Molar Incisor Hypomineralization: Prevalence and severity in six to nine-year-old Sarajevo children

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DOI 10.23804/ejpd.2020.21.03.16

Abstract

Aim Research aimed to gather aepidemiological parameters of MIH from a sample of Sarajevo children born between the years 1999 and 2003. Prevalence of MIH, distribution according to severity (mild vs. moderate/severe cases) and distribution according to phenotypes (MIH vs MH) were investigated.

Materials and Methods Study design: This was a cross-sectional, observational, aepidemiological study that was conducted on a sample of 446 children aged 6 to 9 years. It was conducted as a part of regular dental screening of children attending a randomly selected primary school in the Bosnian capital city of Sarajevo.

Results The overall prevalence of MIH was 11.5%. MIH prevalence varied between 19.9% of examinees born in year 2002 to 8.4% among those born in 2003. Number of teeth affected varied from 1 to 7. The average number of affected teeth was 3.82 ± 1.46. Demarcated opacities were recorded on 13.89%, post-eruptive enamel breakdown on 11.28% and atypical filling on 6.2% index teeth. Mild cases of MIH were rare in our sample, 18% of subject had only demarcated opacities present. A smaller percentage of examinees (35.3%) had hypomineralisation present only on first permanent molars (MH group). Out of 64.7% of subjects in MIH group, 37.25% had one incisor affected and 21.57% had two incisors affected.

Conclusions Over 80% of study subjects with MIH were categorised as moderate/severe case of MIH and they represent a major problem with regards to dental treatment. It is necessary to plan a multi-disciplinary approach for dental care of this population. It is necessary to educate primary care dentists to recognise this condition and provide recommended treatment to patients with mild clinical picture, while directing those with more severe problems to specialised doctors.

KEYWORDS MIH prevalence; Age cohorts' differences; MIH severity.

Introduction

Molar Incisor Hypomineralisations were investigated worldwide, the majority of studies reported prevalence between 8% and 20%. High values were registered among Brazilian (40.2%) and German examinees (36.51%) [Pentapati et al., 2017]. MIH is not so common clinical finding among children in India (0.48%), Hong Kong (2.8%) and Libia (2.9%) [Fteita et al., 2006; Cho et al., 2008; Soviero et al., 2009].

The number of teeth with mild form of hipomineralisation (demarcated opacites only) differs between countries. Mild form of Molar Incisor Hypomineralization (MIH) is recorded in Finland (45.8%), Greece (49.04%) and Germany (84.5%) in kids older than 9 years [Leppaniemi et al., 2001; Lygidakis et al., 2008a; Dietrich et al., 2003]. In a previous Bosnian study of 12-year-olds, 47% of index teeth were affected and demarcated opacities were found on 25% of teeth examined. This implies that in our population almost half of teeth with demarcated opacities progress in severe stages of MIH over a period of 5 to 6 years after tooth eruption [Muratbegovic et al., 2007].

According to the European Academy of Paediatric Dentistry (EAPD) guidance two phenotypes of this condition may be present. The first is Molar Hypomineralisation (MH), which affects only first permanent molars (teeth 1 to 4), and the second is Molar Incisor Hypomineralisation (MIH), which affects first permanent molars and permanent incisors [Lygidakis et al., 2008a; Chawla et al., 2008a]. Distribution of subjects with MIH and MH differs between countries. Equal MIH/MH distribution was reported in Poland, where 50% of subjects had MIH [Glodkowska et al., 2019]. MIH was more common (57%) than MH (47%) in Australian examinees [Chawla et al., 2008a]. Among Greek children (with all index teeth erupted at the time of examination) distribution between groups was 71.6% in MIH and 28.4% n MH group [Lygidakis et al., 2008a]. It was suggested that MIH and MH form a spectrum where MIH is more severe form of the condition than MH [Chawla et al., 2008a].

