


# Molar Incisor Hypomineralization—Influence on Dental Caries Experience Indexes: A Cross-sectional Study

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## ABSTRACT

**Aim and objective:** To evaluate the influence of the clinical characteristics inherent to Molar Incisor Hypomineralization on the values and scores of the DMF-T and ICDAS indexes.

**Materials and methods:** Eight hundred and eight seven teeth were examined, from 39 individuals aged 3–14 years ( $8.95 \pm 3.26$ ), who had at least one first permanent molar (FPM) or second primary molar with signs of hypomineralization, according to the criteria of the European Academy of Paediatric Dentistry. Hypomineralized teeth were evaluated for the presence of restorations, post-eruptive breakdowns (PEB), and dental caries, being considered sound for the DMF-T when there was the presence of PEB without caries lesion. Chi-square and Kruskal Wallis tests ( $p \leq 0.05$ ) were used to detect differences.

**Results:** Two hundred and five teeth showed signs of hypomineralization. The average number of opacities was influenced by the period of dentition, with more opacities when the primary dentition and the eruption of FPM and permanent incisors were complete ( $p \geq 0.05$ ). Hypomineralized teeth showed a higher DMF-T value, mainly of the decayed component (12%), in contrast to 2.5% of nonhypomineralized teeth. It was not possible to associate ICDAS scores 1 and 2 to hypomineralized surfaces, due to the overlap with the diagnosis of early enamel caries. The values of this index changed in the presence of cavitation by caries (scores 3,4,5,6), but not in the presence of PEB.

**Conclusion:** Due to the impossibility of differential diagnosis with caries lesion, PEB, and opacities present in hypomineralized teeth tend to overestimate the values and scores of the DMF-T and ICDAS, respectively.

**Clinical significance:** Make future suggestions for epidemiological studies in the area.

**Keywords:** Cross-sectional study, Dental caries, Dental Enamel, Dental Enamel Hypoplasia, Molar.

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## INTRODUCTION

Nonfluoride enamel hypomineralization involving first permanent molars (FPMs) and incisors has been described in the literature since 1970,<sup>1</sup> but only in 2001 the terminology Molar Incisor Hypomineralization (MIH) was suggested to characterize qualitative enamel defects involving one to four FPMs, frequently associated with similarly affected permanent incisors.<sup>2</sup> Related MIH defects can also be observed in primary dentition, especially in teeth formed during the same period of the FPMs, as second primary molars (SPMs), which when affected receive the name hypomineralized second primary molars (HSPM).<sup>3–5</sup>

These developmental defects of dental enamel may also be present in other groups of teeth such as premolars,<sup>6</sup> second permanent molars,<sup>7</sup> primary,<sup>8</sup> and permanent canines,<sup>7</sup> resulting in opacities varying in color and severity.<sup>9</sup> Porosity associated with opacities may contribute to the presence of immediate post-eruptive breakdowns (PEB), leaving the dentin exposed and increasing the risk for the development of caries lesions.<sup>10,11</sup>

Most studies evaluating caries experience in patients with MIH/HSPM use the Decayed, Missing, Filled Teeth (DMF-T) index,<sup>12–22</sup> proposed by the World Health Organization.<sup>23</sup> However, teeth with hypomineralization signs will probably be overestimated regarding DMF-T values, since PEB, extracted FPMs, and/or atypical restorations placed on these elements will increase the D, M, and F components, respectively.<sup>24</sup> Few studies also use the International Caries Detection and Assessment System (ICDAS) index to establish the relationship between dental caries and MIH/HSPM.<sup>25,26</sup> However, by diagnosing early-stage of caries lesions,<sup>27</sup> this index allows the

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opacities present in the enamel surface of hypomineralized teeth to act as a confounding factor, which may also overestimate the relationship between caries and MIH/HSPM.

Therefore, this report evaluates the influence of hypomineralization defects on dental caries experience indexes (dmf-t/DMF-T and ICDAS) based on detailed data collected from a patient cohort in order to raise awareness for future epidemiological studies in the area.

