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How serious is Molar Incisor Hypomineralisation (MIH) among 8- and 9-year-old children in Bosnia-Herzegovina? A clinical study

ABSTRACT

Aim *To determine the prevalence of MIH in 8- and 9 year-old children in the city of Kljuc, Bosnia-Herzegovina, and to describe the distribution and severity of the affected teeth.*

Materials and methods *Study design: All 8- and 9-year-olds (n=104) living in Kljuc (born 2004/2005) were invited to participate, and 103 were examined by a calibrated clinician. Written, informed consent was obtained from all participants' relatives, as well as a questionnaire designed to assess potential risk indicators. Index teeth were all permanent first molars and incisors (12 teeth). Opacities (>1mm), post eruptive breakdown (PEB), atypical restorations and previous extractions caused by MIH were registered.*

Results *The prevalence of MIH was 11.7% (n=12), significantly higher for girls than for boys (14.6% vs. 9.7%; p<0.05). The maxillary first molars and incisors were 1.8 (p<0.02) and 2.3 (p<0.05) times more frequently affected than the mandibular ones, respectively. Seven (30%) of the affected molars had opacities, 8 (35%) had PEB and 8 (35%) atypical restorations. No molars had been extracted due to MIH. The use of penicillin due to adenoid infections in the first 5 years was associated with a higher prevalence of MIH (41.7% vs. 19.6%).*

Conclusions *The prevalence of MIH (11.7%) supports the data previously published from Bosnia-Herzegovina. Girls had higher prevalence of MIH than boys; first molars and incisors in the maxilla were almost twice as often affected as in the mandible. Use of penicillin in the first 5 years was associated with a higher prevalence.*

Keywords *Children, Molar Incisor Hypomineralization, Prevalence.*

Introduction

The term Molar Incisor Hypomineralisation (MIH) is used to describe the clinical appearance of the chronological enamel disturbance of systemic origin affecting one or more first permanent molars (FPMs) and often incisors. The second primary molars and the permanent canines are also frequently involved [Weerheijm et al., 2003]. The severity of MIH may vary greatly, and ranges from mild opacities to severe posteruptive breakdown (PEB). Occasionally, permanent molars can be extracted due to severe damage as a consequence of MIH.

The reported prevalence of MIH varies widely, from 2.4% to 40.2% [Jälevik, 2010]. In the age group 8 to 10 years, prevalence between 4.3% and 18.4% has been reported [Jälevik et al., 2001; Jasulaityte et al., 2008; Janković et al., 2014; Petrou et al., 2015]. There are only two published studies on the prevalence of MIH in Bosnia-Herzegovina, where it has been found to be 12.3% and 12.8% among 12- and 8-year-olds, respectively [Janković et al., 2014; Muratbegovic et al., 2007]. According to the Judgement Criteria of MIH [Weerheijm et al., 2003], modified in 2010 [Lygidakis et al., 2010], the best age for a cross-sectional study of MIH is 8 years. At this age, in most children, all four first permanent molars and the majority of incisors are erupted and not affected by dental caries or restorations, and therefore the signs of MIH are still present [Weerheijm et al., 2003]. In a recent study, Petrou et al. [2015] showed that the severity of MIH lesions is associated with an increasing number of affected teeth and surfaces per child. Detailed knowledge of the intraoral distribution of MIH at tooth surface level has been suggested to be predictive of the treatment need and for that reason a new severity index has been purposed [Oliver et al., 2014].

Although there has been an increased focus on the aetiology of MIH in the literature in the last decade the susceptibility for the condition is still uncertain. Perinatal conditions and medical conditions during the first five years of life such as asthma, tonsillitis, adenoiditis, fever and antibiotics intake have been mentioned as potential causes [Alaluusua, 2010; Allazzam et al., 2014; Fagrell et al., 2011; Lygidakis et al., 2008].

