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Original Article

Molar-Incisor Hypomineralization in Schoolchildren of Manaus, Brazil

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Abstract

Objective: To analyze the prevalence and severity of Molar Incisor Hypomineralization (MIH) and its relationship with dental caries in public school children in Manaus/AM. **Material and Methods:** Overall, 2,062 primary school children aged 6-10 years were examined to obtain MIH, DMFT, dmft and DDE indexes. The participation of five schools in each district of the city of Manaus was randomly determined, totaling 40 schools, and in each of them, two classes of each grade of elementary school in two shifts were selected, totaling 10 classes. Clinical examinations were conducted by two previously calibrated examiners in school environment under natural lighting. Data collected were submitted to descriptive statistical analysis by Chi-square, Fisher's Exact and Mann-Whitney tests at 5% significance level. **Results:** The prevalence of MIH in Manaus was 9.12% and no significant association with gender and age of schoolchildren was found. The mandibular arch was the most affected, with greater number of teeth being affected on the left side. The most frequently affected teeth were the mandibular permanent first molars, followed by maxillary counterparts and maxillary/mandibular central incisors. The most frequent diagnosis was mild MIH. The DMFT of children with MIH was 1.58 and dmft was 2.47, higher than those of the unaffected group. A correlation was found between DDE and MIH. **Conclusion:** Early diagnosis of MIH is imperative, since children affected show high risk for the development of dental caries.

Keywords: Epidemiology; Child; Caries; Dental hypomineralization.

Introduction

Despite having been identified clinically in Sweden in the late 1970s [1], the expression of molar-incisor hypomineralization (MIH) was first suggested in 2001 to describe a qualitative alteration of enamel of systemic origin that affects 1 to 4 permanent first molars, frequently also affecting permanent incisors [2].

Clinically, it is characterized by demarcated white, cream, yellow or brown opacities, smooth surface, and normal enamel thickness and, in the most severe cases, the hypomineralized enamel may become porous and break easily, shortly after eruption, mainly under the influence of masticatory forces, leaving dentin unprotected [3]. Thus, MIH may lead to the development of caries, presence of atypical restorations and ultimately extractions [4,5]. The literature reports a positive association between the presence of this defect and dental caries [4,6-7].

Teeth affected by MIH are often sensitive to thermal, chemical and mechanical stimuli, making anesthetic action difficult and consequently the management of the child during dental treatment [8,9], in addition to creating serious aesthetic problems [10]. It is not easy to restore a tooth affected by MIH and treatment is ten times longer than dental caries treatment [11,12].

The etiology of MIH cannot be totally explained, but a variety of environmental and systemic factors that sensitize the ameloblasts in the prenatal, perinatal periods, and during the first three years of childhood appear to be associated [13-17]. Genetic predisposition cannot be ruled out [18,19].

MIH is currently recognized as a worldwide dental health problem and epidemiological data from several countries have been constantly published. Its prevalence ranges from 2.4 to 40.2% among studies worldwide [1,4,20-21]. Epidemiological knowledge of MIH is an important indicator for defining actions to promote oral health. In Brazil, data on this condition as well as its prevalence in the population are scarce and nonexistent in the Northern states. The development of a special care program with emphasis on preventive and restorative measures is of utmost importance in an attempt to maintain the affected teeth in the oral cavity. This fact motivated the present study that aims to establish the prevalence and severity of MIH, as well as its association with dental caries in schoolchildren aged 6-10 years in the city of Manaus (AM).

Material and Methods

This cross-sectional study invited to participate 2,800 of the 102,169 children aged 6-10 years enrolled in public schools of Manaus, Amazonas, Brazil, in the year 2014. The municipality of Manaus, located in the Brazilian Northern region, northeastern state of Amazonas, has human development index (HDI) of 0.737 and 351 municipal elementary schools, of which 264 are located in urban areas and only 87 in the rural areas. Fluoridation of the public water supply is non-existent. The study was approved by the Ethics Committee of the Federal University of Amazonas-UFAM (Protocol No. 515 026). The parents and/or guardians of children were informed about the purpose

of the study and methodology, and signed the informed consent form (ICF), authorizing their children to participate in the study.

