Molar Incisor Hypomineralization in Colombia: Prevalence, Severity And Associated Risk Factors

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Aim: *To determine prevalence, severity, and risk factors associated with Molar Incisor Hypomineralization (MIH) in schoolchildren between 6 and 15 years of age in Medellin, Colombia.* ***Study design:*** *We conducted a retrospective observational study including 1.075 children born and residing in Medellin, Colombia. A structured questionnaire addressing gestational period and first three years of child's life was administered to biological mothers. Two calibrated examiners established MIH diagnosis following the European Academy of Paediatric Dentistry criteria. Data were analyzed using descriptive statistics, bivariate analysis, and linear regression with a 5% significance.* ***Results:*** *Study population was predominantly male (70.7%), average age was 9.3±1.9 years. Prevalence of MIH was 11,2%. The majority of defects (85%) were mild. MIH was associated with alterations during last gestational trimester, type of childbirth and respiratory problems.* ***Conclusion.*** *MIH prevalence in schoolchildren between 6 and 15 years of age was 11.2%, being mild defects more frequently found. MIH was associated with different factors during pregnancy and the first three years of life.*

Keywords*: MIH, Children, Colombia*

INTRODUCTION

Molar incisor hypomineralization (MIH) is an enamel defect of systemic and multifactorial origin affecting at least one permanent molar, and may –or may not- be associated to permanent incisors[1]. Teeth affected by MIH exhibit well-demarcated opacities that range in color from white, cream, yellow, to dark brown, and with or without loss of structure[2]. Similarly, the exhibit reduced mineral, hardness, and elastic modulus, as well as increased quantities of protein, carbon, and carbonate[3]. In addition, they are more porous, and present an underlying chronic condition, evidenced by the increase in pulpal innervation density, and immune cell accumulation[4]. Clinically, these alterations produce hypersensitivity, which, on one hand, leads to limited oral hygiene on behalf of the patient, favoring biofilm build-up and development of dental caries lesions[5], and on the other hand, making difficult the action of local anesthetics[4]. These characteristics make MIH patients require up to 10 times more treatment than patients without this condition, requiring more invasive treatments, experiencing dental fear and anxiety, and thus displaying issues with behavior management and implementation of dental treatment[6].

Several studies have addressed the association of MIH with different etiological factors, and have discussed prenatal factors such as tobacco use and maternal illnesses, perinatal factors such as preterm birth and low birth weight, and postnatal factors including diseases during the first three years of life such as fever, infections, and use of antibiotics[7-9]. However, systematic reviews suggest that none of the analyzed risk factors is a direct cause of MIH[10,11].

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The worldwide prevalence of MIH is estimated to be 14,2 %[12], however, data from Latin America are limited to those from Argentina[13], Brazil[14,15], Mexico[9], and Uruguay[16]. Therefore, in this study we have determined the prevalence and severity of MIH, as well as its association with etiologic factors in schoolchildren between 6 and 15 years of age in Medellin, Colombia.

MATERIALS AND METHOD

The Ethics Committee of CES University (Medellin, Colombia) approved this study (Protocol number 37). Participating schools, children, and legal guardians provided informed signed consent, in agreement with the principles established for medical research in human subjects in the Declaration of Helsinki.

We conducted an observational epidemiological study between June 2011 and October 2013 in a sample of schoolchildren (n= 1.075) between 6 and 15 years of age. Participants attended private or public schools in the city of Medellin, and were selected by stratified random sampling according to school size. The city of Medellin is located in the State of Antioquia (Colombia) and has a population of 2 million inhabitants (2011). By national regulation, the entire population has access to fluorinated salt (220 ppm F^-). Based on a previous study by da Costa-Silva and colleagues[11], our initial estimated study population size was of 2.000 schoolchildren with a MIH prevalence of 19.8%, assuming a sampling error of 1.5%, and a 95% confidence interval.

