Prevalence of molar incisor hypomineralization (MIH) and its association with some risk factors in group of children attending two specialized dental centers in Erbil city

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Background and objectives: Molar incisor hypomineralization (MIH) is frequent in children and the etiology is different. The study was conducted to determine the prevalence, and risk factors of MIH and to investigate the relationship between the severity of the defect in the teeth affected by MIH and the risk factors.
Method: A total of 361 children in the age range of 7–12 years participated in the study. The sample was taken from a group of children attending two specialized dental centers in Erbil city. The participating children were examined for MIH using the European Academy of Pediatric Dentistry Criteria. The children's parents were asked about the child's pre, peri-, and postnatal condition utilizing a structured and validated questionnaire.
Results: A total of 99 children (40 males and 59 females) were affected with MIH, with a prevalence of 27.4%. the most common defect was demarcated opacity, among all analyzed etiological factors, only diabetes was found to be significantly associated with MIH in children (p = 0.020).
Conclusion: diabetes was the only etiological factor that showed a significant association with MIH in the studied group of children
Keywords: age groups, dental enamel hypoplasia, etiology.

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Introduction

Tooth enamel is the only hard tissue in the human body that once formed it not remodeled. The consequence is that any structural alterations during its development are permanent. These defects could be seen as enamel opacities or hypoplasia.[1] Defective calcification of an otherwise normal fully developed organic enamel matrix results in hypomineralization, a qualitative defect. This is seen clinically as changes in color and translucency of the enamel and presents as enamel opacities which can be either demarcated or diffuse.
The term molar-incisor hypomineralization (MIH) was first introduced in 2001 by Weerheijm *et al* and it was defined as 'hypomineralization of systemic origin, presenting as demarcated, qualitative defects of the enamel of one to four first permanent molars (FPMs) frequently associated with affected incisors. Although MIH is considered to be an idiopathic condition, its concise etiology remains unclear. On the one hand, the proposed risk factors for MIH include prenatal (maternal smoking or maternal illness/infection), perinatal (infant hypoxia, low birthweight with/without premature birth, caesarian delivery, birth complications, or calcium shortage), and postnatal factors (breastfeeding, nutrition, dioxins, childhood illnesses, medications) but none of these can be considered causative. On the

other hand, MIH has been recently proposed to be a multifactorial genetic, not an idiopathic, condition, and if additional gene variations are also present, then it may result in the involvement of permanent canine and premolars additional to molars and incisors.[2]

Clinically, hypomineralization is characterized by opacities of varying size and can be discolored from white to yellow/brownish. The opacities have normal enamel thickness and a defined demarcation between the affected and the sound enamel. Opacities occur more often on the occlusal and buccal surfaces. MIH is classified as 1: mild, when there are demarcated opacities without posteruptive enamel breakdown, and 2: severe, when posteruptive enamel breakdown occurs.

The hypomineralized enamel is less hard than the normal enamel as it contains a higher content of protein. The normal enamel shows a well-organized and distinct prism and crystal structure. In contrast, the hypomineralized enamel has less distinct prism edges and crystals, and the interprismatic space is more marked. Therefore, the hypomineralized enamel is more porous than the normal enamel.[3]

The lower strength of the hypomineralized enamel can result in posteruptive breakdown soon after tooth eruption or later under the effect of the masticatory forces. Consequently, the posteruptive enamel breakdown facilitates plaque accumulation and the development of dental caries. The plaque accumulation is also favored when children with MIH do not brush their teeth due to hypersensitivity of the affected teeth.[4]

This research is aimed to assess the prevalence of MIH in a group of children aged (7 -12) attending two public dental hospitals in Erbil city. Find out the association of MIH and associated risk factors. Find out the difference in proportions of MIH related to age, gender, type of teeth affected (first permanent molar alone or both first permanent molar and permanent incisor) and maxillary and mandibular teeth.

Methods

Study design and sampling:

A cross-sectional epidemiologic study was conducted among the group of children in Khanzad and Hawler specialized dental training centers aged 7 years to 12 years of both genders in Erbil city. Ethical approval to conduct the study was obtained from the Hawler Medical University College of Dentistry.