The participation of five schools in each district of the city of Manaus was randomly determined, totaling 40 schools, and in each of them, two classes of each grade of elementary school in two shifts were selected, totaling 10 classes (equiprobabilistic sampling). Then, through their legal representatives, children selected were invited to participate.

The inclusion criteria were as follows: children aged 6-10 years, enrolled in municipal public elementary schools, natural from and resident in Manaus, and all permanent first molars erupted in the oral cavity (at least 2/3 of the crown evident in the arch and free from gingival tissue). The exclusion criteria were: malformation of dental enamel associated with syndromes, dental fluorosis, amelogenesis imperfect, and presence of fixed orthodontic appliances.

The calibration of examiners was conducted with 50 children treated at the Department of Pediatric Dentistry, Faculty of Dentistry, Federal University of Amazonas to test the reliability of the study, of instruments and tests. The Kappa inter-examiner agreement for variables dental caries, MIH and enamel developmental defects (DDE) were 0.89, 0.87 and 0.90, respectively. The intra-examiner agreements were above 0.88 for dental caries, MIH and DDE.

The presence of dental caries was recorded through the decayed, missing and filled teeth index (DMFT for permanent and dmft for primary teeth), following the criteria of the World Health Organization [22]. Not fluorotics enamel defects (DDEs) in deciduous dentition were also investigated in accordance with modified enamel defects index proposed by the International Dental Federation [23]. These independent variables were dichotomized as follows: presence or absence of dental caries in permanent (DMF-T> 0 and DMF-T = 0) and deciduous teeth (dmf-t> 0 and dmf-t = 0); absence or presence of enamel defects in deciduous teeth (EDD > 0 and EDD = 0).

To determine the prevalence and severity of MIH, the criteria of the European Academy of Pediatric Dentistry [3] were used: demarcated enamel opacities were considered mild defects; post-eruptive fractures, atypical restorations, and extractions due to MIH were considered severe defects. Non-erupted teeth were also considered. Demarcated opacities that were > 2 mm [24] in diameter were considered, which were divided according to color: white, yellow or brown [1,25]. The differential diagnosis between MIH injuries and dental caries white spots was based on criteria of previous study [6].

Clinical examinations were conducted by two previously calibrated examiners in school environment under natural lighting. Participants were instructed to brush their teeth before examination and during examination and were positioned to receive maximum illumination. Teeth to be investigated were dried with sterile gauze. Oral flat mirrors and periodontal CPI probes were used during examination.

The presence or absence of MIH (MIH > 0 and MIH = 0) was considered the dependent variable. Its relationship with clinical variables (caries in deciduous or permanent dentition, presence of DDEs in deciduous teeth) and demographic variables (age, gender, and area of residence) was

evaluated using the Mann-Whitney and Kruskal-Wallis tests. The odds ratio (OR) was used at 5% significance level to analyze the strength and direction of association. Data were analyzed using Stata SE, version 10.1 (Texas, USA).

Results

Of a total of 2,800 children aged 6-10 years invited to participate in the study, 2,062 were included in the sample. The reason for the exclusion of 738 children was one of the following: not returning the signed informed consent form (n = 309); presence of syndromes associated with tooth enamel malformation (n = 12); amelogenesis imperfecta (n = 3); absence of at least one permanent molar erupted in the oral cavity (n = 176); use of fixed appliances (n = 6); refusal to be examined due to dental fear (n = 7); missing on the day of examination (n = 225).

The prevalence of children with MIH was 9.12% (n = 188). When considering the prevalence of the change in urban (9.2%, n = 158) and rural areas (8.7%, n = 30), no statistically significant difference was found between the two areas. No statistically significant difference was found between genders (p = 0.541), since it was present in 9.5% of boys (98 of 1.031) and 8.7% of girls (90 of 1.031). The mean age of children with MIH was 8.45 years (± 1.31) and those unaffected by MIH was 8.58 years (± 1.24).

Table 1 shows the presence of MIH with respect to variables area, gender, age, DMFT, dmft and DDE.

Table 1. Descriptive analysis of the study variables.

