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THE PREVALENCE AND SEVERITY OF MOLAR INCISOR HYPOMINERALIZATION (MIH) AMONG 8 YEAR-OLD CHILDREN IN AMMAN, JORDAN

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ABSTRACT

Background: Little prevalence studies relating to molar incisor hypomineralization (MIH) exist for Middle East populations in general and among Jordanian children in particular.

Aim: To assess the prevalence and severity of MIH in a group of 3rd year class school children resident in Amman, Jordan as well as to describe its distribution in first permanent molars and incisors.

Methods: A cross-sectional study with a representative sample was used. A simple random sampling technique produced 1412 school children aged 8-9- years. All children were examined by a single calibrated examiner. The first permanent molars and incisors were examined for molar incisor hypomineralization using the chart of Ghanim et al. based on the criteria of European Academy of Paediatric Dentistry (EAPD). Analysis of data was performed with a p value set at 0.05.

Results: Of a total of 1412 schoolchildren 186 (13.17%) were diagnosed with MIH. Maxillary teeth were more commonly affected than the mandibular but the difference was not significant ($p>0.05$) and the maxillary molar was the most affected. Demarcated creamy white opacities were most frequently encountered followed by post eruptive breakdown. Atypical restorations and caries because of MIH were uncommon. More than the half of teeth was diagnosed with severe form of MIH. The severity increases with the increase of number of affected molars.

Conclusion: Molar incisor hypomineralization was high among the children examined. Demarcated opacities were more frequent than breakdown. The severity of the lesions increased with the number of affected teeth.

KEYWORDS: MIH, Jordan, Prevalence

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INTRODUCTION

Molar incisor hypomineralization (MIH) is a clinical term that was first given to the condition by Weerheijm who defined it as 'hypomineralization of systemic origin of one to four first permanent molars (FPMs), frequently associated with affected incisors' [1]. Further work by the working group of the European Academy of Paediatric Dentistry (EAPD) led to the establishment of the judgment criteria that helped the clinicians in the diagnosis of the condition [2].

Hypomineralization defects can also occur in primary teeth [3]; the second primary molar has been diagnosed with MIH like defects similar to those described by Weerheijm [2]. The condition is attributed to disruption of ameloblastic activity during the transitional and maturational stages of amelogenesis [4]. The time of exposure is believed to occur between the last trimester of pregnancy and 3 years of age, the time when FPMs are developing and enamel is forming [5]. A few possible causes of MIH were mentioned, such as environmental toxins, exposure to dioxin due to prolonged breast-feeding [6-7] or prenatal, perinatal and neonatal medical problems [6]. Other suggested causes may include oxygen shortage due to respiratory diseases [8] possibly combined with low birth weight [9], otitis media and frequent childhood diseases with high fever [10]. However, the role of genetics in the etiology of MIH should not be overlooked [11-12].

Clinically, MIH defects present as opaque lesions with colors varying from white to yellow or brown, with distinctive borders between affected and sound enamel. In severe cases, post-eruptive enamel breakdown (PEB) can occur soon after the tooth erupts into the oral cavity presenting as enamel hypoplasia rather than hypomineralization. Children affected with these defects have higher treatment needs [13-14] and had shown more dental fear and anxiety [15] which further complicated the management. The need for orthodontic treatment intervention as a consequence of tooth extraction caused by MIH has also been reported [16]. Two surveys have shown that the clinicians are aware of the condition and consider it to be a clinical problem [5,17].

Despite the limited number of studies in the Middle East, alarming high prevalence rates of MIH were reported in this region (8.6% to 27.2%) [18-22].