Recently, recording of Hypomineralised Second Primary (HSPM) was also recommended. This index is recommended for use in population-based and clinical screenings for diagnosis

of MIH and other enamel defects of hypomineralised second primary molars [Ghanim et al., 2018]. The prevalence of children with one or more permanent or primary teeth affected with some degree of pulpal involvement was also associated with the presence of MIH/HSPM [Gambetta-Tessini et al., 2019]. MIH/ HSPM index was not applied in our study since examinations were performed before it was developed.

Registration of subjects according to type and severity of affected teeth (need for clinical treatment) is proposed. Examinees are divided into two groups, the first being mild cases in which all affected teeth have mild form (demarcated opacity). The second group is represented by moderate/severe cases for subjects that have one or more moderate/severely affected teeth (with post-eruptive enamel breakdown or atypical fillings) that require clinical attention.

MIH is a well-known but rarely investigated condition in Bosnia and Herzegovina. There is a lack of continious investigation of MIH. MIH prevalence among Bosnian 12-year-olds born in year 1992 was 12.3%. Difference of MIH prevalence ranged between 2.5% and 32.5% depending on the area of residence, the prevalence among Sarajevo residents was 10% [Muratbegovic et al., 2007].

The present study aimed to gather aepidemiological parameters of MIH, rarely investigated and reported for Bosnian chidren. Prevalence of MIH among Sarajevo children aged 6 to 9 years, as well as distribution according to severity (mild vs. moderate/severe cases) and distribution according to phenotypes (MIH vs MH) were investigated.

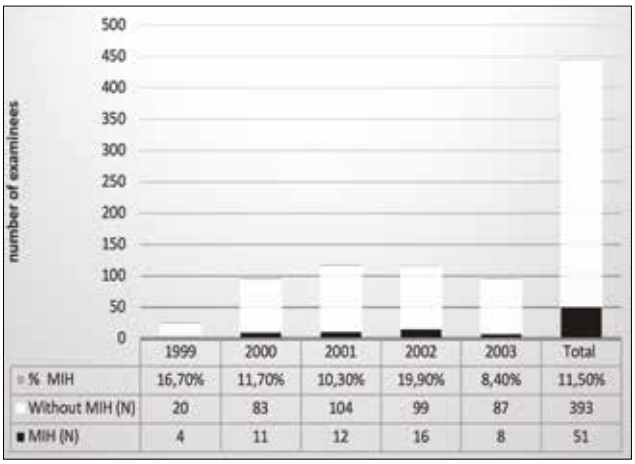

FIG. 1 Sample distribution and MIH prevalence according to age cohorts.

Materials and methods

This is a cross-sectional, observational aepidemiological study. It was conducted as a part of regular dental screening conducted by the Paediatric Dentistry Department, Faculty of Dentistry, University of Sarajevo. The sample consisted of children that were attending one randomly selected primary school in the Bosnian capital city of Sarajevo. Only examinees aged 6 to 9 years for whom school obtained parental consent for participation were included.

Final sample included 446 children that were examined by one dentist, trained to diagnose and differentiate MIH. Repeated examinations were conducted on 10% of the sample (44 examinees). Every 10th examined child, the same child was re-examined the next day to test intra-examiner reliability. The Cohens Kappa showed very good intra-examiner reliability (Kappa = 0.90, $p < 0.0001$).

Dental examinations were conducted in a clasroom, under wet conditions. Gross plaque or food debris was removed with cotton-rolls prior to the examination. For MIH examinations additional light sorce was used (dental headlamp).

Four first permanent molars and eight permanent incisors (index teeth) were examined and the findings recorded according with the recommended criteria for MIH diagnosis and recording [Weerheijm et al., 2003].