Variable	MIH		P-value	Total
	No	Yes		
Zone (n; %)			0.794	
Urban	1561 (90.8)	158 (9.2)		1719 (100)
Rural	313 (91.3)	30 (8.7)		343 (100)
Gender (n; %)			0.541	
Male	933 (90.5)	98 (9.5)		1031 (100)
Female	941 (91.3)	90 (8.7)		1031 (100)
Age (mean, sd)	8.58 (1.24)	8.45 (1.31)	0.226	8.57 (1.25)
dmft (mean, sd)*	2.08 (2.42)	2.47 (2.59)	0.028	2.11 (2.44)
DMFT (mean, sd) **	0.79 (1.21)	1.58 (1.59)	<0.001	0.86 (1.26)
DDE (n, %) **			<0.001	
Yes	111 (79.3)	29 (20.7)		140 (100)
No	1763 (91.7)	159 (8.3)		1922 (100)

Table 2 shows the average number of teeth affected by MIH according to gender, with similar average among boys (4.06 ± 1.51) and girls (3.74 ± 1.53) (p = 0.161). MIH was diagnosed in 735 teeth from 188 children affected. Of these teeth, 546 (74.3%) were first molars: 55.9% (n = 305) were lower molars and 44.1% (n = 241) were upper molars. Incisors were less affected (n = 189; 25.7%) and of these, upper and lower central incisors presented the same proportion of MIH (p = 0.812).

Table 2. Average number of teeth affected by MIH according to gender.

MIH	Male	Female	Total	p-value
N affected teeth	398	337	735	
Mean (SD)	4.06 (1.51)	3.74 (1.53)	3.91 (1.53)	0.161
N affected molars	296	250	546	
Mean (SD)	3.02 (0.88)	2.78 (0.98)	2.90 (0.94)	0.105
N affected incisors	102	87	189	
Mean (SD)	1.04 (1.12)	0.97 (1.18)	1.01 (1.15)	0.507

Regarding the hemi-arch, there were 351 (47.8%) teeth affected on the right side and 384 (52.2%) on the left side, indicating a statistically significant difference for this variable (p = 0.019) (Table 3).

Table 3. Distribution of teeth affected by MIH according to arch and hemi-arch affected.

Affected tooth	Upper arch[a]			Lower arch[a]		
	Right hemi-arch[b]	Left hemi-arch[b]	Total	Right hemi-arch[b]	Left hemi-arch[b]	Total
Central incisor	38	44	82[c]	41	43	84[c]
Lateral incisor	0	4	4	12	7	19
First molar	111	130	241	149	156	305
Total	149	178	327	202	206	408

[a]Chi-square test, α = 5%, p <0.001; b p = 0.670; cp = 0.812.

Of the total number of children diagnosed with MIH, 61.7% had changes in the permanent incisors and first molars, while 2.1% showed hypomineralization in only one permanent molar. In most affected teeth, the enamel defect severity was mild (84.7%), manifesting through demarcated opacity whose color ranged from white to brownish, white being the most common (49%). However, 12.2% showed post-eruption fractures, 1.5% showed atypical restorations and 1.5% teeth extracted due to MIH, totaling 15.2% of severe alterations.

Among children with MIH, 67.6% had dental caries in the permanent dentition and 68.1% in the primary dentition. Approximately 73.6% of decayed or filled permanent teeth were first lower molars and 26.4% were first upper molars. It was observed that 220 molars affected by MIH showed association with dental caries, either by the past history (filled teeth) or current history (restored with caries or decayed) (Table 4). Of incisor with MIH, 100% were healthy.

Table 4. Clinical conditions of first permanent molars affected by MIH, n (%).

Dental condition	16	26	36	46	Total
Healthy	85 (76.58%)	98 (75.38%)	60 (38.46%)	72 (48.32%)	315
Decayed	26 (23.42%)	32 (24.62%)	80 (51.28%)	71 (47.65%)	209
Restored with caries	0	0	6 (3.85%)	1 (0.67%)	7
Restored without caries	0	0	3 (1.92%)	1 (0.67%)	4
Extracted	0	0	7 (4.49%)	4 (2.68%)	11
Total	111	130	156	149	546

The DMFT value of schoolchildren affected by MIH was 1.58 (± 1.59) and the dmft was 2.47 (± 2.59), which are higher than values of the total sample; (DMFT: 0.86; ± 1.26), (dmft: 2.11; ± 2.44). Table 5 shows correlation between dental caries in both dentitions of children and MIH (p <0.001 and p = 0.031). Association between MIH and the presence of enamel defects in the deciduous dentition was also found (p <0.001).