According to a systematic review a wide variation in prevalence rates has been reported (2.4% to 40.2%) [23]. In European countries prevalence rates varied from 3.6% to 7.5% [4,24]. Outside Europe, data from Western Australia gave a prevalence of demarcated opacities as 22% [25], whereas data from Hong Kong indicate the lowest prevalence of MIH in the literature (2.8%) [26]. The highest reported prevalence of MIH was amongst Brazilian children (40.2%) [27]. A study was performed by Zhao et al. to systematically estimate the pooled prevalence of MIH evidenced from 70 studies from around, the pooled prevalence of MIH was 14.2% globally [28]. This study aims to assess the prevalence and severity of MIH in a group of primary school children resident in Amman, Jordan as well as to describe its distribution in first permanent molars and incisors.

METHODS

Ethical approval

The research protocol was approved by the Academic Research Ethics Committee at the School of Dentistry and then approved by the Council of the School of Postgraduate Studies at the University of Jordan. Permission from the Ministry of Education and the United Nations Relief and Works Agency (UNRWA) headquarters was also obtained. The selected schools were contacted and provided with the required authorities' permission to have their approval for the participation in the study. Prior to data collection, a cover letter and consent form were given to the children included in the sample to be signed by the legal guardian who accepts their children to participate in the study.

Study design and sampling procedure

This study was cross-sectional study surveyed third grade (8-9-year-old) school children attending in Amman. Data collection was performed over a 4 months period, from September to December 2015.

A list of names of private and public schools in Amman along with their addresses, phone numbers and numbers of attending children was obtained from the Department of Statistics/ Ministry of Education in Jordan. Another list of the names of schools which belong to UNRWA was also obtained from the agency with the required information. At the time of the study and according to the official figures, a total of 60,248 children were enrolled in the 3rd grade classes in schools in Amman. The G. power 3.0.10 software was used to calculate the lowest number of subjects required in the study. Using the exact test as descriptive study with the effect size of 0.1 (low), two tailed level of significance, α=0.05, power of 0.95 (maximized), the lowest number of subjects required was 1293. A simple random sampling technique was used to select 2.5% of each type of schools. More than the required number of schools was selected to overcome the problem of refusal of participation in the study. At the end of the random selection, 28 schools were selected. Then all 3rd grade school children in each selected school who met the inclusion criteria and presented with a signed consent form and filled questionnaire at the day of examination were included. A total of 2748 were approached to compensate for the drop out of subjects during the study. The final sample size of this study included 1720 (61.8%) children representing about 2.9% of the target population. However, as 308 children were excluded, the final sample size was 1412 schoolchildren representing about 2.3 % of the target population. Exclusion criteria included participants who were not present at the day of examination, those who have not all index teeth present, and participant having amelogenesis imperfecta, dentinogenesis imperfecta, diffused opacity, tetracycline staining, white spot lesions, fluorosis, opacity only on the incisors and when at least one of the index teeth is not present.

Calibration

The clinical examination was carried out by a single examiner (A.A). A calibration exercise was carried prior to initiating the study. Experienced and trained examiner at the Department of Pediatric Dentisty- The University of Jordan (MH) carried out the training exercise. A set of 20 photographs including both MIH and other enamel developmental defects was scored and the exercise repeated twice. Using kappa statistics, the inter-examiner agreement for MIH was very good (0.81). During the study, intra-examiner reliability was checked through duplicate examination of every 10th subject and the intra-examiner reliability score was excellent (0.89). Prior the main study, the clinical examination was tested by a pilot study. One school was randomly selected, which was not part of the study, and consent forms were sent to the parents of randomly selected 20 children. There was no need to change the proposed examination method.