Schoolchildren between 6 and 15 years of age, born in the city of Medellin, with fully erupted first molars and permanent incisors, complete etiological factors assessment questionnaire, and signed informed consent were included in this study. Schoolchildren with restored teeth, crowns, bands, anterior teeth opacities, undergoing orthodontic treatment, and diseases associated with dental malformations, dental fluorosis, amelogenesis imperfecta, and/or previous dentoalveolar trauma were excluded from the study. Questionnaires filled out by adoptive parents, legal guardians (non-biological), or other family members were excluded from the analysis in order to guarantee trustworthy answers from the biological mother regarding pregnancy and child's first three years of life.

MIH diagnosis and associated risk factors

Clinical evaluation was performed at each school, in a classroom using portable dental equipment with artificial light, wooden spatula, flat mirror number 5, and dental probe recommended by the World Health Organization. After cleaning and drying teeth with sterile gauze, two calibrated examiners (intraexaminer reliability: kappa = 0.87; interexaminer reliability: kappa = 0.85) evaluated all teeth present in the mouth, and diagnosed MIH based on the criteria proposed by the European Academy of Paediatric Dentistry[2]. Opacities greater than 1.0 mm in diameter were classified according to color (white-cream, yellow, or brown); and to severity as mild (opacity without loss of structure) or severe (opacity with loss of structure compromising enamel and/or dentin, with atypical restorations, and/or exodontia due to hypomineralization). Diagnosis of MIH was based on the most severe defect present in molars or permanent incisors[14].

A structured questionnaire with single-answer questions was previously validated in a group of 25 mothers attending dental visit. The validated questionnaire and clear instructions on how to correctly fill it out were sent to biological mothers of all schoolchildren participating in this study. Questions were organized in order to obtain information regarding the last trimester of the pregnancy (infections, diseases, or hypocalcemia), type of birth (considering full term those children born between the 37th and 42nd week of pregnancy, and preterm those born before the start of the 37th week of pregnancy), low birth weight (< 2.500 gr), prolonged lactation (≥ 2 years), respiratory problems, any high fever (≥ 39 ºC) in the first year of the child´s life, urinary tract infection, chickenpox, and use of antibiotics (amoxicillin, penicillin, and/ or cephalosporin) during the first three years of the child's life, as described in previous studies[7-9,11] (Figure 1).

Figure 1. Survey on etiological factors associated with MIH.

Questionnaire on etiological factors associated with Molar Incisor Hypomineralization (MIH)

Child's name: Current age (years):

Name of respondent:

Relationship to child: □ biological mother □ biological father □ other

Did the mother experience any illness during the third trimester of pregnancy? (Maternal illness, infection, and/or maternal hypocalcemia)?

□ Yes □ No

How many weeks did the pregnancy last until the baby was born?

What was your baby's weight at birth?

For how many months was your child breastfed?

Did your child have any respiratory diseases during his/her first three years of life?

□ Yes □ No If so, which one?

Did the child have any episodes of high fever (≥ 39 ºC) during his/her first three years of life?

□ Yes □ No

Did the child have measles during his/her first three years of life?

□ Yes □ No

Was the child given antibiotics (amoxicillin, penicillin, or cephalosporin) during his/her first three years of life?

□ Yes □ No

Statistical analysis

Data were collected, tabulated, and analyzed using Statistical Package for Social Sciences version 21.0 for Windows (SPSS Inc., Chicago, IL, USA) software. Qualitative variables were described as relative frequencies and expressed as percentages. The prevalence of MIH was calculated by point estimates and confidence interval (95%). Association of MIH with gender and age was evaluated performing a Chi-square test. Odds ratio (OR) was calculated to quantify the risk of presenting MIH according to prenatal and

postnatal conditions. In addition, an exploratory multivariate analysis was performed using logistic binary regression to adjust OR that were significant in bivariate analysis. For all analyses, level of significance was set at 5%.