## MATERIALS AND METHODS

### Ethical Aspects

This study was approved by the local Institutional Ethics Committee, under protocol number 2.985.768. All guardians signed an informed consent form agreeing with data collection and use for the purpose of this study.

## Study Design

This has been an observational, cross-sectional study, based on a clinical evaluation of children living in the city of Rio de Janeiro, Brazil, referred for the Pediatric Dental Clinic of the Universidade Federal do Rio de Janeiro, Brazil, for dental treatment during the period from August 2018 to September 2019. This study was reported according to the STROBE Statement checklist.<sup>28</sup>

## Participants

Eligibility criteria: During the recruitment, all children aged between 3 and 14 years old, who showed at the first appointment, at least one FPM or SPM affected by idiopathic enamel hypomineralization were referred for inclusion in the study. Exclusion criteria were: children with other developmental defects of teeth, such as fluorosis, amelogenesis imperfecta, and dentinogenesis imperfecta; syndromes associated with enamel formation defects; patients undergoing orthodontic treatment with the fixed appliance; partially erupted molars where any of the surfaces were not completely visible and noncooperative patients, who did not allow an adequate clinical examination.

## Calibration and Reproducibility

Theoretical training on the diagnosis of MIH/HSPM was undertaken by two examiners (FGFV, FMFS), based on the classical MIH definitions for permanent<sup>3</sup> and primary teeth.<sup>4</sup> For dmft-t and DMF-T, the training was based on the evaluation of clinical photographs published on the SB Brasil 2010 page.<sup>29</sup> For ICDAS, this was done based on the ICDAS II handbook<sup>30</sup> and by undertaking the ICDAS E-Learning Course.<sup>31</sup>

To evaluate inter and intraexaminer agreements for MIH/HSPM, the two examiners evaluated 27 clinical images containing several dental enamel alterations, including fluorosis, hypoplasia, amelogenesis imperfecta, and MIH/HSPM in different teeth and surfaces, showing varied discoloration and severity degrees. After 2 weeks, the images were reevaluated and Kappa statistics were performed to measure inter and intraexaminer agreement, with values of 0.9 and 0.84, respectively.

Interexaminer agreement for the caries evaluations was also performed by two examiners (FGFV, GFR), who independently examined eight children of varying ages, with and without MIH/HSPM. Clinical examination and annotation (dmft-t / DMF-T and ICDAS) were performed after previous prophylaxis. The teeth were evaluated under artificial light with the aid of a flat mirror. The interexaminer agreement percentage was calculated by the Kappa coefficient, with a final result of 0.8 for dmft-t / DMF-T and 0.75 for ICDAS.

## Assessment of Dental Caries and Presence of MIH

The clinical examination was performed in a dental clinic setting. The teeth were evaluated after professional cleaning, under artificial

light with the aid of a flat mirror and at least one attempt to dry with compressed air. Patients presenting with tooth sensitivity preventing professional prophylaxis received supervised tooth brushing with dentifrice indicated for sensitive teeth and drying was performed with gauze or cotton rolls.

From each patient, a single examiner (F.G.F.V) evaluated all teeth that erupted in the mouth in relation to the presence of hypomineralization. White, yellow-white, and/or yellow-brown opacities with more than 1 mm length in patients where at least one FPM or SPM was affected were considered as hypomineralization signs. Permanent incisors were only considered as part of the MIH spectrum if a FPM or a SPM were concomitantly affected, according to the criteria established by the European Academy of Pediatric Dentistry.<sup>3</sup> This same rationale was applied to other types of erupted teeth showing hypomineralization defects.