After obtaining authorization from both dental centers, written consent for the participation of the children in the study was obtained from parents. The sampling for this study aimed to be representative of children attending Khanzad and Hawler specialized dental training centers. Based on statistical calculations the sample size required for this study was estimated to be 361 children. Children were randomly selected from Khanzad and Hawler specialized dental training centers.

Inclusion criteria:

Children (male and female) from 7 years to 12 years of age.

Children who were present on the day of examination.

Children who are having their MIH index teeth erupted (i.e., permanent first molars and incisors).

Exclusion criteria:

Children who refused to participate were excluded.

Those children with some physical or mental handicap, a history of serious illness, or a chronic medical condition such as cardiac disease were excluded from the study.

Children with generalized development defects such as amelogenesis imperfecta, dentinogenesis imperfecta, hypoplasia, diffuse opacities, white spot lesions, tetracycline stains, erosion, fluorosis, and Turner's hypoplasia.

Children wearing orthodontic appliances such as brackets and bands which interfere with the evaluation of teeth and uncooperative children.

Data collection

Data collection was carried out by the author. The author was assisted by a cooperative recording assistant. Data were collected by completion of the proforma after a face-to-face interview of their parents in the local language (Kurdish) and clinical examination of each child. The study proforma was prepared in both English and the local

language. The study proforma was divided into 2 parts; the first part was questionnaires; which were further subdivided into three parts include questions covered general information that comprise demographic status, socio-economic status, and risk factors of Molar incisor mineralization such as prenatal, perinatal, and postnatal history up to 3 years. The second part comprised the recording format of MIH (European Academy of Pediatric Dentistry (EAPD) criteria for MIH.[5]

Questionnaire:
The scientific evidence was critically reviewed to identify the suspected etiological factors for MIH that have been hypothesized. Following careful review, a structured and validated carefully constructed questionnaire associated with MIH and related to the child or parental history was designed. Those children whose parents could not be reached either because she passed away or for any other reasons, were excluded.The questionnaire was filled out during a face-to-face interview with the accompanying parent, and it contains three parts: The first part recorded demographic characteristics.
The second part asked about socioeconomic status, and the third part asked about prenatal, perinatal, and postnatal conditions.
Demographic data of each participant was first recorded using a modified World Health Organization oral health assessment form for children (2013) including the child's name, gender, age, locality, and school level, place of birth, residence before the documentation of the findings of the oral examination.[6]
All the data were collected and scored using the European Academy of Pediatric Dentistry (EAPD) criteria for MIH.
EAPD criteria (2003):
0 – Normal
1 – Demarcated opacity. figure 1 (a)
2 – Posteruptive enamel breakdown. figure 1 (b)
3 – Atypical restorations. figure 1 (c)
4 – Extracted molar due to MIH. figure 1 (d)

These criteria were in line with the judgment criteria for MIH set by the European Academy of Pediatric Dentistry (EAPD) in 2003. Since the reproducibility of screening small demarcated opacities is low, only lesions with a diameter of 2 mm or more were included. This is in line with earlier studies. The diagnosis of MIH was set when lesion was present in at least one FPM. In line with the EAPD criteria for MIH, enamel hypoplsia, diffuse opacities indicating fluorosis, and developmental enamel defects affecting the majority or all teeth were not recorded as MIH.5

Statistical analysis:
Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 26). Chi-square test of association was used to compare the proportions of two or more groups. Fisher's exact test was used when the expected frequency (value) was less than 5 of more than 20% of the cells of the table. A p-value of ≤ 0.05 was considered as statistically significant.

