

# Prevalence, Pattern, and Severity of Molar Incisor Hypomineralization in 8–12-year-old Schoolchildren of Moradabad City

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## ABSTRACT

**Aim and objective:** Recently, molar incisor hypomineralization (MIH) has become more evident and one of the most common reasons for loss of teeth in children after dental caries. Being a country with a diverse ethnic population, the prevalence of MIH in different regions of India may differ. Hence, the present study was undertaken to determine the prevalence, pattern, and severity of MIH in 8–12-year-old Schoolchildren in Moradabad city.

**Materials and methods:** This study was conducted in various schools of Moradabad city to target a sample of 2,300 children aged between 8 and 12 years. The examination was done in their respective schools by a calibrated examiner in natural daylight using European Academy of Pediatric Dentistry diagnostic criteria for MIH 2015. The results, thus obtained, were statistically analyzed using Pearson's Chi-square test.

**Results:** A prevalence of 3.96% (91/2300) for MIH was reported without any gender predilection. Molar hypomineralization showed a prevalence of 1.3% (29/2300) whereas the prevalence for hypomineralization of second primary molars was 1.4% (22/1620). The most common type of defect was type 2 and most of the affected teeth were of grade I. Mandibular molars were more commonly affected compared to the maxillary molars.

**Conclusions:** A prevalence of 3.96% (91/2300) was observed for MIH. Frequent dental screening camps should be organized in schools at the community level for the enhancement of early diagnosis of MIH and designing appropriate management strategies.

**Keywords:** Epidemiological study, Hypomineralization of second primary molar, Molar hypomineralization, Molar incisor hypomineralization, Prevalence.

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## INTRODUCTION

The mineralization of first permanent molar (FPM) starts around birth and is completed at approximately 3 years of age.<sup>1</sup> Once mineralization is complete, enamel is not remodeled, and therefore any defects during development are known to be permanent. Any disturbance occurring during the secretion phase leads to hypoplasia whereas, in the maturation phase, it causes hypomineralization.<sup>2</sup>

Over the past 20 years, a peculiar and specific pathological condition causing idiopathic enamel hypomineralization of FPM and incisors has been identified. It has been termed as “nonfluoride hypomineralization,” “hypomineralized permanent first molars,” “cheese molars,” and “idiopathic enamel hypomineralization” by various authors.<sup>3–7</sup> The condition was subsequently termed as “molar incisor hypomineralization” by Weerheijm in 2001.<sup>4</sup> The latest definition of MIH by the European Academy of Pediatric Dentistry (EAPD), is “hypomineralization of systemic origin of one to four permanent first molars, frequently associated with affected incisors.”<sup>4</sup>

Two different phenotypes of MIH have been identified as molar hypomineralization where only FPM are involved and molar incisor hypomineralization where FPM and permanent incisors (PI) are involved.<sup>8</sup> The simultaneous collateral association of coronal mineralization of second deciduous molar (SPM) with the FPM and PIs, can cause defects like MIH in SPM. This term has been referred to as hypomineralization of second primary molars (HSPM).<sup>8</sup>

The severity of MIH may vary considerably and one to all four of the FPM may be affected in different individuals. In few European

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countries where dental caries has shown a decline, MIH has become more evident and one of the leading causes for loss of teeth in the young population after dental caries. Epidemiological data from several countries estimate the prevalence of MIH from 2.8% in Hong Kong,<sup>9</sup> 13.7% in Kenya,<sup>10</sup> to 42% in Brazil.<sup>11</sup>

Majority of studies estimating its prevalence have been conducted in European countries while data from Asian countries

is scarce, with only few regional cohort studies from Hong Kong,<sup>9</sup> Singapore,<sup>12</sup> Thailand,<sup>13</sup> Nepal,<sup>14</sup> and India.<sup>15–26</sup> Being a country with a diverse ethnic population, the prevalence of MIH in different regions of India may differ. Mittal et al.<sup>16</sup> in 2014 determined a prevalence rate of 6.31% in 6–9-year-old school-going children of Chandigarh. Similarly, Kirthiga et al.<sup>17</sup> in 2015 reported a prevalence rate of 8.9% in Davangere.

