

# Developmental Enamel Defects in Relation to Intelligence Quotient among Primary Schools Students

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## ABSTRACT

**Objective:** To assess the relationship between the enamel defects and the intelligence quotient among a group of children.

**Subjects and Methods:** A cross sectional study was carried out in Al-Najaf city, Iraq by which a total of (1122) primary school student aged from 8-10 years old were included. All the students were examined for the presence of the enamel defects in the permanent teeth. Their intelligence quotient was determined using Raven's colored progressive matrices. Statistical analysis was done using SPSS version 21.

**Results:** The results of the current study showed that the prevalence of the developmental enamel defects among the total sample (22.37%) was more prevalent among the intellectually impaired subjects (24.64%). However, the results were statistically not significant.

**Conclusion:** This study concluded that a relationship was found between the enamel defects and the level of the intelligent quotient, by which it was highly prevalent among the intellectually impaired children.

**Key words:** Enamel defects, Permanent teeth, Intelligence quotient (IQ), Najaf

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## INTRODUCTION

Enamel is a unique in that it is a highly mineralized tissue in its structure, development and chemical nature; it is the most highly mineralized and hardest tissue in the body. However, very little organic matrix is found in the mature enamel [1]. Developmental defects of enamel are defined as disturbances in hard tissue matrices and in their mineralisation, arising during odontogenesis. These defects may be localised that affecting single or multiple teeth or systematic that affecting groups of teeth developing at the time of disturbance [2].

When the enamel is formed, it is irreplaceable, dental enamel manufactured by secretory cells called ameloblasts, these cells affected by any changes in their environment during the prolonged period of enamel manufacturing. Any impairment in the function of the ameloblasts can lead to changes in the appearance of the dental enamel. The enamel defects may appear as a little alteration in the color of the tooth or a lack of enamel entirely [3]. However, the developmental defects of enamel can occur as changes in the quality or in the quantity of enamel and appear in various manifestations clinically. Hypomineralization of enamel appears clinically as a demarcated or diffuse opacities while the hypoplastic

defects of enamel appears as insufficiency in the quantity of the enamel [4]. Several conditions identified to be a causative factor for the developmental defects of enamel, including local, systemic, environmental and genetic factors [5]. Systemic conditions that may lead to enamel defects include nutritional insufficiency, poisonings, infectious diseases, perinatal and postnatal complications and many other medical problems, while the localized defects of enamel could be related to trauma, localized infection (resulting from necrosis of the pulp in the primary predecessor tooth) and irradiation [3]. Amelogenesis imperfecta is a diverse set of genetic disorders that lead to different grades of hypomineralization, hypomaturation and/or hypoplasia of tooth enamel [6].

Intelligence quotient is a total score obtained from several standardized tests planned to assess the human intelligence [7]. Hypoplastic defects of enamel were found to be common in children with cerebral palsy, and those had intellectual disabilities or hearing defects [8]. At birth, the enamel of the first permanent molar begins to be mineralized [9]. Intellectual disabilities can be caused by premature birth which mostly related with medical complications at birth and premature functions of the body, both of them may increase the risk of hypoxia [9,10]. The normal function of ameloblasts may affected by oxygen insufficiency and calcium insufficiency which can be causative factors to the enamel defects [11].

This study aimed to get knowledge about the relation between the enamel defects of permanent teeth and the intelligent quotient among group of children.

### MATERIALS AND METHODS

A protocol for this study was submitted and reviewed by the Scientific and Ethical Committee of the Pedodontics and Preventive Dentistry Department at the College of Dentistry in the University of Baghdad, Iraq. Therefore, approval was gained. An approval was obtained from the Directorate of General Education in Al-Najaf city in order to conduct the study at the primary schools without obstacles. The guidelines of the Helsinki declaration was followed in this study, where the parents/guardians of each child were informed completely (regarding the study design, purposes and probable benefits of the study) before their involvement by a written signed consent ensuring them for their right to withdraw (if they wanted) from this study at any time they want.

This study was carried out during the period from December 2017 until May 2018. Clinical examination was done using plane mouth mirror, dental probe and twizzer. The criteria of the developmental defects of enamel of WHO index was used for the examination and recording of the enamel defects of the permanent teeth. It was classified into three basic types according to their clinical appearance to: Demarcated opacity, diffuse opacity and hypoplasia. The buccal surface of the indexed teeth was examined visually from the incisal edge of the incisors or the cusp tip of other indexed teeth to the gingival margin and from the mesial to the distal embrasure. This examination was done after the removal of plaque and food debris, in a wet condition to distinguish it from the demineralized area that can be recognized after dryness [12].