Each examinee with demarcated opacities (DO), post-eruptive enamel breakdown (PEB) and atypical restoration (AR) in at least one index tooth – with the exception of demarcated changes only in the incisors – was diagnosed with MIH. Restauration with atypical size and shape, meaning margins of filling extended to the buccal or palatal smooth surface of FPM with frequent presence of opacity at the border of restauration were registered as AR. Buccal restoration in incisors not related to trauma are also registered as AR. Examinees with opacities only on incisors were not diagnosed with MIH, because it was impossible to exclude the possibility that the changes were due to other aetiological factors (trauma, infection of primary teeth). Examined children with at least one extracted first permanent molar were also diagnosed with MIH if demarcated opacities, post-eruptive enamel breakdown or atypical fillings were found in at least one of their permanent incisors or first permanent molars. The examinees with one, two, three or all four extracted first permanent molars, but without MIH signs in one remaining index teeth, were not diagnosed with MIH. Demarcated opacities having a diameter less than 2 mm were not recorded. Teeth that were not fully erupted by the time of examination were recorded only if at least half of the crown was available for visual exam.

Examinees were categorised into two groups according to the severity of the clinical apperance. Those with demarcated

				Distribution of registered categories on index teeth N (%)				
	Number examinees	Number of examinees with MIH	MIH prevalence	Not affected teeth	Demarcated Opacities	Post-eruptive Enamel Breakdown	Atypical Filling	Extracted due to MIH
2004	560	69	12,3%	441 (53%)	204 (24.7%)	72 (8.7%)	38 (4.6%)	73 (8.8%)
2009*	444	51	11.5%	371 (60.6%)	85 (13.9%)	69 (11.3%)	38 (6.2%)	3 (0.5%)

7.51% (N=46) of teeth were recorded as non-erupted at the time of examination.

TABLE 1 Comparison of aepidemiological parameters between MIH studies conducted in 2004 and 2009 for Bosnia and Herzegovina.

Clinical Appearance	% Index teeth (Number of teeth)											
	16	26	36	46	11	12	21	22	31	32	41	42
Not affected	35.3 (18)	31.4 (16)	21.6 (11)	25.5 (13)	56.9 (29)	76.5 (39)	58.8 (30)	66.7 (34)	96.1 (49)	80.4 (41)	94.1 (48)	84.3 (43)
Demarcated opacity	19.6 (10)	27.5 (14)	11.8 (6)	9.8 (5)	37.3 (19)	3.9 (2)	33.3 (17)	9.8 (5)	3.8 (2)	3.9 (2)	5.9 (3)	0 (0)
Post-eruptive Enamel Breakdown	23.5 (12)	25.5 (13)	41.2 (21)	43.1 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)
Atypical filling	19.6 (10)	15.7 (8)	19.6 (19)	19.6 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Extracted due to MIH	0 (0)	0 (0)	3.9 (2)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Not erupted	2 (1)	0 (0)	2 (1)	0 (0)	5.9 (3)	19.6 (10)	7.8 (4)	23.5 (12)	0 (0)	15.7 (8)	0 (0)	13.7 (7)
Total	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)	100 (51)

TABLE 2 Distribution of clinical appearance (defect types) registered on index teeth groups.

opacities only, were categorised as mild cases. Subjects with at least one tooth recorded as in progression stage (post-eruptive enamel breakdown, atypical fillings or tooth extracted due to MIH) were accounted as moderate/severe cases.

Examinees were also categorised in the MIH (affected first permanent molars and permanent incisors) and MH group (first permanent molars affected only).

The Statistical Package for Social Science, version 15.0 (SPSS Inc., Chicago, IL, SAD) was used for data analysis. Descriptive statistic included frequencies and percentage, average values and standard deviation. Chi-square test was used for categorical data and the significance level was set at $p<0.05$.

The study was conducted in accordance with the ethical standards and 1964 Helsinki declaration, and was approved by the Faculty of Dentistry, University of Sarajevo (Scientific and Educational Committee 09-263-1).