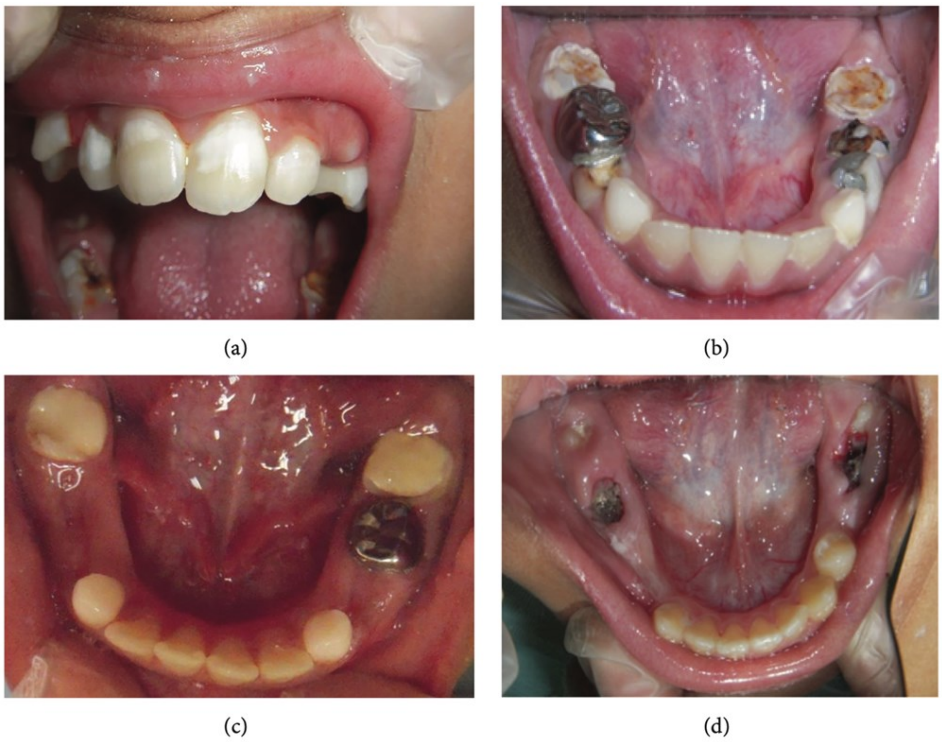

Figure1: Diagnostic criteria of molar incisor hypomineralization. (a) Demarcate opacities (incisors). (b) Posteruptive breakdown (molars). (c) Atypical restorations (molars). (d) Extracted molars.7

Results

The total number of children was 361. Their mean age (SD) was 9.3 (1.7) years. The median was 9.2 years, and the age range was 7-12 years. The largest proportion of the sample (47.4%) was aged 7-8 years, and more than half (55.4%) were females. Around half (46.5%) of the fathers and 48.8% of the mothers were graduates of primary schools or just read and write. The majority (71.5%) of the fathers were unskilled manual workers, while 88.9% of the mothers were housewives. More than half (58.4%) of the families live in owned houses, and the rest live in rented houses. More than two-thirds (67.3%) had a family car, and the family income was enough for daily needs for 50% of the sample (Table 1).

It is evident in Table 2 that almost all of the children recorded as normal in teeth #7, #10, #23, and #26, while 73.4%, 75.6%, and 78.7% of the children had normal #19, #30, and #14 respectively. Other details are presented in Table 2.

Result related to prenatal risk factors showed that no significant association was detected between the prevalence of MIH with the following factors: tetracycline intake ($p = 0.296$), congenital heart diseases ($p = 0.474$), kidney disease ($p = 0.578$), history of febrile disease ($p = 1.000$), generalized malnutrition or any abnormal situations ($p = 0.809$). On the other hand, all the diabetics had MIH compared with 26.9% among non-diabetics ($p = 0.020$), Table 3.

On the other hand, regarding neonatal factors results showed that no significant association was detected between the prevalence of MIH with the following neonatal factors: twin pregnancy ($p = 0.698$), mode of delivery ($p = 0.633$), prematurity ($p = 0.803$), and low birth weight ($p = 1.000$), Table 4.

Table 1: Socio-demographic characteristics of the studied sample.

	No.	(%)
Age (years)		
7-8	171	(47.4)
9-10	108	(29.9)
11-12	82	(22.7)
Gender		
Male	161	(44.6)
Female	200	(55.4)
Father's education		
Primary/Read and Write	168	(46.5)
Secondary and Institute	94	(26.0)
College	80	(22.2)
Illiterate	19	(5.3)
Mother's education		
Primary/Read and Write	176	(48.8)
Secondary and Institute	58	(16.1)
College	58	(16.1)
Illiterate	69	(19.1)
Father's occupation		
Unemployed	9	(2.5)
Unskilled manual worker	258	(71.5)
Skilled manual worker	15	(4.2)
Non manual worker	57	(15.8)
High rank	22	(6.1)
Mother's occupation		
Housewife	321	(88.9)
Unskilled manual worker	6	(1.7)
Skilled manual worker	5	(1.4)
Non-manual worker	29	(8.0)
House ownership		
Rent	150	(41.6)
Owned	211	(58.4)
Car ownership		
Yes	243	(67.3)
No	118	(32.7)
Income		
Not enough for daily need	139	(38.5)
Enough for daily need	183	(50.7)
Exceeds daily need	39	(10.8)
Total	361	(100.0)