Table 5. Bivariate relationship between MIH and the proportion of children with caries experience in deciduous / permanent dentition, need for treatment (NT) related to dental caries and DDE.

Variable	MIH				p-value	OR [CI 95%][b]
	MIH >0		MIH =0			
	n	%	n	%		
Caries in permanent dentition						
DMFT=0	61	32.4	1086	58.0		
DMFT >0	127	67.6	788	42.0	<0.001[a]	2.87 [2.07-4.01]
Caries in deciduous dentition						
dmft=0	60	31.9	1124	60.0		
dmft >0	128	68.1	749	40.0	0.031[a]	1.42 [1.02-1.99]
Need for treatment						
NT=0	32	17.0	646	34.5		
NT>0	156	83.0	1228	65.5	<0.001[a]	2.56 [1.72-3.92]
Enamel defect in deciduous dentition						
DDE=0	159	84.6	1763	94.1		
DDE>0	29	15.4	111	5.9	<0.001[a]	2.50 [1.64-3.92]

Discussion

Even with different protocols and variables considered in epidemiological studies on MIH in Brazil and worldwide, the prevalence observed in Manaus (9.12%) in 2014 proved to be similar to that found in Turkey [26] in 2009 (9.1 % and 9.2%) and India [27] in 2012 (9.2%). However, it was lower than the prevalence found in Brazilian states of the Northeastern and Southeastern regions [6,21,24]. The results of this epidemiological study refer to the prevalence of MIH, considering that the design was characterized by a careful selection, calculation and sample representativeness based on the population of schoolchildren of Manaus.

The average number of teeth affected by MIH was 3.91, higher than the average observed in Hong Kong [4], in some European countries [1,25] and South American countries [28]. However, it was lower than that reported by other authors [5,9], who reported 5.6 and 4.8, respectively. The most commonly observed defect in this study, consistent with literature [14,15,24] was demarcated opacity (84.7%), more frequently white. This finding is not in agreement with that found by previous studies [7,15], which observed greater prevalence of opacities of yellow-brownish color. In this study, the prevalence of severe lesions was 15.2%, higher than that observed in other studies [9,24]. Higher percentage of post-eruption fractures (12.2%) was found in our study compared to that found in Araraquara/Brazil (5.3%) [24]. This may possibly be associated with the feeding of children from Manaus, predominantly composed of coarse-grained flour, which associated with the weak resistance of affected teeth, may contribute to increased susceptibility to fractures in the tooth structure.

The tooth eruption stage is also a significant factor related to the prevalence of MIH, being recommended at least more than half of the visible crown [24]. However, this observation is not always considered [3], which may influence data recorded by different researchers [4,6]. It should also be considered that, according to the International Dental Federation - IDF [23], defects smaller than 1 mm in diameter should not be recorded, as small opacities in the enamel are very common. Thus, this study included only lesions with diameter ≥ 2 mm [5,6,9,28]. Changes with diameter smaller than 2 mm have been considered in a previous study [21] and others did not mention the size [2,4,25], again resulting in inaccuracies regarding the prevalence of MIH.

Caries experience found in Amazonian students examined was low, which facilitated the diagnosis of MIH, as in populations with high incidence of dental caries, lesions can be masked [4,13,24]. This possibly occurred due to the availability of fluoride in toothpastes and the implementation of the "Health in School" Program by the Municipal Administration of Manaus for nearly three years.