Results

The final sample consisted of 444 examinees, two subjects were excluded due to unknown date of birth. Prevalence of MIH was 11.5% (n= 51), the number of female subjects affected was higher (n=28). A variation of prevalence of MIH between different age cohorts was noted. The prevalence of MIH among examinees born in the year 2002 was 19.9%, followed by those born in 2000 and 2001 (11.7% and 10.3%, respectively), while for those born in the year 2003 prevalence of MIH was 8.4%. MIH was found in 4 subjects among the 24 examinees born in 1999 (16.7%). Sample distribution and MIH prevalence according to age cohorts of examinees is presented in Figure 1.

The number of affected teeth ranged from 1 to 7. On average 3.82 teeth (SD±1.46) were affected. Difference between the affected average teeth for males (3.83, SD±1.370) and females (3.82, SD ±1.565) was not statistically significant (Chi square test 0.764, $p>0.05$).

Out of all index teeth examined in subjects with MIH (n=612), 60.62% (n=371) did not show hypomineralisation. Demarcated opacity was registered on 13.89% of the teeth (n=85), posteruptive enamel breakdown on 11.28% (n= 69) of the teeth, atypical filling on 6.2% (n=38) of the teeth. Percentage of teeth extracted as a consequence of hypomineralisation was 0.49% (n=3), all of them being lower first permanent molars; 7.51% (n=46) of the teeth were not erupted at the time of examination (Table 1).

The number of hypomineralised teeth is higher in the upper jaw (n=108) when compared with those in the lower jaw (n=85), but with no statistically significant difference ($p>0.05$). There was no significant difference in the number of affected teeth on the left (n=99) and right side (n=94) ($p>0.05$) (Table 2).

A smaller percentage of examinees (35.3%) had hypomineralisation only on the first permanent molars (MH group). Examinees with two and four first permanent molars affected by hypomineralisation were equally present in sample (each group 35.3%); 23.5% examinees had three FPM affected and 11.8% had one FPM affected. Out of 64.7% subjects that had hypomineralisation on the first permanent molars and permanent incisors (MIH group), 37.25% had one incisor affected, and 21.57% had two incisors affected. A small number of examinees had three or four permanent incisors affected. The number of teeth affected varied between one and seven (one subject had four incisors and three FPM affected). Distribution of examinees according to number and percentage of first permanent molars and permanent incisors affected is presented in Table 3.

Mild cases of MIH were rare in our sample, 18% of subject had only demarcated opacities present on index teeth affected. The remaining subjects were categorised as moderate/severe cases and had post-eruptive enamel breakdown, atypical filling or extracted tooth due to MIH on one or more index teeth.

Out of 82% of moderate/severe cases, 33% had two teeth in progression, 21% had four teeth in progression, and remaining 18% had three teeth in progression. One tooth with progression was registered in 10% of examinees.

Discussion

Studies conducted worldwide reported a prevalence ranging from 0.48% to 40.16% [Pentapati at al., 2017]. MIH prevalence among our examinees was 11.5%, which is comparable with the percentages registered previously in Bosnia and Herzegovina (12.3%), Greece (10.2%) and Lithuania (9.7%) [Muratbegovic et al., 2007; Lygidakis et al., 2008b; Jasulaityte et al., 2007]. Prevalence for Sarajevo examinees aged 12 in 2004 was 10%

Number of hypomineralised FPM	Number of hypomineralised permanent incisors					Distribution of examinees according to number of FPM affected N (%)
	0	1	2	3	4	
1	2 (33.3)	1 (16.7)	2 (33.3)	1 (16.7)	0 (0)	6 (100)
2	7 (46.7)	7 (46.7)	1 (6.7)	0 (0)	0 (0)	15 (100)
3	4 (33.3)	3 (25.0)	4 (33.3)	0 (0)	1 (8.3)	12 (100)
4	5 (27.8)	8 (44.4)	4 (22.2)	1 (5.6)	0 (0)	18 (100)
Distribution of examinees according to number of permanent incisors affected N (%)	18 (35.3)	19 (37.3)	11 (21.6)	2 (3.9)	1 (2.0)	51 (100)

TABLE 3 Distribution of examinees according to the number of first permanent molars and permanent incisors affected.