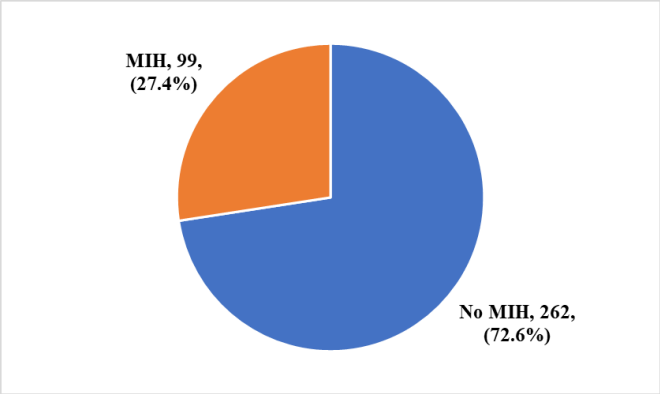

Figure 1: Prevalence of Molar Incisor Hypo-mineralization (MIH) in the studied sample.

Table 2: Categories (severity) of MIH by tooth.

	Normal	Demarcated opacity	Post-eruptive enamel break-down	Atypical res-toration	Extracted tooth
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Upper right first permanent molar					
#3	289 (80.1)	35 (9.7)	35 (9.7)	2 (0.6)	0 (0.0)
Upper right permanent lateral incisor					
#7	355 (98.3)	6 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)
Upper right permanent central incisor					
#8	305 (84.5)	54 (15.0)	2 (0.6)	0 (0.0)	0 (0.0)
Upper left permanent central incisor					
#9	304 (84.2)	54 (15.0)	2 (0.6)	1 (0.3)	0 (0.0)
Upper left permanent lateral incisor					
#10	356 (98.6)	5 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)
Upper left first permanent molar					
#14	284 (78.7)	37 (10.2)	36 (10.0)	2 (0.6)	2 (0.6)
Lower left first permanent molar					
#19	265 (73.4)	29 (8.0)	50 (13.9)	9 (2.5)	8 (2.2)
Lower left permanent lateral incisor					
#23	353 (97.8)	8 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)
Lower left permanent central incisor					
#24	323 (89.5)	37 (10.2)	1 (0.3)	0 (0.0)	0 (0.0)
Lower right permanent central incisor					
#25	325 (90.0)	35 (9.7)	1 (0.3)	0 (0.0)	0 (0.0)
Lower right permanent lateral incisor					
#26	354 (98.1)	6 (1.7)	1 (0.3)	0 (0.0)	0 (0.0)
Lower right first permanent molar					
#30	273 (75.6)	25 (6.9)	51 (14.1)	8 (2.2)	4 (1.1)

Table 1. Socio-demographic characteristics of the studied sample.
Table 2. Categories (severity) of MIH by tooth.

		No MIH	MIH	
	N	No. (%)	No. (%)	p
Drugs (tetracycline)				
No	351	253 (72.1)	98 (27.9)	
Yes	10	9 (90.0)	1 (10.0)	0.296*
Diseases				
Congenital heart diseases				
No	259	261 (72.7)	98 (27.3)	
Yes	2	1 (50.0)	1 (50.0)	0.474*
Kidney disease				
No	357	258 (72.3)	99 (27.7)	
Yes	4	4 (100.0)	0 (0.0)	0.578*
Diabetes mellitus				
No	357	261 (73.1)	86 (26.9)	
Yes	3	0 (0.0)	3 (100.0)	0.020*
History of febrile disease				
No	360	261 (72.5)	99 (27.5)	
Yes	1	1 (100.0)	0 (0.0)	1.000*

It is evident in table 5 that there was no significant association between the prevalence of MIH with postnatal factors: asthma (p = 0.184), type of infant feeding (p = 0.572), duration of breastfeeding (p = 0.403), medication use by mothers during breastfeeding (p = 0.051), trauma to primary teeth (p = 1.000), and primary teeth infection (p = 0.145). It is worth mentioning that the prevalence of MIH was 66.7% among children whose mothers had history of medication use during breastfeeding compared with 26.9% among those with no such history. The difference was close to the significance level, Table 5.

