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Prevalence of molar incisor hypomineralization in Egypt as measured by enamel defect index a cross sectional study

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ABSTRACT

Aim: This study aimed to estimate the prevalence of molar incisor hypomineralization *(MIH)* in a group of Egyptian children the aged from 8 to 12 years, using both enamel defect index (*EDI*) and the diagnostic criteria.

Subjects and methods: Sampling was done per unit of time (convenience sample) from 1st of December 2014 till 30th of November 2015 (one year). Clinical visual examination took place on the dental unit, using natural light, teeth were cleaned gently using gauze and were wet with saliva when examined. After dental screening of children, (MIH) data was scored including 12 indexed teeth using the **EDI,** diagnostic criteria and severity index. Statistical analysis was performed using IBM® SPSS® and data was presented as frequency and percentages.

Results: 1001 children were included in the study (49.85%) males (50.14%) females. Prevalence rate calculated in the studied group was (2.3%); males (39.1%) and females (60.9%). The most prevalent clinical defect of MIH was the opacity. Among affected teeth it was found (77%) of the observed affected teeth were mildly affected while (23%) were severely affected.

Conclusion: EDI and diagnostic criteria deliver an acceptable estimate for MIH in the Egyptian population, however further studies are recommended.

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1. Introduction

Molar incisor hypomineralization (MIH) refers to hypomineralization of systemic origin, which affects first permanent molars and is frequently associated with permanent incisors [1]. The condition is simply related to the disruption of ameloblastic action during the transitional and maturational stages of amelogenesis [2]. These disruptions may be the result of some systematic conditions during the child's first years of life which coincides with the periods of crowns' mineralization.

The prevalence of MIH worldwide was reported from 2.4% to 40.2% this difference in the rates is due to the lack of both a consistent classification index and a standardized methodology of assessment for MIH. Most of the prevalence studies of MIH have been carried out in the European countries. Knowledge about the magnitude of MIH seems desirable as it is vulnerable for consequences like rapid caries development, early enamel loss, soft structure and sensitivity.

In 2003 the EAPD had published the diagnostic criteria for the clinical status of MIH which was the approach of choice for many prevalence studies since then [3–10] Scoring took place in the manner of either the absence or the presence of each element of the diagnostic criteria.

The clinical picture of MIH along with its diagnostic criteria decided and agreed on during the workshop held in May 2009 by the EAPD [11]:

- **Demarcated opacities:** The affected teeth show clearly demarcated opacities at the occlusal and buccal part of the crown. The defects vary in colour and size. The colour can be white, creamy or yellow to brownish. The defect can be negligible or comprise the major part of the crown. It is recommended that defects less than 1 mm are not to be reported.

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- **Enamel disintegration** (post eruptive enamel loss): The degree of porosity of the hypomineralized opaque areas varies. Severely affected enamel subjected to masticatory forces soon breaks down, leading to unprotected dentine and rapid caries development.
- **Atypical restorations:** FPM and incisors with restorations revealing similar extensions as MIH are recommended to be judged as affected.
- **Tooth sensitivity:** The affected teeth may be reported as sensitive, ranging from a mild response to external stimuli to spontaneous hypersensitivity; these teeth are usually difficult to anaesthetize.
- **Extracted teeth**: Extracted teeth can be defined as having MIH only in cases where it is noted in the records or there are demarcated opacities on the other FPM. Otherwise it is not possible to diagnose MIH.

As a new approach, the Enamel Defects Index (EDI) was created based on the principle of each category scored independently as present [1] or absent [0], simplifying decision making. The basic-level categories are hypoplasia, opacity, and posteruptive breakdown as shown in Table 1 scored by clinical diagnosis, resulting in a three-digit score per tooth surface examined, ranging from 000 to 111 [12].

Severity should be recorded as mild or severe in order to help the clinician. In mild cases there are demarcated enamel opacities without enamel breakdown, occasional sensitivity to external stimuli e.g. air/water but not brushing and only mild aesthetic concerns on discolouration of the incisors. In severe cases there are demarcated enamel opacities with breakdown, caries, persistent/spontaneous hypersensitivity affecting function e.g. during brushing and finally strong aesthetic concerns that may have socio-psychological impact [13,14].