The aim of the present study was to report the prevalence of MIH in a group of 8- and 9-year-olds in Bosnia-Herzegovina, and to examine the distribution and severity of the affected tooth surfaces. In addition, possible etiological factors associated with MIH were evaluated.

Materials and methods

Study population and area

All 8- and 9-year-olds (born 2004/2005) (n=104) living in the city of Kljuc, in the North West part of Bosnia-Herzegovina, were invited to participate, and therefore three different schools were included in the study. All schools were directly contacted and permission for the data collection was obtained from relevant authorities.

Calibration

Prior to the study, two calibration sessions were performed to calculate the inter- and intra-observer agreement. This was undertaken to ensure that the main examiner (EC) was sufficiently calibrated to make a definite diagnosis. The calibration sample consisted of 20 standardised intraoral photographs of teeth with and without MIH. The Judgement Criteria of MIH [Weerheijm et al. 2003] were used to assess the diagnosis in selected index teeth (n=12): the first permanent molars (FPM) (16,26,36,46) and incisors (12,11,21,22,32,31,41,42). In the cases where two scores were registered on the same surface, the most severe score was chosen (opacity < post eruptive breakdown (PEB) < atypical restoration).

Three examiners performed the registrations which were repeated after 21 days (2. examination) under identical light and room conditions. The codes used in the kappa-calculations (at the patient level) were: 0=MIH free and 1=MIH affected.

Oral examination and questionnaire

The clinical examination was performed in a classroom by a calibrated investigator (EC). Each child was examined in a regular chair by bending the head backwards. Headlamp for assuring the optimal lighting intraorally was used. If necessary, cotton rolls and toothbrush were used for superfluous saliva and plaque removal, respectively. However, the teeth examined were wet. In line with the Judgement Criteria of MIH (1) the buccal, occlusal and palatinal/lingual surfaces of all FPMs (16,26,36,46) were examined systematically, as well as the buccal surfaces of all permanent incisors (12,11,21,22,32,31,41,42). Characteristics like opacities (white-cream/yellow-brown colour) >1mm, post eruptive breakdown (PEB), atypical restorations and previous extractions judged as due to MIH were registered [Weerheijm et al., 2003]. In the cases where two scores were registered on the same surface, the most severe score was chosen (opacity < post eruptive breakdown (PEB) < atypical restoration). The participant was recorded with MIH when at least one FPM was affected.

In addition to the clinical examination, each participant's guardian was asked to answer a questionnaire designed to provide information possibly related to the aetiology of MIH, and included questions regarding relevant medical information on mother's pregnancy, birth and the child's first five years of life. In the questionnaire, the respondents were asked about the following: 1) Was the child born prematurely, and the number of weeks early; 2) Child's birth weight in grams; 3) Mother's health and medication during the pregnancy; 4) Complications during the delivery; 5) Child's past illnesses; 6) Child's medication in the first five years of life; 7) Child's current diseases.

Statistical analysis

The statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, Inc. Chicago, IL, USA version 20). The absolute frequencies and proportions were obtained for data analysis (descriptive) and bivariate analysis (Chi-squared test) for testing possible associations between the variables. The level of significance was set at 5%. Calculation of weighted kappa (κw) was undertaken using a spreadsheet programme (Microsoft Excel). Cohen's kappa was rated as suggested by Landis and Koch [1977]: < 0.40 = poor agreement; 0.41-0.60 = moderate agreement; 0.61-0.80 = substantial agreement; 0.81-1.0 = very good agreement.

Ethical considerations

The study was performed according to the guidelines of Good Clinical Practice and the Declaration of Helsinki, and approved by the local Regional Committee for Medical Research Ethics in Oslo, Norway (REK no. 2013/2299). Written, informed consent was obtained from all participants' guardian/relatives, and could be withdrawn at any time and for any reason. The anonymity of the participants was provided.

Results

The results from the calibration showed an inter- and intra-observer variation for the three examiners expressed by weighted kappa (κw) of 1.00 and 1.00, respectively. The inter-observer variations for the three examiners when compared to the scorings of a previously calibrated clinician (KRS) are shown in Table 1.