RESULTS

In this study, a total of 1.075 schoolchildren were included, which were predominantly male (70.7%), and had an average age of 9.3±1.9 years, being 50% between 8 and 10 years of age. MIH was diagnosed in 120 patients (11.2%), corresponding to 358 teeth, with a confidence interval of 95% (9.3%; 13.1%). Prevalence by gender was 11.7 % in males, and 10.4 % in females, however this difference was not statistically significant (Table 1). Of teeth presenting MIH (358), opacities were observed in 508 surfaces. The majority of defects (85%) were classified as mild, being white the most frequent color (52%), followed by yellow (47%), and only one case presented brown opacity. Rough appearance was observed in 90.8% of teeth (Table 2).

Alterations during last gestational trimester, type of childbirth, low birthweight and respiratory problems and urinary tract infection, behaved as risk factors for MIH in our sample. However, upon adjusting OR by logistic regression, low birthweight, and urinary tract infection no longer behaved as risk factors (Table 3).

Table 1. Number and percentage of children with and without Molar Incisor Hypomineralization (MIH) by gender and age. Medellin, 2011-2013.

Variable		MIH				p–value*
	n %	MIH > 0		MIH = 0		
		n	%			
Gender	Female	46	10.4	397	89.6	0.561
	Male	74	11.7	558	88,3	
Age group	6–8 years	33	8.2	368	91.8	0.061
	8.1–10 years	54	13.1	357	86.9	
	10.1–15 years	33	12.5	230	87.5	

*Chi-Square test, $\alpha = 5$

Table 2. Severity, color, and enamel structural changes in patients with Molar Incisor Hypomineralization. Medellin, 2011-2013.

Variable		n	%
Severity	Mild	102	85
	Severe	18	15
Color	White	63	52.5
	Yellow	56	46.7
	Brown	1	0.8
Changes in enamel structure	Rough	109	90.8
	Smooth	11	9.2

Table 3. Distribution of variables by prenatal and postnatal conditions in patients with and without Molar Incisor Hypomineralization (MIH). Medellin, 2011-2013.

Variables		MIH < 0	MIH = 0	OR (CI95%)	p-value*	OR^F (CI95%)
Alterations during last gestational trimester (maternal illness or infection and/ or maternal hypocalcemia)	Yes	18	63	2.50 (1.42; 4.38)	0.001*	2.63 (1.42; 4.88)
	No	102	892			
Type of childbirth	Full term	52	246	2.20 (1.49; 3.25)	0.000*	2.15 (1.46; 3.24)
	Preterm (before the start of the 37th week of pregnancy)	68	709			
Low birthweight (< 2.500 gr)	Yes	34	216	1.35 (0.88; 2.07)	0.162	1.26 (0.79; 2.03)
	No	86	739			
Prolonged maternal feeding (≥ 2 years)	Yes	114	880	0.62 (0.26; 1.45)	0.264	-
	No	6	75			
Respiratory problems	Yes	82	438	2.55 (1.70; 3.82)	0.000*	2.48 (1.63; 3.78)
	No	38	517			
Any fever (≥ 39 ºC) in the first year of the child's life	Yes	29	190	1.28 (0.82; 2.01)	0.274	-
	No	91	765			
Urinary tract infection	Yes	3	10	2.4 (0.67; 8.93)	0.170	3.3 (0.82; 13.2)
	No	117	945			
Chickenpox	Yes	1	8	0.99 (0.12; 8.02)	0.996	-
	No	119	947			
Use of antibiotics (amoxicillin, penicillin, and/or cephalosporin)	Yes	27	219	0.98 (0.62; 1.54)	0.915	-
	No	93	736			

MIH: Molar Incisor Hypomineralization; OR: Odds Ratio; *statistically significant p-value <0.05; OR^F: adjusted Odds Ratio.