MIH is challenging when it comes to management, it depends mainly on early diagnosis. Proper data regarding prevalence allows for better understanding of the disease which reflects on the clinical judgment. Therefore, conducting such a study in Egypt is of prime importance. This study is an attempt for precise data collection relevant to the disease which could be the base for further research in relation to proper management and better care that concern clinicians along with the knowledge and awareness about the possible etiological factors among the community.

2. Aim of the study

This study aimed to estimate the prevalence of molar incisor hypomineralization *(MIH)* in a group of Egyptian children the aged from 8 to 12 years, using both enamel defect index (*EDI*) and the diagnostic criteria.

3. Subjects and methods

3.1. Ethical approval

Methodology of this study was primarily revised and approved by the ethical committee of Faculty of Oral and Dental Medicine, Cairo University.

3.2. Consent

Prior to clinical examination the aim of the study was explained to the mother and informed consent was obtained. Referred patients were called and the aim of the study was explained by telephone. Only those who showed up in the examination appointments and met the inclusion criteria during the one year duration period of the study were considered part of the sample.

3.3. Setting and location

Clinics at Pediatric Departments at educational dental hospital of Faculty of Oral and Dental Medicine Cairo university and those at Future University in Egypt.

3.4. Operator

Single evaluator, Master Degree student in Department Pediatric of Dentistry and Dental Public Health, Cairo University and a teaching assistant at Department Pediatric of Dentistry and Dental Public Health, Future University in Egypt.

3.5. Calibration

Theoretical training for MIH was performed. Intra examiner calibration took place using 30 photographs of 18 patients with MIH and 12 cases with other enamel defects were used to calibrate the examiner [15] before the beginning of the study and after six months. The selection of photographs and supervision of the theoretical training and calibration was done executed by the help of a clinical pathologist at the Department of Oral Pathology, Future University in Egypt.

During the first 6 months sampling took place at the outpatient clinic of Future University in Egypt. Three other pediatric dentists at Department Pediatric of Dentistry and Dental Public Health, Future University in Egypt went through the theoretical training mentioned above. They were asked to refer any suspected or preliminary diagnosed case of MIH.

During the last 6 months sampling took place at the outpatient clinic of Cairo University, Department Pediatric of Dentistry and Dental Public Health, Due to the increased number of residents performing diagnosis and referral, theoretical training was not applicable and accordingly they were asked to refer any case with visible enamel defect to be evaluated by the calibrated examiner.

3.6. Population

Sampling was done per unit of time (convenience sample) from 1st of December 2014 till 30th of November 2015 (one year) in the same pattern as [16].

During the first 6 months (1st December2014–31st of May 2015) 400 patients were examined ranging in age from 8 to 12 years who were seeking dental care at educational dental hospital of Faculty of Oral and Dental Medicine, Future University in Egypt.

Table 1
Category definitions of the basic version of the Enamel Defects Index.

Hypoplasia	A defect involving the surface of enamel and associated with a reduced thickness; this may be translucent or opaque
Opacity	A defect involving an alteration in the translucency of enamel, which can be variable in degree. The enamel is of normal thickness, with a smooth surface. The opacity may be white, yellow or brown in colour, with a demarcated or diffuse border.
Posteruptive break down	A defect including the loss of surface enamel after tooth eruption

Then from (1st June 2015–30th of November 2015) another 650 patients were examined ranging in age from 8 to 12 years who were seeking dental care at educational hospital of Faculty of Oral and Dental Medicine, Cairo university.

3.7. Eligibility criteria

3.7.1. Inclusion criteria

Patient aged from 8 to 12 years; patient seeking dental care in educational dental hospitals; Positive patient's acceptance for participation in the study; Eruption of at least 2 mandibular permanent first molars.

3.7.2. Exclusion criteria

Presence of orthodontic appliance; Patient suffering from any other type of enamel defect.

3.8. Clinical examination

Clinical examination took place on the dental unit, using day light, disposable mirror and teeth were wet when examined. Exclusion criteria were checked and those who showed presence of appliance (e.g. space maintainer) or other dental defects other than MIH were excluded from the study.