The clinical appearance of dental surfaces affected by hypomineralization signs were also recorded in relation to the presence of post-eruptive breakdown (PEB), caries lesions, and restorations. For the differential diagnosis between a carious lesion or PEB, the teeth were gently dried with gauze or cotton rolls and a dentine scoop was used when necessary to confirm the presence of typical carious/softened dentin. If hypomineralized teeth with PEB did not have associated caries lesion injuries, they were considered sound for the dmft-t/DMF-T index. All opacities resulting from hypomineralization, with or without PEB, were considered as ICDAS 2 due to the impossibility of differential diagnosis with early caries lesions. When possible, the presence of restorations was also recorded if performed by due to post-eruptive breakdowns or caries by consultation of the dental record.

## Statistical Analysis

Statistical analysis was performed using the SPSS<sup>®</sup> program (Statistical Package for the Social Sciences<sup>®</sup>, version 21.0, Chicago, USA) and the data were analyzed using Chi-square ( $\chi^2$ ) and Kruskal Wallis test ( $p \leq 0.05$ ).

## RESULTS

All referred eligible patients ( $n = 39$ ) were examined and included in the study, with mean age  $8.95 \pm 3.26$ . From a total of 887 teeth, 205 presented hypomineralization signs. The mean number of opacities throughout the mouth was influenced by the period of dentition, with higher values if the primary dentition was still present and the eruption of first permanent molars and incisors was complete ( $p \geq 0.05$ ). The mean number of surfaces with clinical sequelae also increased when the presence of PEB was considered (Table 1).

When the clinical condition of teeth with and without hypomineralization defects was analyzed in the whole sample, the presence of hypomineralization was associated with a higher

**Table 1:** Mean number of opacities and values for DMFT/dmft in teeth with and without PEB

Period (years)	Ratio between total teeth/hypomineralized teeth	Mean opacities in the mouth	Mean DMFT/dmft	Mean DMFT/dmft with PEB
Primary dentition (3–5)	0.38	12.6 <sup>a</sup>	3.6	6.8
First transitional period (6–8)	0.17	6.33 <sup>a</sup>	5	5.78
Inter-transitional period (8–10)	0.28	12.71 <sup>a</sup>	2.71	4.14
Second transitional period (10–12)	0.21	8.5 <sup>a</sup>	4.5	6.17
Permanent dentition (12–14)	0.17	7.17 <sup>a</sup>	5.17	5.67

Uppercase letters in superscript indicate statistical difference ( $p \leq 0.05$ ); PEB, post-eruptive breakdowns

dmf-t/DMF-T value, mainly of the decayed component. Twelve percent of hypomineralized teeth presented the D component of dmf-t/DMF-T, in contrast to 2.5% of nonhypomineralized teeth (Table 2).

Table 3 shows that it was not possible to correlate ICDAS scores with the presence of caries lesions in the initial stage on surfaces where hypomineralization opacities were present. The value of this index changes in the presence of cavitation due to caries (scores 3,4,5,6), but not in the presence of PEB.

## DISCUSSION

Molar Incisor Hypomineralization (MIH) is a condition with a worldwide prevalence ranging from 2.4–40.2%<sup>32</sup> and studies conducted with subjects in different age groups is one of the reasons for the discrepancy between these values.<sup>33</sup> In the present study, it was a possibility to note that the number of opacities was higher when SPMs, FPMs, and incisors fully erupt, which suggests that the best time for accurate diagnosis of this condition in primary dentition is at 3 years of age and in permanent dentition is around 8 years old, as previously suggested.<sup>3,33</sup> With the establishment of a complete permanent dentition, a decrease in the average opacities across the mouth is observed compared to the complete primary dentition (Table 1). This is justified by the fact that in this sample, SPMs with hypomineralization defects have been one of the inclusion criteria. In addition, the fact that only one premolar and no second permanent molar with signs of hypomineralization were observed may also have contributed to that.

Some studies have been conducted to define the association between MIH and dental caries. It is known that the characteristics of hypomineralized enamel<sup>34</sup> make it susceptible to the development of posteruptive breakdowns<sup>10</sup> and caries,<sup>3</sup> and indeed, previous studies that evaluated this relationship found increased dmf-t/DMF-T values in patients with MIH,<sup>12–17,19–22,35</sup> as well as observed in our results (Table 2).