Diagnostic criteria of Molar incisor hypomineralization

The short data set form of the charting criteria suggested by Ghanim et al [29] was adopted in this study as the diagnostic criteria and clinical appearance of the defects in permanent teeth. The proposed charting method incorporates the components of the EAPD criteria [14] and the modified index of developmental defects of enamel for grading the clinical status of MIH and its extent on the involved tooth surface as well as other enamel defects [29]. The short data set form was designed to grade only index teeth which have been mentioned in the definition of MIH, namely first permanent molars and permanent incisors[29]. The investigators preferred to score children using a modified short-form chart. The following modification of the index has been suggested by the investigators for the purpose of this study:

(1) score 1 was excluded because assessing the non-MIH defects is not within the scope of this study, (2) score 6 was excluded (missing due to extraction) since only cases where all index teeth present were included in the study, (3) score 7 was also excluded because the investigators believe that the potential cause of breakdown is impossible to be determined, and (4) regarding extension of the lesion (severity), mild and moderate scores were combined in one category. Following is the charting criteria proposed by Ghanim et al. [29] modified by the investigators for the purpose of the present study.

A. Charting criteria

0 = No visible enamel defect.

1 = White, creamy demarcated, yellow or brown demarcated opacities.

2 = Post-eruptive enamel breakdown (PEB).

3 = Atypical restoration.

4 = Atypical caries.

Lesion extension criteria (only after diagnosing MIH)

I = less than one third of the tooth affected.

II =at least one third but less than two thirds of the tooth affected.

III = at least two thirds of the tooth affected.

The clinical examination was performed in a suitable school environment with the aid of an assistant to record the observations on a pre-tested data sheet provided for that purpose. The teeth were dried using sterile cotton rolls and examined with the aid of a portable torch (Penlight torch) and gloved hands. All precautions to optimize the cross-infection control were taken into consideration.

Statistical analysis

The collected data were analyzed using the SPSS package version 21.0. A descriptive analysis of the prevalence and distribution of the clinical recordings was performed. To test inter and intra examiner reliability Cohen's kappa statistics was used. The level of statistical significance for all tests was set at 5%.

RESULTS

Of the 2748 school children who were invited to participate in the survey, 1720 returned a positive signed consent form making a response rate of 61.8%. However 308 children were excluded because they did not meet the inclusion criteria (not presents on the day of the examination or do not have all the index teeth). The final sample size was 1412 with 729 male (51.63%) and 683 female (48.37%).

According to the proposed charting used in this study, MIH was diagnosed in 186 children making an overall prevalence of 13.17% among school children in Amman (Jordan). Among the children who were diagnosed having MIH, males had a prevalence of (No=92, 12.6%) and females (No= 94, 13.7%) with statistically significant between them (P >0.05).

Table 1 shows the distribution of the affected children according to the number of the affected molars. Approximately, one third of the affected children had one permanent molar only affected and also one third had two permanent molar only affected.

TABLE (1) Distribution of the affected children according to the number of affected permanent molars (N=186)

Number of molars affected	N (%)
One permanent molars affected	68 (36.56)
Two permanent molars affected	64 (34.41)
Three permanent molars affected	34 (18.28)
Four permanent molars affected	20 (10.75)
Total	186 (100)

There were 377 permanent molars and 123 incisors affected, the mean number of affected teeth per child was 2.0 for the molars and 0.7 for the incisors. Table 2 shows the distribution of the affected children by arch and by affected tooth type. There is no statistically significant difference in the distribution of the affected teeth by arch ($p>0.05$). In general, the maxillary incisors were more affected than the mandibular but this difference was not statistically significant. However, the lowers lateral incisors were more affected than the maxillary ones and the difference was not statistically significant ($p>0.05$).

TABLE (2) Distribution of the affected children by arch and by affected tooth type

Tooth type	N (%)	N (%)	P
Maxillary permanent molar	194 (51.5)		0.06
Mandibular permanent molars affected	183 (48.5)		
Total	377 (100)		
Maxillary central incisor	66 (53.7)	69 (56.1)	0.53
Maxillary lateral incisor	3 (2.4)		
Mandibular central incisor	34 (27.6)	54 (43.9)	
Mandibular lateral incisor	20(16.3)		
Total	123(100)		

Table 3 shows the prevalence of MIH among affected index teeth. The upper right permanent molar was the most commonly affected tooth followed by the upper left When comparison was made between maxillary right and left molars and mandibular right and left molars, in both circumstances, no statistically significant differences were found ($P>0.05$). Also, No significant difference was found in the occurrence of MIH between maxillary right and left incisors, as well as between mandibular right and left incisors. Overall, the maxillary right molar was the most frequently affected (19.8%) while maxillary right lateral incisor was the least affected (0.2%).