The result of the present study showed that the more the age, the less the prevalence of MIH, but the difference was not significant (p = 0.075). No significant association was detected between gender and the prevalence of MIH (p = 0.324).

Table 3. Prenatal factors that are associated with the prevalence of MIH.

		No MIH	MIH	
	N	No. (%)	No. (%)	p
Twin pregnancy				
No	334	243 (72.8)	91 (27.2)	
Yes	26	18 (69.2)	8 (30.8)	0.698**
Mode of delivery				
Normal	241	173 (71.8)	68 (28.2)	
Cesarean section	120	89 (74.2)	31 (25.8)	0.633**
Prematurity				
No	341	247 (72.4)	94 (27.6)	
Yes	20	15 (75.0)	5 (25.0)	0.803**
Low birth weight				
No	347	252 (72.6)	95 (27.4)	
Yes	14	10 (71.4)	4 (28.6)	1.000*
Total	361	262 (72.6)	99 (27.4)	

Table 4. Neonatal factors that are associated with the prevalence of MIH.

		No MIH	MIH	
	N	No. (%)	No. (%)	p
Twin pregnancy				
No	334	243 (72.8)	91 (27.2)	
Yes	26	18 (69.2)	8 (30.8)	0.698**
Mode of delivery				
Normal	241	173 (71.8)	68 (28.2)	
Cesarean section	120	89 (74.2)	31 (25.8)	0.633**
Prematurity				
No	341	247 (72.4)	94 (27.6)	
Yes	20	15 (75.0)	5 (25.0)	0.803**
Low birth weight				
No	347	252 (72.6)	95 (27.4)	
Yes	14	10 (71.4)	4 (28.6)	1.000*
Total	361	262 (72.6)	99 (27.4)	

Table 5. Postnatal factors that are associated with the prevalence of MIH.

		No MIH	MIH	
	N	No. (%)	No. (%)	p
Asthma				
No	358	261 (72.9)	97 (27.1)	
Yes	3	1 (33.3)	2 (66.7)	0.184*
Diabetes and congenital hypothyroidism				
No	361	262 (72.6)	99 (27.4)	NA
Celiac disease				
No	361	262 (72.6)	99 (27.4)	NA
Cancer				
No	361	262 (72.6)	99 (27.4)	NA
Nephrotic syndrome and chronic renal failure				
No	361	262 (72.6)	99 (27.4)	NA
Type of infant feeding				
Breast feeding	109	77 (70.0)	32 (29.4)	
Bottle feeding	75	58 (77.3)	17 (22.7)	
Both	177	127 (71.8)	50 (28.2)	0.572**
Duration of breast feeding if practiced				
< 6 months	50	34 (68.0)	16 (32.0)	
1-1.5 years	89	60 (67.4)	29 (32.6)	
> 1.5 years	147	110 (74.8)	37 (25.2)	0.403**
Medication use by mothers during breastfeeding				
No	353	258 (73.1)	95 (26.9)	
Yes	6	2 (33.3)	4 (66.7)	0.051*
Trauma to primary teeth				
No	353	256 (72.5)	97 (27.5)	
Yes	8	6 (75.0)	2 (25.0)	1.000*
Primary teeth infection				
No	351	257 (73.2)	94 (26.8)	
Yes	10	5 (50.0)	5 (50.0)	0.145*
Total	361	262 (72.6)	99 (27.4)	

Table 6. Prevalence of MIH by age and gender.

		No MIH	MIH	
	N	No. (%)	No. (%)	P*
Age (years)				
7-8	171	133 (77.8)	38 (22.2)	
9-10	108	76 (70.4)	32 (29.6)	
11-12	82	53 (64.6)	29 (35.4)	0.075
Gender				
Male	161	121 (75.2)	40 (24.8)	
Female	200	141 (70.5)	59 (29.5)	0.324
Total	361	262 (72.6)	99 (27.4)	

*By Chi-square test.