Both the diagnostic criteria agreed on by ***Lygidakis et al., 2010*** and the Enamel Defect Index (EDI) were used. Demarcated opacities were defined as opacities with different colors and distinct margins to the adjacent enamel; while the EDI was used for the presence of a score for the post-eruptive enamel break.

Teeth are named according to the FDI notation and severity index used according to [13] and recently included in the EAPD recommendations [11].

4. Results

In this study the prevalence of MIH out of the studied sample was calculated. Also prevalence of each featured defect in each indexed tooth, prevalence of each featured score in each scoring method used and prevalence of type of tooth affected by MIH were calculated.

Data presented as mean, standard deviation (SD), frequency and percentage when appropriate. Clinical parameters showed a nonparametric distribution so Kruskal Wallis test used to study the different between tested groups followed by Mann Whitney *U* test for pair wise comparison. The significance level was set at $P \leq 0.05$.

Statistical analysis was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, and USA) Statistics Version 23 for Windows and MidCalc® Version 12.2.1 (MedCalc Software bvba, Ostend, Belgium).

In this study the following was observed regarding the demographic data of the participants, there were more female subjects (60.9%) diagnosed than males (39.1%) (Fig. 1) though the distribution of the studied sample between both genders was almost equal.

In this study the following was observed regarding the prevalence of MIH in the studied sample of this population, out of the 1001 enrolled children aged from 8 to 12 years old 23 children were diagnosed with MIH which represents (2.3%) of the studied sample. (Fig. 2).

In this study the following was observed regarding distribution of MIH within incisor indexed teeth (Fig. 3), according to the EDI scores 83 (45.1%) of the examined incisors were normal (000) while 71 (38.6%) showed signs of opacity, 8 (4.3%) showed signs of hypoplasia and 22 (12.0%) showed signs of both. According to the diagnostic criteria no signs of PEB, extractions due to MIH or no

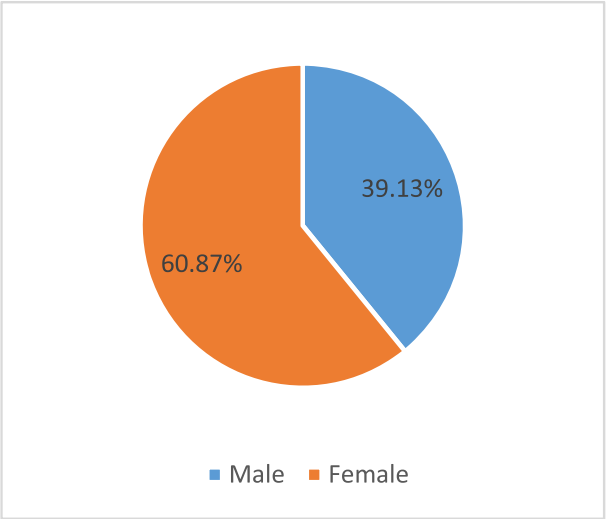

Fig. 1. Pie Chart showing the percentage of male and female MIH cases.

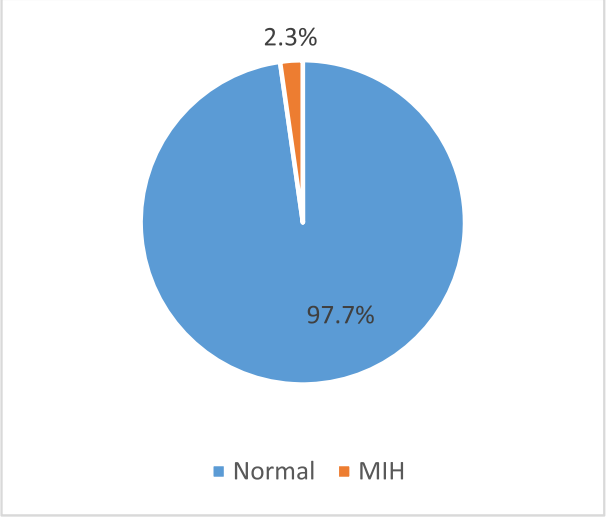

Fig. 2. Pie Chart showing the percentage of MIH within the sampled population.