DISCUSSION

In this study, we have determined a prevalence of MIH of 11.2% in schoolchildren between 6 and 15 years of age in Medellin, Colombia. To our knowledge, this is the first report on prevalence and associated risk factors of MIH in Colombia. Our results are similar to those reported for MIH prevalence in Montevideo–Uruguay (11.8 %)[16], and in Araraquara – Brazil (12.3 %)[15], and is lower than that reported in Buenos Aires – Argentina (15.9 %)[13] and in Mexico City–Mexico (15.8 %)[9]. When analyzed by continent, MIH prevalence is highest in South America[12,17]. However, divergence in global results may be due to type of population sample used in each study (sample size, participants' age, inclusion and exclusion criteria, molar and incisor eruption state), clinical diagnostic criteria used, calibration process, training, and the way clinical evaluation is performed[17].

In this study, MIH was diagnosed if there was at least one first permanent molar affected, whether it was associated or not to permanent incisors. Schoolchildren with opacities only in incisors were not diagnosed with MIH, since by definition[18], it does not follow the classical pattern of this type of enamel defect, and may therefore introduce errors in diagnosis and prevalence.

Weerheijm *et al*, recommend diagnosing MIH from 8 years of age[2], however, in this study –as well as that by Souza et al.,- schoolchildren from 6 years of age with fully erupted first permanent molars were included[7]. This may have influenced the estimated prevalence of MIH in our population sample, however it was a methodological strategy that considered the current Colombian reality regarding dental caries and the association between MIH and dental caries[5], aiming at early diagnosis, avoiding development of dental caries, and the beginning of restorative cycle and/or loss of dental structure.

Regarding severity, mild defects were the most prevalent in our population sample (85%), which is in agreement with previous studies assessing MIH severity[14,19]. Altogether, these studies suggest that mild defects are the most frequently encountered. Unlike teeth with normal enamel, teeth affected by MIH exhibit prisms and enamel crystal alterations, less mineral content, and significantly inferior mechanical properties, hardness, and elastic module[20]. Using polarized light microscopy, Jälevik and Noren found that yellow/brown opacities are more porous than white/cream opacities[21]. Thus, lesion severity, associated symptoms, eruptive state, patient's age, patient and family's expectations, as well as cost-benefit ratio are factors that should be considered when deciding treatment[22].

Prenatal, perinatal, and postnatal factors have been previously associated to MIH[7-9,11]. With regards to prenatal alterations, in this study an association between alterations during last gestational trimester and MIH was identified. This period is critical since initiation of amelogenesis of first molars and incisors coincide[23]. Additionally, recurrent high fever, viral infections, hypertension, diabetes, frequent use of antibiotics, and malnutrition during prenatal period have been associated to MIH[24].

A higher prevalence of MIH was also found in premature children and children with respiratory problems. In general, these children present chronic health alterations that may affect amelogenesis, specifically calcium ion metabolism, which together with sodium and phosphorous ions play an important role in the dental enamel mineralization stage[25,26]. In addition, premature children present incomplete lung development, which may compromise oxygen supply to ameloblasts, affecting their proper function[27].

Other factors frequently associated with MIH such as low birthweight[27], prolonged maternal feeding[28], frequent episodes of high fever[7], urinary tract infection[9], chickenpox[29], and use of antibiotics[8] were not found to be significantly associated. In general, ameloblasts have been described as highly specialized cells that are extremely sensitive to local and systemic alterations. Any disturbance at the end of pregnancy or during the first three years of a child's life may induce changes in ameloblast modulation (pH cycle) during the mineralization stage[26]. On the other hand, because of the design and methodology of our study, we can only establish associations rather than cause-and-effect. To date, evidence regarding risk factors and etiology of MIH is inconclusive[10,11]. Therefore, the understanding of MIH etiology represents a great challenge that must be overcome. Future studies should be designed to identify and understand how these factors may influence amelogenesis biomolecular events.

CONCLUSION

The Prevalence of MIH in the city of Medellin was 11,2%, of which 52% of lesions were classified as mild. A significant association between MIH and complications during the last gestational trimester, low birthweight, respiratory problems, and urinary tract infection were identified in our study population.

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