The prevalence and distribution of MIH

Of the 104 8- and 9-year-olds who were invited

Examiner	1.examination	2.examination
	KRS	KRS
E1	0.83 (0.69-0.97)	0.83 (0.70-0.97)
E2	0.84 (0.71-0.98)	0.87 (0.74-1.00)
E3	0.81 (0.79-0.85)	0.82 (0.79-0.85)

TABLE 1 The inter-observer variations for the three examiners (E1-E3) compared to the scorings of a previously calibrated clinician (KRS) after 1. and 2. examination during the calibration.

to participate, one was not present at school on the examination day, and therefore 103 children (62 boys and 41 girls) were included in the study. The prevalence of MIH was 11.7% (12 of 103 children). The girls were more frequently affected by MIH than the boys; 14.6% and 9.7%, respectively ($p<0.05$).

Of the 12 children affected by MIH, 4 had one or two teeth affected, 1 had three, while 7 had 4 or more than 4 teeth affected with MIH (Fig. 1). Most of the children (n=6) had 2 FPMs affected, while 5 had either, three, four or five incisors with MIH (Fig. 1).

The maxillary first permanent molars (FPM) (16 teeth) were 1.8 times more frequently affected than the mandibular FPM (8 teeth); $p < 0.02$. The maxillary first molars on the right side (9 teeth) were more often affected than the molars on the left side (7 teeth). The same pattern was also observed in the mandible. The maxillary incisors (14 teeth) were 2.3 ($p<0.05$) times more frequently affected than the lower ones (6 teeth).

The same teeth were affected on both sides in 4 out of 12 participants with MIH, showing a symmetrical distribution of the enamel disturbances in one third of the cases.

Characteristics of the affected first permanent molars (FPM) and incisors

Of the 23 affected FPMs, 7 (30%) had opacities (>1mm), 8 (35%) had post eruptive breakdown (PEB), and 8 (35%) had atypical restorations (Fig. 2). In the maxilla (tooth 16 and 26) 11 of the 15 affected FPM had PEB or atypical filling, while in the mandible (tooth 36 and 46) 6 of the 8 affected FPM had PEB or atypical filling (Fig. 2). No molars had been extracted due to MIH. The occlusal surfaces in all 23 affected FPMs had enamel disturbances, while in 16 of these teeth the buccal surfaces were also affected.

A total of 17 incisors were found to be affected, mainly with opacities (>1 mm) (Fig. 3). In the maxilla, only 2 of the 14 affected incisors (tooth 12 and 21) were registered with PEB, while 10 of 14 had opacities. In the mandible, all eight affected incisors had opacities (Fig. 3). All enamel disturbances on the incisors were localised on the buccal surfaces.

The questionnaire related to the health condition

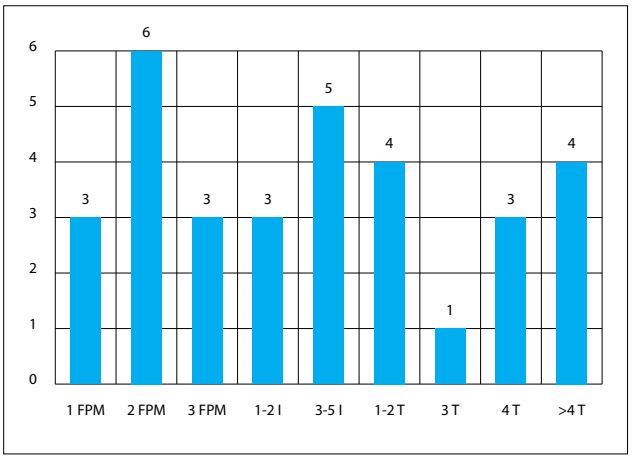

FIG. 1 The distribution of affected first permanent molars (FPMs), incisors (I) and teeth (T) on individual level.