Table 4 shows the characteristics of lesions of the examined teeth according to the criteria used in the diagnosis of MIH and DMH in this study. Hypomineralized lesions were more frequently diagnosed in the molar and incisor teeth. Incisor teeth showed no post eruptive breakdown, atypical caries or restorations.

Table 5 shows that most of the affected permanent molars showed lesion extension of type I. Most affected teeth with lesion extension type I was tooth number 26 while severe lesions including more than

TABLE (3) The prevalence of lesions among the affected index teeth

Tooth type*	16	12	11	21	22	26	36	32	31	41	42	46
N	99	1	30	36	2	95	90	10	16	18	10	93
%	19.8	0.2	6	7.2	0.4	19	18	2	3.2	3.6	2	18.6

**** FDI notation system***

TABLE (4) Distribution of affected teeth according to the diagnostic criteria

	Diagnostic criteria	Molars	Incisors
Code	Clinical features	N (%)	N (%)
0	No visible enamel defect	210 (55.8)	114 (92.76)
1	White, creamy demarcated, yellow or brown demarcated opacities	91 (24.2)	9 (7.18)
2	Post-eruptive enamel breakdown (PEB)	36 (9.5)	0 (0)
3	Atypical restoration	31 (8.2)	0 (0)
4	Atypical caries	7 (1.9)	0 (0)

two thirds of the tooth surface was more recorded in tooth number 36. The central incisors had similar distribution of the lesion extension where most of the cases showed type I. Only few lateral incisors were affected with MIH and most of teeth have also lesion with type I extension. However, it was noteworthy that none of incisor teeth (both central and lateral) showed lesion extension type III (Table 5).

The severity of the lesions is dichotomized into severe and mild according to the criteria used in this study. The affected participants had more severe lesions than mild/moderate lesions, 35% (65) had mild/moderate lesions whereas nearly more than the half (121, 65%) had severe lesions. As shown in Table 6, a highly statistically significant relationship was found between the number of affected permanent molars and the severity of lesions. Children with more severe lesions had a higher number of affected molars (P<0.0005).

TABLE (6) Distribution of children according to the number of affected permanent molars and severity

Number of permanent molars	Mild	Severe	P-value
One permanent molar	40	28	<0.0005
Two permanent molars	18	46	
Three permanent molars	4	30	
Four permanent molars	1	19	
Total	63	123	186

DISCUSSION

The current study investigated the prevalence of MIH among 9-10 years-old school children in Amman Jordan. It was a cross-sectional epidemiological regional survey with a representative sample. The final sample size of 1412 children selected was almost equally distributed between males and females to reflect the prevalence in each gender. The response rate was relatively low (53.%) and this may be attributed to the refusal of some and

TABLE (5) The distribution of affected teeth by lesion extension

Level of lesion extension	16	26	36	46	Total N (%)
Lesion extension I	64	71	51	50	236 (62.60)
Lesion extension II	18	9	7	13	47 (12.47)
Lesion extension III	17	15	32	30	94 (24.93)
Total	99	95	90	93	377 (100)
Level of lesion extension	11	21	31	41	N (%)
Lesion extension I	25	30	14	15	84 (84)
Lesion extension II	5	6	2	3	16 (16)
Lesion extension III	0	0	0	0	0
Total	30	36	16	18	100(100)
Level of lesion extension	12	22	23	42	Total (%)
Lesion extension I	1	1	9	9	20 (86.96)
Lesion extension II	0	1	1	1	3 (13.04)
Lesion extension III	0	0	0	0	0
Total	1	2	10	10	23 (100)

some parents who were afraid their children be approached by strangers.