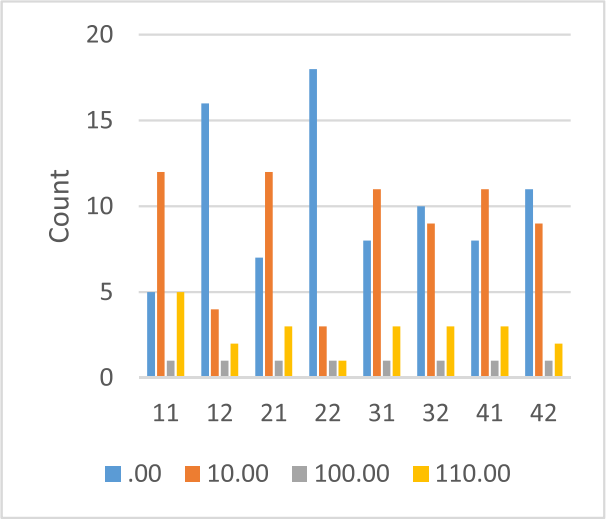

Fig. 3. Bar Chart showing the frequency of EDI score of incisors.

eruptions due to MIH were observed in the incisors, only 6 (3.3%) had atypical restorations distributed. Distribution of frequency of Demarcated opacities, (84%) of the affected incisors were mild (yellowish discoloration) while (16%) of them were severely affected (brownish discoloration) distribution is shown in (Fig. 4) teeth are represented in graphs using FDI notation while in the severity index yellowish discoloration stands for mild and brownish discoloration stands for severe affection by MIH.

On examining FPM the following was observed regarding the distribution of MIH among them, according to the EDI scores 3 (3.3%) of the examined molars were normal while 18 (19.6%) showed signs of both hypoplasia and opacity and 23 (25%) showed signs of hypoplasia, opacity and PEB as shown in (Fig. 5). According to the diagnostic criteria 23 (25%) showed signs of PEB, none showed signs of extractions due to MIH and only 1 M (1.1%) showed signs of no eruptions due to MIH. Finally 12 M (13%) had atypical restorations. 61 (68.5%) of the affected molars were mild (yellowish discoloration) while 28 (31.5%) of them were severely affected (brownish discoloration) (Fig. 6).

On studying data regarding all examined indexed teeth, according to EDI scores the most prevalent score was the opacity alone occupying (43%), while according to the diagnostic criteria the demarcated opacity was the most prevalent observed clinical feature of MIH representing (66%) of all examined teeth. Regarding the severity of MIH, in this study it was observed that of all examined affected teeth only (23%) were severely affected and (77%) were mildly affected.

5. Discussion

MIH is considered an example of life time prevalence where its occurrence has taken place at some time before the examination and till the time of recording the data the defect still exists. Prevalence studies are important for patients and dental practitioners to apply appropriate measures in order to limit the effect of MIH and for policy makers to have a reliable picture of the defect characteristics in a specific population in addition to reaching appropriate diagnosis and prognosis at both the individual and population level.

The index primarily used in this study was the basic level EDI index due to the fact that post eruptive enamel break down is clearly scored by that index. The EDI was preferred over the mDDE index owing to the fact that it was time consuming and doesn't quite represent the clinical feature of MIH in details this comes in accordance with [17].

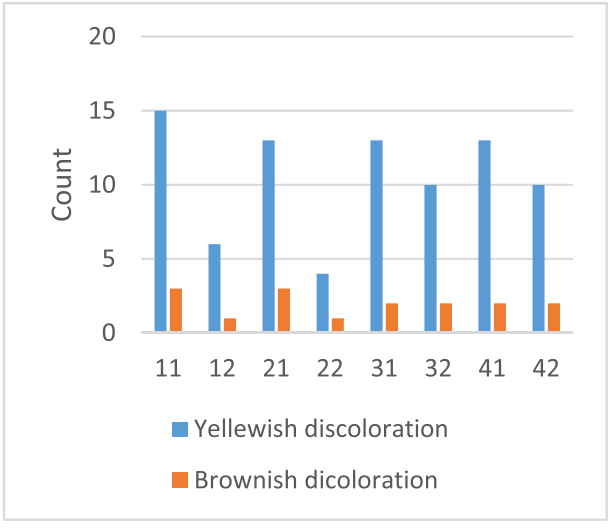

Fig. 4. Bar Chart showing the frequency of Severity of incisors.

