1931)<sup>(12)</sup> proposed a classification for mottled enamel, which depended on the degree of severity of defects. Using this index, Dean *et al.* (1942)<sup>(13)</sup> studied the geographical distribution of mottled enamel in the United States, relating the prevalence of this condition to the fluoride content of the water. They reported that with (1–2 ppm) fluoride in drinking water (33%) of children exhibited some degree of mottled enamel, normally milder form; whilst at (5 ppm) and higher (100%) of children were affected, and the mottling was predominately of the more severe forms.



This index is attractive since it has been found to be a useful summary of the severity of mottling in a community and exhibits a simple linear relationship with the natural logarithm of fluoride in the drinking water.

Because of this long association between the term "enamel mottling" and fluoride in drinking water, it has gradually been taken to be a cause and effect relationship, which may or may not be the cause.

After that many researches proposed other classification of mottled enamel as Young (1973)<sup>(14)</sup>, Jackson *et al.* (1975)<sup>(15)</sup> and Al-Alousi *et al.* (1975)<sup>(9)</sup>, which were very similar and were based solely on the clinical appearance of the lesions and so could be used in high and low fluoride areas, and therefore the cause may be attributed to many aetiological factors apart from fluoride have been implicated.

The results of water investigations showed 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 more than twice the recommended optimum level of fluoride. On the other hand, water investigations reveal concentration of fluoride ranges between (0.11–0.19 ppm) in Tarkaif province, which is in accordance to the concentration reported in a study carried out by Al-Alousi<sup>(16)</sup>. Therefore, Tarkaif province is considered as low fluoride level area.

The results revealed a high prevalence of mottled enamel within Sinjar students of about (95.8%) for individual and (65.3%) within teeth of these students. This is in accordance with other studies that reported when the concentration of fluoride is high<sup>(1, 17, 18)</sup> (more than the optimal level); while other studies reported less mottled enamel in area with optimal fluoride, ranged between (8%)<sup>(19)</sup> to (36%)<sup>(20)</sup>. Other use permanent incisor teeth only reported (35%)<sup>(15)</sup> to (39%)<sup>(9, 16)</sup>. The high prevalence of mottled enamel in this area may be related to climatic condition of this province. The high temperature especially 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 students during teeth formation.

While the prevalence of mottled enamel in low fluoride area (Tarkaif province) was (18.1%) for individual and (3.6%) within teeth of these children. These findings are in accordance with other studies for individual<sup>(21–23)</sup> and for teeth affected<sup>(24)</sup>.

When testing the prevalence of individual and teeth affected by mottled enamel for community difference (between Sinjar and Tarkaif provinces) there were very high significant differences between the two communities.

In Sinjar province, from (11250) teeth were examined, [7348 (65.3%)] were mottled. The high percentage of mottled enamel was type "A" (44.3%) of the total teeth, that type had white areas less than (2) mm in diameter, followed by type "B" (16.8%) and type "E" (2.7%). The coloured areas (brown) had only seen in (3.8%) of the total teeth. while in Tarkaif province, from (12621) teeth were examined, only [457 (3.6%)] were mottled. Also type "A" reported the high prevalence (1.5%), followed by type "B" (0.8%) and type "C" (0.5%). These findings are confirmed the results obtained by Al-Alousi<sup>(16)</sup> in his study in Iraqi students. Also in other study by Al-Alousi *et al.*<sup>(9)</sup> and Akapta<sup>(25)</sup>, they reported that predominant type of mottling teeth is "A", followed by types "B" and "E".

In the high fluoride community, the males reported high prevalence of mottled enamel than females with significant difference between them. This was in agreement with other study<sup>(9)</sup>, while no significant difference in non-fluoridated area between males and females<sup>(23, 26, 27)</sup>.



It was concluded from this study that the mottling of the teeth in Sinjar province is due to the high concentration of fluoride in water, also due to climate effect that increase the water consumption and increase the concentration of fluoride intake. While in non-fluoridated area (Tarkaif province) there were (18.5%) of individuals with mottled enamel; that mean these mottled teeth could be due to other factors and not entirely due to fluoride. This confirms the findings of other studies<sup>(9, 16, 23)</sup>.

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