[Muratbegovic et al., 2007].

There are studies that report prevalence variation between age cohorts, Germany (2.4% to 11%), Bulgaria (2.4 to 7.8%) and Sweden (3.6% to 15.4%) [Dietrich et al., 2003; Kukleva et al., 2008; Koch et al., 1987]. Prevalence range in our sample varied from 8.6% to 19.9% (Fig. 1). MIH prevalence registered for examinees born in year 2002 (19.9%) is the highest registered for Sarajevo. Prevalence registered among our examinees born in year 1999 (16.7%) has to be interpreted carefully due to the small number of examinees in this group (N=24) [Jalevik et al., 2010]. According to Elfrink [2015] the minimum sample size should be calculated in accordance with prevalence. For an estimated prevalence between 10% and 15% the sample size should be between 138 and 87 children [Elfrink et al., 2015].

Some studies reported higher MIH prevalence among boys [Jalevik., 2001a]. Higher prevalence in girls than boys is frequently reported (as for our sample), only few reported this difference to be statistically significant [Pentapati et al., 2017]. Differences in the number of male and female examinees with MIH, as well as regarding the average number of affected teeth between male and female examinees were not significant in our study.

It was not proven with certainty that maxillary or mandibular molars are more susceptible to MIH. It was suggested that the greater number of upper molars is due to influence of aetiological factors during the mineralisation phase of the upper teeth which starts earlier than in the lower jaw [Leppäniemi et al., 2001]. Prevalence of developmental defects of enamel is highest at locations where the enamel is thickest, and that is the case with upper incisors when compared with the lower ones [Calderara et al., 2005]. Mandibular molars are more likely to be wetted by saliva or partially obscured by tongue movements during examination, making mild hypomineralisations harder to detect than in maxillary molars [Chawla et al., 2008b]. MIH was more common in the upper jaw in many studies [Leppaniemi et al., 2001; Preusser et al., 2007; Choe et al., 2008; Ligidakis et al., 2008a; Muratbegovic et al., 2007]. According to Weerheim [2003] and Chawla [2008b], the distribution of the affected molars in the maxilla and mandible was even. In the current study, same as in previously conducted research in Bosnia and Herzegovina, Swedish and Italian studies, the affected teeth were more common in the upper jaw, although no statistically significant difference was found [Muratbegovic et al., 2007; Jalevik et al., 2001; Calderara et al., 2005]. It must be taken into account that in the current study two thirds of teeth not erupted were in the upper jaw. Most of the not erupted teeth were permanent incisors (Table 2), that being one of the problems when registering MIH at younger age.

In our study index teeth with demarcated opacities were most prevalent (14%), followed by teeth registered as having post-eruptive enamel breakdown (11.3%), while the percentage of teeth with atypical filling was 6.2.

A smaller percentage of teeth was affected in the current study (39.4%) when compared with results from year 2004 (47%) [Muratbegovic et al., 2007]. Differences in distribution of progressive stages of hypomineralisation (post-eruptive breakdown, atypical fillings and extraction due to MIH) are noted too (Table 1). The noted differences can be linked to the age of examinees, in 2004 were examined 12-year-olds while in the current study examinees were aged 6 to 10 years. Percentage of teeth registered as extracted due to MIH in the current study is relatively small (0.5%) when compared with values registered for 12-year-olds examined in 2004 (8.8%). The number of teeth extracted due to MIH increase with age and accordingly a smaller number of teeth is registered as having PEB and AF. MIH is a progressive condition and older examinees frequently have progressive stages [Lygidakis et al., 2008a; Leppaniemi et al., 2001]. Percentage of teeth with progressive stages of hypomineralisation (post-eruptive breakdown, atypical fillings and extraction due to MIH) increase with age since this is a progressive disease, 22.1% in 12-year-olds compared with 18% among younger examinees in the current study.