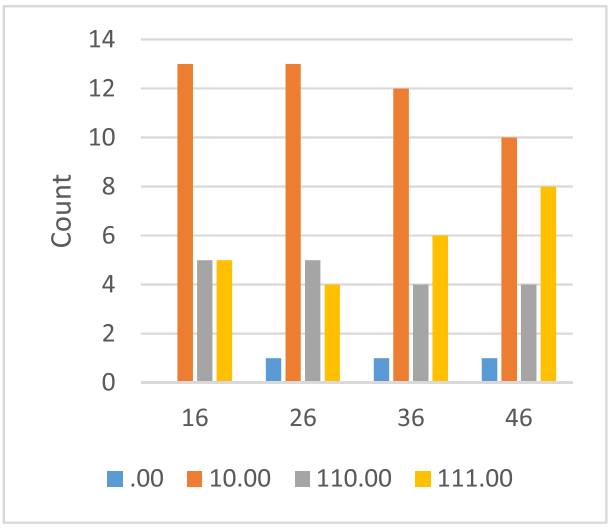

Fig. 5. Bar Chart showing the frequency of EDI score of molars.

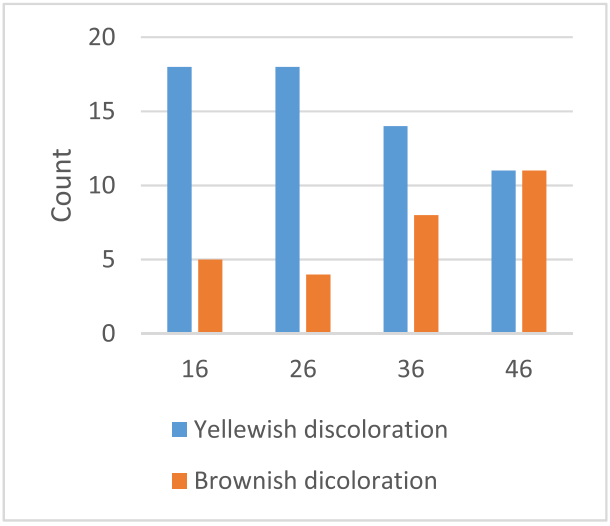

Fig. 6. Bar Chart showing the frequency of Severity of molars.

However, it was found to be insufficient as the EDI included one score for opacities to indicate demarcated as well as diffuse opacities which was less accurate. Therefore; it was combined with the diagnostic criteria agreed on by ***Lygidakis et al., 2010*** for precise recording of data [11].

In the present study the severity index was used according to ***Jasulaityte et al., 2007*** and recently included in the EAPD recommendations teeth were either mild or severe, in mild cases there were demarcated enamel opacities without enamel breakdown, occasional sensitivity to external stimuli like air/water but not brushing and only mild aesthetic concerns on discolouration of the incisors [13]. In severe cases there were demarcated enamel opacities with breakdown, caries, and persistent/spontaneous hypersensitivity affecting function like during brushing and finally strong aesthetic concerns that may have socio-psychological impact [11].

In this study 1001 children aged 8–12 years old, 502 females (50.2%) and 499 males (49.8%), 23 children were diagnosed by MIH

9 of them were males (39.1%) and 14 were females (60.9%) which suggests that in the studied population MIH is observed more in females than in males. This is against other studies performed earlier showing no significant difference between the genders [18,19].

According to the EDI scores the most prevalent score was the opacity, in FPMs (19.6%) showed signs of both hypoplasia and opacity while in affected incisors (38.6%) showed signs of opacity, (4.3%) showed signs of hypoplasia and (12.0%) showed signs of both. This is consistent with the results of the diagnostic criteria of the MIH and the fact only (8%) of all examined affected teeth had PEB and only (7%) suffered from atypical restoration. From all examined teeth (66%) suffered from demarcated opacities. This was consistent with other studies that concluded that *demarcated opacities* were the *most frequent* enamel *defect in their studied sample occupying* (76%) [15,18].