#### Criteria of enamel defects index

- **Normal.**
- **Demarcated opacity:** The translucency of enamel is altered and separated from the adjacent normal enamel by clear boundary with an intact surface and normal thickness of enamel and its color may be white, yellow, creamy or brown.
- **Diffuse opacity:** The translucency of enamel is altered in variable degree and usually white in color, without clear boundary between the opacity and the adjacent normal enamel, which can be patchy or linear.
- **Hypoplasia:** The surface of enamel is affected by this defect and related with a localized reduction in the thickness of the enamel. It might happen in the form of:
  1. **Pits:** Single or multiple, shallow or deep, arranged horizontally in rows across the surface of the tooth or scattered.
  2. **Grooves:** Single or multiple, narrow or wide.

3. **Partial or complete enamel absence over sizable region of the tooth dentin:** The affected enamel may be opaque or translucent.

- **Other defects:** Any abnormality that cannot be scored under any of the three basic defects (listed above).
- **Demarcated and diffuse opacities.**
- **Demarcated opacities and hypoplasia.**
- **Diffuse opacities and hypoplasia.**
- **All three conditions** (Demarcated, diffuse and hypoplasia).
- **Not recorded:** Any indexed tooth or teeth that were missing would not be recorded.

The ten index teeth involved were: upper central incisors, lateral incisors, canines and right and left first permanent premolars, in addition to lower right and left first permanent molars.

Raven's Colored Progressive Matrices were used to calculate the intellectual ability of each child. The models were presented in the form of matrices. In each test item, the child was asked to identify the missing part that completes the model [13].

Scores of IQ were classified into the following categories:

- Intellectually impaired : 72-80
- Below average: 81-90
- Intellectually average: 91-110
- Above average: 111-125
- Intellectually superior: 126-135

#### Statistical analysis

Data analysis was done by using descriptive statistics (percentage, frequency mean and standard error (SE)) and inferential statistics (level of significance was set at 5%, by which  $p > 0.05$  was not significant,  $p < 0.05$  was significant and when  $p = 0.05$  it was marginal significant) through Statistical Package for Social Science (SPSS Software version 21).

### RESULTS

Distribution of the enamel defects by the intelligent quotient categories showed that the enamel defects were more prevalent among the intellectually impaired subjects (24.64%), while it were less prevalent among the intellectually superior subjects (15.38%). However, the results were statistically not significant. For the total sample, it was found that the prevalence of enamel defects was 22.37% (Table 1).

The distribution of the teeth affected by the developmental defects of enamel by subjects revealed that the upper right and left central incisors (tooth no.11, 21 respectively) were the most teeth affected by the enamel defects (10.54%, 10.39% respectively). In

contrast the upper right first premolar was the least affected tooth (tooth no. 14) (2.10%) (Table 2).

**Table 1: Distribution of enamel defects by IQ**

Variables	Categories	Anomalies	No.	%	p-value
IQ	Intellectually impaired	With	51	24.64	0.884
		Free	156	75.36	
	Below average	With	59	21.85	
		Free	211	78.15	
	Intellectually average	With	108	21.73	
		Free	389	78.27	
	Above average	With	31	22.96	
		Free	104	77.04	
	Intellectually superior	With	2	15.38	
		Free	11	84.62	
Total sample	With	251	22.37		
	Free	871	77.63		

**Table 2: Distribution of the teeth affected by enamel defects by subjects**

Teeth No.*	The presence of enamel defects			Missing
	With	Free	Total	System
11	No.	117	993	12
	%	10.54	89.46	
12	No.	52	917	153
	%	5.37	94.63	
13	No.	7	226	889
	%	3	97	
14	No.	11	514	597
	%	2.1	97.9	
21	No.	115	992	15
	%	10.39	89.61	
22	No.	58	914	150
	%	5.97	94.03	
23	No.	8	234	880
	%	3.31	96.69	
24	No.	19	510	593
	%	3.59	96.41	
36	No.	31	1082	9
	%	2.79	97.21	
46	No.	26	1088	8
	%	2.33	97.67	

\*Teeth numbering was done according to the FDI World Dental Federation notation system

Regarding the enamel defects among the IQ categories by scores, results of the current study revealed that the

demarcated opacity was more prevalent in the intellectually impaired category (19.81%). While the

diffuse opacity was more among the above average category (2.96%), on the contrary the less prevalence type of enamel defects was the diffuse opacity and

hypoplasia, which was found as only one case within the intellectually impaired category (Table 3).