A smaller percentage of examinees had all four FPM affected with hypomineralisation in this study (35.3%) when compared with Bosnian subjects examined in the year 2004 (more than 50% of 12-year-olds had all FPM affected). The results of the study conducted in 2004 can be a consequence of early FPMs extraction due to caries complications that is frequent in our 12-year-olds [Markovic et al., 2014]. The fact that in the current study 7.5% of index teeth were registered as not erupted must be taken in account.

The average number of teeth registered as affected in this study (3.83± 1.37) is smaller that the one registered in year 2004 among 12-year-olds (5.59 ± 2). The average number of

affected teeth reported in other available studies is between 2 to 5.7, while the average number of FPMs was between 1.6 and 3.16 [Jasulaityte et al., 2007; Muratbegovic et al., 2007; Lygidakis et al., 2008a; Jalevik et al., 2001; Dietrich et al., 2003; Cho et al., 2008; Calderara et al., 2005].

In the present study, the study subjects were categorised as moderate/severe cases if progressive stage (post-eruptive enamel breakdown, atypical restoration or extractions of permanent first molar due to MIH) was registered in at least one index tooth. Moderate/severe cases were noted for 45% examinees in Lithuania, 42.9% in Chile, 21.8% in Istanbul and 50.6% among Greek examinees [Jasulaityte et al., 2007; Gambetta-Tessini et al., 2019; Kusuku et al., 2008; Lygidakis et al., 2008a]. In our sample only 18% of examinees had mild clinical picture, meaning that all teeth presented demarcated opacities. Also, 18% of our examinees had three teeth with progression. The highest percentage (33%) of our examinees had progression on two index teeth and 21% had four teeth in which demarcated opacity progressed. In total, 82% of study subjects had at least one tooth in progressive stage, meaning moderate/severe MIH in younger age and this is a major problem with regards to dental treatment. Previously it was reported in Bosnia and Herzegovina that children with MIH had a significantly greater need for pulp treatment and extractions. Caries experience mean value among children with MIH in the permanent dentition was almost twice as high than in their healthy counterpart [Muratbegovic et al., 2007].

In recent studies, examinations were performed in a dental chair suggesting that more comparable conditions are ensured this way. One limitation of our study is that children were examined in a classroom although with additional light source. Examination with natural light seems to be the least advisable because of natural changes in the light during the day depending on weather conditions [Elfrink et al., 2015]. Close surveillance of hypomineralised defects in primary and permanent dentitions, as well as the examination of all teeth have clinical importance and is recommended in future aepidemiological investigations [Gambetta-Tessini et al., 2019].

Conclusions

MIH was registered in 11.5% of children, a percentage somewhat lower than that registered in previous studies conducted in Bosnia and Herzegovina, but higher than the 10% registered among Sarajevo 12-year-olds examined in 2004. The average number of teeth affected was also lower than established in previous studies but still, in average, 4 teeth were affected for each examinee.

Mild cases of MIH with only demarcated opacities present on affected index teeth, that require no clinical treatment, were rare in our sample (18%). Remaining study subjects had progressive stages that required extensive restorative dental treatment already in younger age and this is a major problem with regards to dental treatment in the studied population.

Almost two thirds of our examinees have MIH, while the remaining third that have a milder form of MH.

The frequency of MIH-affected teeth varied between study subjects of different age. The highest prevalence, 19.9%, was among examinees born in 2002.

It would be necessary to plan for a multi-disciplinary approach to dental care of this population, including the use of recommended treatment options. It is also necessary to educate primary care dentists to recognise this condition and provide recommended treatment to patients with mild clinical picture, while directing those with more severe problems to specialised doctors. Close surveillance of hypomineralised defects in primary dentition is recommended for future research on MIH as well as conducting examinations in a dental chair.

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