The percentage of individual teeth affected were also calculated taking the sample size as a whole out of the 276 indexed teeth 189 were affected (86.4%). It clearly showed that the upper right first molars were the most commonly affected (8.3%) followed by the rest of the FPMs each occupying (7.9%) then the upper right central incisors (6.5%). This could be very well explained by the fact that the first molars are the first teeth to get mineralized, followed by incisors as mentioned above and for MIH to occur, ameloblasts must be affected in the later mineralization or mature phase of amelogenesis. Since, the first molar is the tooth which is most exposed to environmental changes it is said to be most vulnerable to MIH than incisors this comes in accordance with [20]. However, this was in contrast to another study done by Weerheijm et al. where the results showed that percentage of molars and incisors affected were almost the same [21].

In this study 1001 children aged 8–12 years old, 502 females (50.2%) and 499 males (49.8%), 23 of them were diagnosed of MIH 2.3% which is slightly below the international estimated numbers ranging from 2.4% in Germany [22] and Bulgaria [6], to 40.2% in Rio de Janeiro [10]. Actually, one study reported that 40% of children in Leeds and 44% of children in Sydney had demarcated opacities in at least one FPM [23]. When compared to other studies conducted in the Middle East, in Libya 2.9% [24], in Jordan 17.6% [25], in Iran 12.7% [15], finally in Saudi Arabia 8.6% [26].

6. Conclusions

1. Prevalence of MIH in a convenience sample of Egyptian children aged 8–12 years old was (2.3%).
2. Females were more frequently observed to suffer from MIH than males.
3 Molars were the most prevalent teeth affected.
4 The most prevalent defect reported in this study was opacities
5. Severity of MIH in this studied population was more mild than severe.

7. Recommendations

- Further population based studies to evaluate the prevalence of MIH.
- Further prospective studies to evaluate the effect of systemic conditions during the child's first 3 years of life on the mineralization of enamel in this population.
- Further prospective studies to evaluate the effect of any disturbances occurring during the prenatal or postnatal periods of mothers in this population on the occurrence of MIH.

References

[1] Weerheijm KL, Duggal M, Mejare I, Papagiannoulis L, Koch G, Martens LC, et al. Judgement criteria for molar incisor hypomineralization (MIH) in epidemiologic studies: a summary of the European meeting on MIH held in Athens. Eur J Paediatr Dent. 2003;4:110–3.

[2] Fearne J, Anderson P, Davis GR. 3D X-ray microscopic study of the extent of variations in enamel density in first permanent molars with idiopathic enamel hypomineralisation. Br Dent J 2004;196:634–8. 3.

[3] Muratbegovic A, Marcovic M, Ganibegovic Selmovic M. Molar incisor hypomineralisation in Bosnia and Herzegovina: prevalence, aetiology and clinical consequences in medium caries activity population. Eur Arch Paed Dent. 2007;8:189–94.

[4] Cho SY, Ki Y, Chu V. Molar incisor hypomineralization in Hong Kong Chinese children 2008;5:348–52.

[5] Jasulaityte L, Weerheijm KL, Veerkamp JS. Prevalence of molar-incisor-hypomineralisation among children participating in the Dutch National Epidemiological Survey. Eur Arch Paediatr Dent 2008:218–23.

[6] Kukleva MP, Petrova SG, Kondeva VK, Nihtyanova TI. Molar incisor hypomineralisation in 7-to-14year old children in Plovdiv, Bulgaria—an epidemiologic study. Folia Med Plovdiv 2008;50:71–5.

[7] Kuscu OO, Caglar E, Sandalli N. The prevalence and aetiology of molar-incisor hypomineralisation in a group of children in Istanbul. Eur J Paediatr Dent. 2008;9:139–44.

[8] Lygidakis NA, Dimou G, Briseniou E, Molar-incisor-Hypomineralisation (MIH). Retrospective clinical study in Greek children. I. Prevalence and defect characteristics. Eur Arch Paediatr Dent 2008:200–6.