**Table 3: Distribution of IQ categories with enamel defects by scores**

IQ		Normal	Demarcated	Diffuse	Hypoplasia	Demarcated and diffuse	Demarcated and hypoplasia	Diffuse and hypoplasia	p-value
Intellectually impaired	No.	156	41	4	5	0	0	1	0.774
	%	75.36	19.81	1.93	2.42	0	0	0.48	
Below average	No.	211	47	7	2	0	3	0	
	%	78.15	17.41	2.59	0.74	0	1.11	0	
Intellectually average	No.	389	85	13	7	3	0	0	
	%	78.27	17.1	2.62	1.41	0.6	0	0	
Above average	No.	104	25	4	2	0	0	0	
	%	77.04	18.52	2.96	1.48	0	0	0	
Intellectually superior	No.	11	2	0	0	0	0	0	
	%	84.62	15.38	0	0	0	0	0	

Results of the present study showed that there was no statistical significant difference concerning the distribution of teeth with enamel defects according to the IQ categories (Table 4). However, statistical marginal

significant results were found concerning the teeth free from enamel defects (normal) in relation to the IQ categories.

**Table 4: Distribution of the enamel defects scores among the IQ**

IQ categories		Normal	Demarcated	Diffuse	Hypoplasia	Demarcated and diffuse	Demarcated and hypoplasia	Diffuse and hypoplasia
Intellectually impaired	Mean	6.473	0.324	0.053	0.029	0	0	0.01
	SE	0.134	0.052	0.028	0.014	0	0	0.01
Below average	Mean	6.444	0.274	0.048	0.007	0	0.011	0
	SE	0.117	0.038	0.018	0.005	0	0.006	0
Average	Mean	6.708	0.314	0.05	0.022	0.006	0	0
	SE	0.087	0.034	0.014	0.01	0.003	0	0
Above average	Mean	7.119	0.43	0.044	0.015	0	0	0
	SE	0.167	0.08	0.023	0.01	0	0	0
Intellectually superior	Mean	7.308	0.385	0	0	0	0	0
	SE	0.382	0.311	0	0	0	0	0
Statistics	F	3.689	0.98	0.094	0.526	0.945	2.383	1.105
	p-value	0.005	0.418	0.984	0.717	0.437	0.05	0.352

**DISCUSSION**

The current cross sectional study showed that the prevalence of the developmental defects of enamel for the total sample was 22.37%, which was higher than that reported by Orenuga et al. in Nigeria [14] and Idiculla et al. in India [15]. However, it was lower than that reported by Basha et al. in India [16] and Robles et al. in Spain [17]. Differences between the studies concerning the prevalence of enamel developmental defects may be attributed to the variations in the subjects age and numbers and the technical examination methods (such as

method of lighting or whether the teeth were dried or not). In addition, another cause for the differences between these studies may be related to the variation in the terminologies and diagnostic criteria used by these studies [18-20]. This study showed that the highest prevalence of the enamel defects was found among the intellectually impaired children. This result agreed with that concluded by Bhat et al. when they found that the children with cerebral palsy, mental retardation and sensory neural defects had greater frequency of developmental hypoplastic enamel defects in their primary teeth than the others [8]. This finding suggested

that the presence of a particular systemic disturbances interfering with neurological development might also affect the development of the tooth germ [21]. Damaged enamel cannot recover from the injury; therefore, it might give information on the timing and nature of the insults potentially affecting other ectodermally derived structures, such as the brain [22]. The present study reported that the most affected teeth by the enamel defects were the upper central incisors, meanwhile Robles *et al.*, in Spain [17] and Hawas *et al.* in Egypt [23] reported the same finding. This finding can be explained by the fact that trauma to the deciduous teeth during permanent teeth formation (the mostly affected teeth by trauma are the incisors) is relatively common causing defects on the surfaces of their permanent successors [24]. Findings of the present study revealed that the demarcated opacity was found to be the most common type of the enamel defects, suggesting that the teeth affected by this type of defects had been subjected to localized and transitory injuries [25], this result was in agreement with the results reported by Ghanim *et al.* in Iraq [26], Yadav *et al.* in India [27] and Jälevik *et al.* in Western Sweden [28]. This prevalent demarcated opacity was followed by the diffuse opacity and hypoplasia and these findings were in accordance with that reported by Basha *et al.* [16] and Jälevik *et al.* [28].

### CONCLUSION

The prevalence of the developmental enamel defects among the total sample was (22.37%). There was relationship between the developmental enamel defects and intelligence quotient with the highest prevalence among the intellectually impaired children and the demarcated opacity was found to be the most common type of the enamel defects. The upper right and left central incisors were the most teeth affected by the enamel defects.

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### CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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