The mineralization of the first permanent molars begins at around 32 weeks of intrauterine life, the crown is completed at about four years and eruption occurs at around 6 years of age. The development of incisors occurs a little later. As MIH probably have systemic etiology [13,14,16,26], it seems logical that such defects occur simultaneously in incisors and first molars because the mineralization of these teeth occur at the same time. However, this study corroborates the findings of other studies [1,9], in which the first molars were the most frequently affected, while lateral incisors were the least affected. Similarly to literature, it was observed that lower molars were the most affected [9,25,27], disagreeing with the findings of other authors [4,5,15,24]. As for the side, higher prevalence in the left hemi-arch was found. However, there is no explanation in literature for the higher occurrence in one of the arches, since the period of mineralization of the first molar is identical to maxilla and mandible [15].

Association between caries experience in the permanent dentition and MIH was found [4-6,24,29], unlike the results found in another study [30]. The enamel of molars with MIH is brittle, porous and frequently fractures when occluding with its antagonist, exposing the dentin and favoring the rapid development of carious lesions [3,24]. The clinical appearance and poor resistance of affected teeth contribute to the increase of invasive treatments in the first permanent molars [5,6,24]. The association found between enamel defects in the primary dentition and MIH may suggest that the former are important predictors for the latter [6].

The findings presented in this study reflect the impact of the clinical consequences of MIH on the oral health of children. In order to prevent or reduce the possibility of manifestation of enamel defects, the importance of guidance during prenatal care is emphasized. In situations where defect is already installed, referring to the DDS is very important to establish early intervention [24].

Further studies on the subject in the State of Amazonas should be carried out, since it is important to know the prevalence of this condition in private schools, as well as to evaluate the knowledge of dentists on this enamel defect.

Conclusion

Although most of the affected children have experienced mild enamel defects, this study demonstrated adverse impact of these defects on the development of dental caries lesions, and that the presence of DDE in the deciduous dentition may be an important MIH predictor. Regional differences in the prevalence of MIH require special attention from health professionals, especially in a country where there is need of contextualization of health promotion and prevention actions.

References

1. Koch G, Hallonsten AL, Ludvigsson N, Hansson BO, Holst A, Ullbro C. Epidemiologic study of idiopathic enamel hypomineralization in permanent teeth of Swedish children. Community Dent Oral Epidemiol 1987; 15(5):279–85.

2. Weerheijm KL, Jalevik B, Alaluusua S. Molar-incisor hypomineralization. Caries Res 2001; 35(5):390–1.

3. Weerheijm KL, Duggal M, Mejàre 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, 2003. Eur J Paediatr Dent 2003; 4(3):110–13.

4. Cho SY, Ki Y, Chu V. Molar incisor hypomineralization in Hong Kong Chinese children. Int J Paed Dent 2008; 18(5): 348–52.

5. Muratbegovic A, Markovic N, Selimovic MG. Molar incisor hypomineralization in Bosnia and Herzegovina: prevalence, etiology and clinical consequences in medium caries activity population. Eur Arch Paed Dent 2007; 8(4):189–94.

6. Costa-Silva CM, Jeremias F, de Souza JF, Cordeiro RC, Santos-Pinto L, Zuanon AC. Molar incisor hypomineralization: prevalence, severity and clinical consequences in Brazilian children. Int J Paediatr Dent 2010; 20(6):426-34.

7. Costa-Silva CM, Ambrosano GM, Jeremias F, De Souza JF, Mialhe FL. Increase in severity of molar-incisor hypomineralization and its relationship with the colour of enamel opacity: a prospective cohort study. Int J Paediatr Dent 2011; 21(5):333-41.

8. Discepolo KE, Baker S. Adjuncts to traditional local anesthesia techniques in instance of hypomineralized teeth. The New York State Dental Journal 2011; 77(6): 22-7.

9. Jalevik B, Klingberg G, Barregard L, Noren JG. The prevalence of demarcated opacities in permanent first molars in a group of Swedish children. ActaOdontol Scand 2001; 59(5): 255–60.

10. Păsăreanu M, Blăn A, Maxim A. Systemic impact of MIH syndrome on the child and adolescent. J Med Prev 2006; 14(1-2): 96-102.

11. Chay PL, Manton DJ, Palamara JEA. The effect of resin infiltration and oxidative pre-treatment on microshear bond strength of resin composite to hypomineralised enamel.Int J Paediatr Dent. 2014; 24(4):1-16.