[9] Kuscu OO, Caglar E, Aslan S. The prevalence of molar incisor hypomineralisation (MIH) in a group of children in a highly polluted urban region and a windfarm-green energy island. Int J Paediatr Dent. 2009;19:176–85.

[10] Soviero V, Haubek D, Trindade C, Matta TD, Poulsen S. Prevalence and distribution of demarcated opacities and their sequelae in permanent 1st molars and incisors in 7 to 13-year-old Brazilian children. Acta Odontol Scand. 2009;67:170–5.

[11] Lygidakis NA, Wong F, Jälevik B, Vierrou AM, Alaluusua S, Espelid I. Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH) an EAPD policy document. Eur Archives Paediatr Dent 2010;11(2).

[12] Elcock C, Lath DL, Luty JD, Gallagher MG, Abdellatif A, Backman B, et al. The new Enamel Defects Index: testing and expansion. Eur J Oral Sci 2006;114(Suppl. 1):35–8.

[13] Jasulaityte L, Veerkamp JS, Weerheijm KL. Molar incisor hypomineralization: review and prevalence data from the study of primary school children in Kaunas/Lithuania. Eur Arch Paediatr Dent. 2007;8:87–94.

[14] Ghanim A, Morgan M, Marino R, Bailey D, Manton D. An in vivo investigation of salivary properties, enamel hypomineralisation and carious lesion severity in a group of Iraqi school children. Int J Paediatr Dent. 2013b;23:2–12.

[15] Ahmadi R, Ramazani N, Nourinasab R. Molar incisor hypomineralization: a study of prevalence and etiology in a group of Iranian children. Iran J Pediatr 2012;22(2):245–51.

[16] Biondi AM, Cortese SG, Martinez K, Ortolani AM, Sebelli PM, Lecno, et al. Prevalence of molar incisor hypomineralization in the city of Buenos Aires. Acta odontol Latinoam 2011;24(1):81–5.

[17] Brook AH, Elcock C, Hallonsten AL, Poulsen S, Andreasen J, Koch G, et al. The development of a new index to measure enamel defects. In: Brook AH, editor. Dental morphology. Sheffield: Academic Press; 2001. p. 59–66.

[18] Ghanim A, Morgan M, Marino R, Bailey D. Manton D Molar-incisor hypomineralisation: prevalence and defect characteristics in Iraqi children. Int J Paediatr Dent. 2011;21:413–21.

[19] Parikh DR, Ganesh M, Bhaskar V. Prevalence and characteristics of molar incisor hypomineralization (MIH) in the child population residing in gandhinagar, Gujarat, India. Eur J Paediatr Dent. 2012;13(1):21–5.

[20] Jälevik B, Klingberg G, Barregard L, Noren JG. The prevalence of demarcated opacities in permanent first molars in a group of Swedish children. Acta Odontol Scand 2001;59:255–60.

[21] Weerheijm KL, Jälevik B, Alaluusua S. Molar-incisor hypomineralisation. Caries Res. 2001;35:390–1.

[22] Dietrich G, Sperling S, Hetzer G. Molar Incisor Hypomineralisation in a group of children and adolescents living in Dresden (Germany). Eur J Paed Dent 2003;4:133–7.

[23] Balmer RC, Laskey D, Mahoney E, Toumba KJ. Prevalence of enamel defects and MIH in non-fluoridated and fluoridated communities. Eur J Paediatic Dent 2005;5:209–12.

[24] Fleita D, Ali A, Alaluusua S. Molar-incisor hypomineralisation (MIH) in a group of school-aged children in Benghazi, Libya. Eur Archives Paediatr Dent 2006;7:92–5.

[25] Zawaideh FI, Al-Jundi SH, Al-Jaljoli MH. Molar Incisor Hypomineralisation: prevalence in Jordanian children and clinical characteristics. Eur archives Paediatr Dent 2011;12(Issue 1).

[26] Allazzam SM, Alaki SM, El Meligy OAS. Molar incisor hypomineralization prevalence and etiology. Int J Dent 2014;1:8.