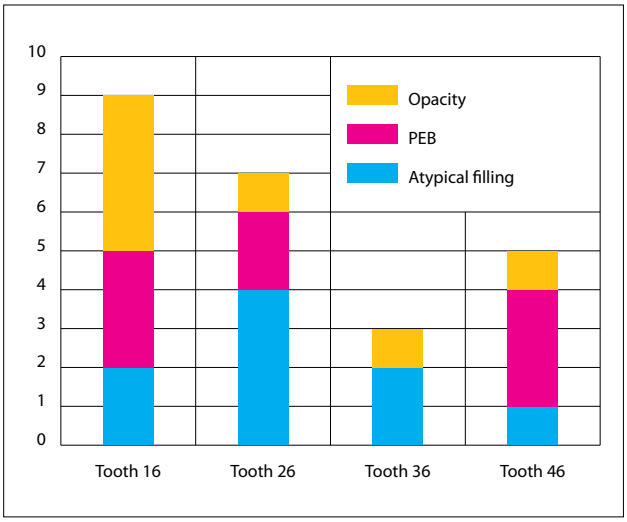

FIG. 2 The distribution and severity of the affected FPM (n=23).

FIG. 3 The distribution and severity of the affected incisors (n=17).

before, during and after childbirth revealed that 5 of the 12 individuals with MIH reported illnesses in the first five years of life, in contrast to 18 of the 92 unaffected children. The use of antibiotics due to tonsillitis was associated with a higher prevalence of MIH (41.7% vs. 19.6%).

Discussion

Molar Incisor Hypomineralisation (MIH) was a common finding among the 8- and 9- year-olds in the city of Kljuc, Bosnia and Herzegovina, where a prevalence of 11.7% was found. Most of the children had at least 4 teeth affected. The prevalence was higher among girls than boys, and the FPMs in the maxilla were 1.8 times more frequently affected than in the lower jaw.

The prevalence of MIH in European countries varies from 2.4% and 37.5% [Jälevik, 2010]. This great variation could reflect a real difference between countries, but could also be explained by lack of standardisation of the methodology in the studies [Elfrink et al., 2015]. Several guidelines have been developed with the intention to make prevalence studies on MIH comparable, and recently new forms of the charting have been proposed with the intention to standardise the studies [Ghanim et al., 2015]. Further, it has been recommended to include a study group large enough to be representative of the selected study population [Elfrink et al., 2015]. If the study group includes several age groups, an average for each age group should be calculated separately [Jälevik, 2010]. Since all three central schools in the city of Kljuc were included in the present study, the population selected was considered as representative of the area. However, the prevalence data was not calculated for each age group separately (2004/2005), since the intention was rather to keep a larger study group. According to the Judgement Criteria of MIH [Weerheijm et al., 2003], the best age for a cross sectional study of MIH is 8 years. At this age, in most children, all four first permanent molars and the majority of the incisors are erupted, and the signs of MIH are still present and not disturbed by dental caries and restorations [Weerheijm et al., 2003]. On the other side, at this age permanent canines are not erupted, and therefore any defects on these teeth could not be registered. One possible confounder in the present study could be the caries prevalence in Bosnia-Herzegovina: the caries experience expressed by DMFT among 6-year-olds in Bosnia-Herzegovina is reported to be between 6.7 and 9 [Deljo et al., 2013; Markovic et al., 2013], higher than reported in Norway [Wigen and Wang, 2010] and several other Western European countries [Marthaler, 2004]. Therefore, there is some risk that some of the atypical fillings registered in the present study sample may have been placed due to dental caries, and not MIH. Though the clinical examination was carried out under simple working conditions, in a classroom in a regular chair and using headlamp, it was easy to determine a diagnosis. It is nevertheless important to emphasise that the examination was conducted by a calibrated observer with a very good inter- and intra-observer agreement, which strengthens the present results and findings.