12. William V, Burrow MF, Messer LB. Microshear bond strength of resin composite to teeth affected by molar hypoplasia using two adhesive system. Paediatr Dent 2007; 28(3): 233-41.

13. Crombie F, Manton D, Kilpatrick N. Aetiology of molar incisor hypomineralization: a critical review. Int J Paediatr Dent 2009; 19(2):73–83.

14. Durmus B, Abbasoglu Z, Peker S, Kargul B. Possible medical aetiological factors and characteristics of molar incisor hypomineralization in a group of turkish children. Acta Stomatol Croat 2013; 47(4):297-305.

15. Ghanim A, Morgan M, Marinˆo R, Bailey D, Manton D. Molar-incisor hypomineralisation: prevalence and defect characteristics in Iraqi children. Int J PaediatrDent 2011; 21(6):413–21.

16. Gottberg B, Berné J, Quiñónez B, Solórzano E. Prenatal effects by exposing to amoxicillin on dental enamel in Wistar rats. Med Oral Patol Oral Cir Bucal 2014; 19(1):38-43.

17. Janković S, Ivanović M, Davidović D, Lečić J. Aetiological factors of molar incisor hypomineralization. Stom Glass Srb 2013; 60(2): 69-75.

18. Jeremias F, Koruyucu M, Küchler EC, Bayram M, Tunac EB, Deeleyd K et al. Genes expressed in dental enamel development are associated with molar-incisor hypomineralization. Arch Oral Biol 2013; 58(10):1434-42.

19. Kühnisch J, Thiering E, Heitmüller D, Tiesler CMT, Grallert H, Heinrich-Weltzien R et al. Genome-wide association study (GWAS) for molar–incisor hypomineralization (MIH). Clin Oral Invest 2014; 18(2):677-82.
20. Jälevik B. Prevalence and diagnosis of molar-incisor-hypomineralisation (MIH): A systematic review. Eur Arch Paediatr Dent 2010; 11(2):59-64.
21. Soviero V, Haubek D, Trindade C, Matta T, 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(3):170–5.
22. World Health Organization. Oral health surveys basic methods. 4.th. ed. Geneva: WHO; 1997.
23. FédérationDentaireInternationale. Commission on oral health, research and epidemiology. A review of the developmental defects of enamel index (DDE Index). Int Dent J 1992; 42(6):411–26.
24. Jeremias F, Souza JF, Silva CMC, Cordeiro RCL, Zuanon ACC, Santos-Pinto L. Dental caries experience and molar-incisor hypomineralization. Acta Odontol Scand 2013; 71(3-4):870-6.
25. Jasulaityte L, Veerkamp JS, Weerheijm KL. Molar Incisor hypomineralization: review and prevalence data from s study of primary school children in Kaunas (Lithuania). Eur Arch Paed Dent 2007; 8(2):87–94.
26. Kuscu OO, Sandalli N, Dikmen S et al. Association of amoxicillin use and molar incisor hypomineralization in piglets: visual and mineral density evaluation. Arch Oral Biol 2013; 58(10):1422-33.
27. Parikh, DR, Ganesh M, Bhaskar V. Prevalence and characteristics of Molar Incisor Hypomineralisation (MIH) in the child population residing in Gandhinagar, Gujarat, India. Eur Arch Paediatr Dent 2012; 13(1):21-6.
28. Jans, MA, Díaz MV, Vergara GC, Zaror, SC. Frecuencia y severidad de La hipomineralización molar incisal en pacientes atendidos em las clínicas odontológicas de La Universidad de La Frontera. Int. J. Odontostomat 2011; 5(2):133-40.
29. Garcia-Margarit M, Catalá-Pizarro M, Montiel-Company JM, Almerich-Silla JM. Epidemiologic study of molar-incisor hypomineralization in 8-year-old Spanish children.Int J Paediatr Dent 2014; 24(1):14-22.
30. Heitmüller D, Thiering E, Hoffmann U, Heinrich J, Manton D, Kühnisch J et al. Is there a positive relationship between molar incisor hypomineralisations and the presence of dental caries? Int J Paediatr Dent 2013; 23(2):116–24.