Discussion

The present study was a cross-sectional epidemiologic study to estimate the prevalence of MIH and its association with some relative risk factors in a group of children attending two specialized dental centers in Erbil city, aged 7–12 years because at this age most children would have had all four first permanent molars and the majority of incisors. In addition, these teeth would not have been exposed to the oral environment long enough to develop dental caries. At an older age, there would be a risk of posteruptive breakdown of enamel and caries initiation. Although the age of 8 years is recommended for studies dealing with MIH, however, in this study we included up to the age of 12 years. This was anticipated to include more participants and also to enable detection of more patterns of the defects as described in the study, other studies have used age groups higher than 8 years.[8] The EAPD MIH index was used for the diagnosis of MIH, because it is easy for clinicians to record, and has also been tested in other studies.[9] In this study 27.4% of the participants were diagnosed with MIH which was higher than the mean global prevalence (13.1% to 14.2%) reported in 2018.[10,11] But comparable to results in Dubai (27.2%)[12] but higher than those reported from Spain (21.8%),[13] Japan (19.8%),[14] Iran (20.2%),[15] Turkey (14.2%),[16] However, our results were found to be lower than those reported in Brazil (40.2%).[17] There was statistically no significant difference in the occurrence of MIH with age in this study, in line with results reported by Oydele et al 2015[18] and[19], but in contradiction with the study by Da costa-Silva et al 2010 that showed a significant increase in MIH with age[20] and the decrease of MIH with age by Saitoh et al 2018.[14]

In the studied sample statistically no significant differences in MIH prevalence were found between sex group, this may indicate that the condition is not a gender associated disease which is in agreement with previous similar studies [21,22] but contrary to results from other studies where the prevalence was higher for girls [23] and in another study by Muratbegovic et al 2007 were higher for boys.[24]

In the present study, The majority of the affected teeth were in the maxillary arch this is in line with earlier studies[9,25] but studies by Yi et al [26] and Elzein et al [27] found an equal distribution of MIH defects in the upper and lower jaws.

Only opacities of 2 mm and larger were jjjjjj

included because enamel lesions less than 2 mm are quite common.[28] In agreement with previous studies, we found that demarcated opacities were the most frequent type of MIH.[7,29] The prevalence of posteruptive breakdown in our study was higher in mandibular teeth than in maxillary teeth which erupts earlier than maxillary teeth this may partly be explained by the inclusion of older children in our study, as some of the demarcated opacities may break down over time. This explanation is supported by the findings of Wogelius et al 2008 who reported an increased prevalence of posteruptive breakdown by increasing age.[30]

The main aim of the present study was to identify the possible etiological association of MIH with pre, peri-, and postnatal events in a group of children attending two specialized dental centers in Erbil city. It is important to mention that such associations are generally difficult to identify, and conclusions should be carefully considered.

The study relied mainly on parents' recall of any abnormalities. The risk was minimized as much as possible through structured questioning conducted by one investigator, which could help the parents recall any related factors. Additionally, the questionnaire information was only taken from the child's parents. other members of the family were not questioned because they would induce a higher risk of recall bias when asked about pre, peri-, and postnatal events. All suggested etiological factors that were described in the previous scientific literature were considered.[22,31]

In recent years, studies on the etiology of MIH have shown that the incidence of MIH is higher in children undergoing high fever and respiratory diseases in the first years after birth, preterm delivery, and low birth weight.[32–34] The maturation stage of tooth enamel starts in the last trimester of pregnancy and continues up to the first three years after birth. Due to premature birth, tooth enamel cannot complete the development of maturation and enamel defects and MIH can develop in patients.[35] Similarly, in the first years of life, the development of health problems such as asthma, frequent upper respiratory infections (adenoid infections) and high fever affect the ameloblastic activity during enamel mineralization and enamel defects are seen in FPMT.[36]

In the present sample, only one of the suggested factors shows a statistically significant association with MIH: diabetic mother. Because of the decrease or absence of oxygen received by the fetus through the placenta. Complications during gestation and adverse conditions at birth have been associated with increased frequency of enamel defects, as they influence ameloblast function.[37]

Conclusion

The present study reports a prevalence of 27,4 % in children in the age group 7 to 12 years. demarcated opacities were the most frequent type of MIH. In the studied sample statistically, no significant differences in MIH prevalence were found between the sex group. Diabetes was the only etiological factor that showed a significant association with MIH in the studied group of children.

Conflict of interest

The author reported no conflict of interests

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