The study sample was selected randomly from the target population using a simple random sampling technique to ensure collecting a representative sample from schools. The age group, 8-9 years old, was selected based on the EAPD criteria [14] to standardize the examination conditions and to facilitate inter-study comparisons. At this age, most of the index teeth are erupted (four first permanent molars and the eight permanent incisors) and not yet affected with the post-eruptive breakdown that might complicate the diagnosis and affect the prevalence rate of the condition. The short examination form proposed by Ghanim et al. [29] was used slightly modified by the investigators to serve the purposes of the study.

The results of the present study showed that MIH is a dental problem in Amman. The overall prevalence of MIH is 13.17% among schoolchildren in Amman. There is a wide variation in prevalence rates reported in studies performed in different countries. This could be attributed to the different diagnostic criteria used, examination variability, lack of standardized calibration procedures, different age groups, differences in birth cohorts, or local environmental factors and [23] or possibly due to actual differences in MIH prevalence between different regions [17]. Compared to other studies, the prevalence of MIH in Amman was higher than that reported in India (6.3%) [30] and (9.2%) [31], Lithuania (9.7%) [32], China (2.8%) [26], and Greece, (10.2%) [33]. However; it was lower than prevalence rates reported in Brazil (19.8%) [34], Jordan (17.85%) [18], Iraq (21.5) [19], Spain (17.85) [35], and Lebanon (26.7%) [22]. The higher and lower rates reported in these cited studies may be attributed to different recording criteria, different examination method (i.e teeth cleaned by brush and dried before examination), and different age groups. Moreover, it is worthnothing that the prevalence found in this study is close to 14.2% found by Zhao et al [28].

The occurrence of MIH was nearly equal in males and females with no statistically significant difference between them. Results of previous studies on gender predilection were conflicting. The findings of several authors [18,21,30,36] supported the gender predilection with females more affected than females, but others reported no gender predilection [13,20,22, 26,31,37]. The meta analysis conducted by Zhao et al. confirmed that no sex predilection has been detected [28]. Although no significant difference was found between the prevalence of MIH in maxillary first permanent and mandibular molars, maxillary molars were more affected. This is in agreement with previous studies [13,19,26,32]. However, other studies found significantly more mandibular permanent molars affected than maxillary teeth [18,35]. Although not statistically significant, the present study showed that maxillary central incisors were more affected than the mandibulars, while mandibular lateral incisors showed higher percentage of hypomineralized lesions than maxillary lateral incisors. Preusser et al. [38] found that maxillary permanent incisors were significantly more frequently affected than the mandibular.

Similar to other studies [18,30,35], the most common lesions encountered were the demarcated opacities in both molars and incisors. Post eruptive breakdown and atypical restoration were the second most common finding.

There is no consensus on classifying the severity of the lesions. Most studies mentioned the range of lesions from demarcated enamel opacities to severe structural loss and atypical restorations (mild to severe). One study used the treatment need [29]. This study showed that nearly more than the half of the cases was with severe form, Petrou et al. (2014) found that nearly half of the affected children exhibited one tooth with severe form of MIH [39]. The percentage of cases with mild/moderate was in accordance with findings of previous studies [18- 19,35].

Given the prevalence of MIH among school children in Amman and the known high treatment need for this condition, it is recommended that

prospective and longitudinal observational studies that follow cohorts of children prenatally and from birth to record their environmental and medical histories until eruption of the permanent first molars and permanent incisors be conducted. This also emphasizes the fact that MIH is not unique to a specific population. Moreover, Jordanian dentists are likely to encounter MIH among their patients; this highlights the importance of educating dentists about MIH clinical presentation, etiology, and management.

CONCLUSION

- The prevalence of MIH among school children in Amman (Jordan) was 13.17%.
- Demarcated opacities were the most prevalent among index teeth and incisor teeth showed no PEB or atypical restoration or caries.

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