In the present study the prevalence was found to be 11.7% among 8-and 9-year-olds, similar to the reports from two published studies conducted in Bosnia-Herzegovina [Janković et al., 2014; Muratbegovic et al., 2007] where 12.3% and 12.8% of the children were affected by MIH, respectively. A similar study from Slovenia [Grošelj and Jan, 2013] among 6 years old reported a prevalence of 21.4%, while in Kaunas, Lithuania [Jasulaityte et al., 2007] a slightly lower prevalence of 9.7% was reported.

The prevalence of MIH in Bosnia-Herzegovina was higher in girls than in boys (14.6% vs. 9.7%, respectively). This is in accordance with some studies [Chawla et al., 2008; Dietrich et al., 2003; Lygidakis et al., 2008], while others report no gender-related difference [Allazzam et al., 2014; Garcia-Margarit et al., 2014; Muratbegovic et al., 2007; Petrou et al., 2014].

Most of the children with MIH had at least 4 teeth affected. Of the 15 affected FPM in the maxilla, 11 had PEB or filling, and 6 of the 8 affected FPM in the lower jaw. This illustrates that most of the children had a severe form of MIH. Even though no extractions due to MIH were registered, probably due to the low age of the children, the condition was more severe among the affected children in Bosnia-Herzegovina compared with findings in other countries [Jasulaityte et al., 2007; Jasulaityte et al., 2008]. This high level of severity of MIH among these young children highlights the recommendations of previous investigators who emphasized the importance of an early diagnosis of MIH, in order to prevent development of more severe defects over time [Oliver et al., 2014; Petrou et al., 2015]. In addition, the study by Petrou et al. [2015] found that the number of affected tooth surfaces was positively correlated with the MIH severity, also supported by the findings in the present study. Previous studies have shown that the maxillary FPM and incisors are more frequently affected by MIH than the lower molars and incisors [Leppäniemi et al., 2001; Martínez Gómez et al., 2012; Muratbegovic et al., 2007]. This was also found in the present study where the FPM in the maxilla were 1.8 times more frequently affected than the mandibular, and the maxillary incisors were 2.3 times more frequently affected than the mandibular incisors. It should also be pointed out that there have been studies which have found the opposite [Chawla et al., 2008; Muratbegovic et al., 2007]. As far as we know, there is no clear explanation for the maxillary teeth to be more affected than the lower, however, Kono et al. [2002] showed that the enamel of the buccal surfaces of the maxillary FPM is thinner than that of the lower molars.

By use of the questionnaire, the present study revealed that 5 of the 12 affected children had a history of penicillin use during the first five years of their childhood, mainly due to adenoid infections. This was also found in a study among 12-year-old Bosnian children [Muratbegovic et al., 2007]. The results in the present study should be interpreted with caution as the study sample was small. However, the questionnaire was designed to identify relevant medical information and was relatively easy to answer. There were no given answers, and the relatives could respond freely to the questions. Therefore, it is assumed that the answers show large portions of the truth in relation to the questions asked. Previously, it has been suggested that infections can have a disturbing effect on ameloblastic activity during enamel mineralisation, however it is important to remember that it is difficult to distinguish whether it is treatment with penicillin or the actual infectious disease that is the influencing factor, or the combination of these [Alaluusua, 2010]. Several possible causes such as high fever, hypoxia, hypocalcemia, antibiotics and dioxins in the breast milk have been mentioned as risk factors for MIH [Alaluusua, 2010; Allazzam et al., 2014; Fagrell et al., 2011; Lygidakis et al., 2008]. There is a need for more studies with larger study samples to clarify possible aetiological factors causing the enamel defects defined as Molar incisor hypomineralisation (MIH).

Conclusion

The results showed a high prevalence of MIH among the 8-and 9-year-olds (11.7%), and many of the affected teeth had severe lesions. Detailed knowledge of the distribution of MIH at tooth surface level and recording the severity grade of affected teeth are beneficial in targeting the individual treatment need.

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Conflict of interest

The authors report no conflicts of interest, and are alone responsible for the content and writing of the paper.

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