**Table 2:** Distribution of sound, decayed, missing and filled elements in teeth with and without hypomineralization in the complete patient sample

Teeth	With MIH		Without MIH	
	(N*)	%	(N*)	%
Sound	149	72.7	635	93.1
Decayed	26	12.7	26	2.5
Missing	0	0.0	2	0.3
Filled	30	14.6	28	4.1
DMF	56	27.3	56	6.9
<b>Total</b>	<b>205</b>	<b>100.0</b>	<b>682</b>	<b>100.0</b>

N\*, absolute numbers

When using the DMF-T index in hypomineralized teeth the components “missing” and “filled” can represent extractions and restorations happened as a result of dental caries, PEB or a combination of both. This may also happen with teeth lost due to traumatic lesions. However, “decayed” component may include lesions caused by caries or PEB.<sup>24</sup> In the present study, it became clear that including PEB lesions in the “decayed” component of the DMF-T increased the final DMF-T score (Table 1). In many situations, the differential diagnosis between PEB and dental caries can be difficult, which may cause the relationship between the disease, treatment need, and the presence of hypomineralization to be also overlooked.<sup>18</sup> For this reason, if DMF-T is used in epidemiological studies, it is important to include the differential diagnosis of PEB caused by hypomineralization defects and carious cavities.

Another characteristic related to hypomineralized teeth, which may be a confounding factor especially for ICDAS, is related to the presence of opacities in enamel. Some authors argue that initial caries is located in areas where enamel hypomineralization rarely occurs<sup>36</sup> but in fact, the porosity associated at opacities may be a contributing factor to the accumulation of biofilm,<sup>11</sup> especially in young children with erupting FPMs without occlusal contacts and in those where sensitivity<sup>37</sup> prevent good oral hygiene habits. In this study, in only 1.1% of cases were carious teeth were classified as ICDAS 2 (Table 3). In this situation, the early lesion was located on a surface other than the hypomineralized one. As it has only occurred in 1.1% of cases, it is clear that opacities in those teeth would be mistakenly assumed to be caries lesions. Thus, ICDAS might not be indicated as a measure of caries experience for hypomineralized teeth, since it was only possible to appropriately score ICDAS in teeth that already had cavitated lesions.

## CONCLUSION

In the absence and impossibility of differential diagnosis with caries lesion, PEB and opacities tend to overestimate the values and scores of the DMFT and ICDAS, respectively. For DMF-T it may be well possible to separate PEB lesions from the carious cavity and this differential diagnosis should be included in the DMF-T score. Similarly, ICDAS is not a good index for teeth with this type of qualitative defect in tooth enamel. We would also recommend that dental caries prevalence/incidence studies exclude hypomineralized teeth as deputies for dental caries experience. Their need for treatment is probably unrelated to the caries experience.

## CLINICAL SIGNIFICANCE

Make future suggestions for epidemiological studies about MIH and dental caries experience.

**Table 3:** Clinical situation of hypomineralized teeth as described by the ICDAS index considering post-eruptive breakdowns

ICDAS scores	Total of teeth		Cariou teeth		Teeth with PEB		Filled teeth		Teeth with severe MIH	
	(N*)	%	(N*)	%	(N*)	%	(N*)	%	(N*)	%
2	178	86.8	2	1.1	29	16.3	24	13.5	51	28.7
3	4	2.0	4	100.0	1	25.0	0	0.0	4	100.0
4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	13	6.3	13	100.0	7	53.8	1	7.7	13	100.0
6	10	4.9	10	100.0	2	20.0	0	0.0	10	100.0
<b>Total</b>	<b>205</b>	<b>100.0</b>	<b>29</b>	<b>14.1</b>	<b>39</b>	<b>19.0</b>	<b>25</b>	<b>12.2</b>	<b>78</b>	<b>38.0</b>

N\*, absolute numbers

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