Apart from differences in environmental, socio-behavioral, and the genetic factors of studied populations the variations in the prevalence rates may be due to the differences in the examination protocol including diagnostic criteria. The lack of a standardized criterion for recording MIH data in epidemiological studies has a major impact on the bewildering variations in the recorded prevalence rate. In 2014, a workshop on molar incisor hypomineralization was held at the 12th EAPD Congress in Sopot, Poland, a unified practical surveying form to classify and diagnose MIH in the clinical practice and epidemiological studies was introduced.<sup>27</sup> Surveys to record the prevalence of MIH are needed to identify the disease burden so that necessary steps can be taken to plan and implement dental health programs in the community. To the best of my knowledge, no epidemiological survey reported the prevalence of MIH based on the new EAPD criteria 2015 in Moradabad city, India. Thus, the present study was undertaken to record the prevalence, pattern, and severity of MIH in 8–12-year-old schoolchildren in Moradabad city, India.

## MATERIALS AND METHODS

The present epidemiological cross-sectional survey was done at various schools of Moradabad. The city is located in western Uttar Pradesh, India and occupies an area of 3493 km<sup>2</sup> with a total population of 887871 (2011 census of India). The levels of fluoride in groundwater of the city is <1.5 mg/L.<sup>28</sup>

The research protocol was reviewed and approved by the Institutional Ethics Committee of Teerthanker Mahaveer Dental College and Research Centre, affiliated with Teerthanker Mahaveer University, Moradabad.

A detailed informed written consent was taken from the school authorities as well as parents/caregivers authorizing their ward in the study.

All 8–12-year-old children with at least one FPM erupted and residing in Moradabad since birth were included.

Children with fluorosis, lesion in the PIs with a history of traumatic injury or infection to the deciduous teeth, syndromes associated with enamel malformation (amelogenesis imperfecta, dentinogenesis imperfecta, etc.) and who were under orthodontic therapy at the time of examination were excluded from the study.

A single, well-trained, calibrated examiner (AK) performed all the examinations at the respective school premises following the guidelines of the World Health Organization (WHO)<sup>29</sup> for epidemiological surveys in oral health.

The examination was commenced with index teeth in the first quadrant and proceeded around to the second quadrant and then continued with the mandibular arch beginning with the third quadrant followed by the fourth quadrant. Only the buccal/labial, palatal/lingual, and incisal/occlusal surfaces of the index teeth were scored. The short data recording sheet described by Ghanim et al. in 2015<sup>27</sup> was used for grading the scores (Table 1).

The recording tool used in this survey compiles the elements of EAPD criteria 2003<sup>8</sup> and modified index of developmental defects of enamel (mDDE index) for scoring the clinical/visual status and

extent of molar incisor hypomineralization on the involved tooth surface. There is a provision to record other enamel defects as well. The recording tool contains two major sections: clinical status criteria and lesion extension criteria. The former records the visual/clinical presentation of enamel lesions and the latter records the size of the lesion. A small section assessing the tooth eruption status (eruption status criteria) is also provided.<sup>27</sup>

## STATISTICAL ANALYSIS

The data thus obtained was tabulated and subjected to a statistical analysis using statistical package for social sciences (SPSS Inc., Chicago, IL) version 17 for windows. Descriptive statistics frequency, percentage, mean, standard deviation were used to summarize the data. Pearson's Chi-square test was used for qualitative analysis. The significance level was predetermined at  $p < 0.05$ .

## RESULTS

Among the 2,300 assessed children, 91 (3.96%) had MIH and 29 presented with molar hypomineralization (MH) (Table 2). Out of 1620 children (with at least 1 SPM) 22 (1.4%) presented with HSPM. Table 3 describes the prevalence of MIH lesions according to index teeth. The most affected tooth by MIH was 46 (2.8%). Table 4 represents the number of incisors to molars affected and a wide variation was observed. Figure 1 demonstrates the distribution of index teeth according to clinical status criteria. Table 5 shows the distribution of index teeth with scores 2–6 according to lesion extension criteria.

## DISCUSSION

MIH is a relatively common developmental disorder resulting in enamel defects in FPM and PI because of various environmental factors which impact the developing enamel, with an underlying genetic predisposition.<sup>30</sup> Clinical presentation may vary depending on the severity of the lesion.<sup>5</sup> The affected teeth are highly sensitive to hot and cold, and tooth brushing leads to compromised oral hygiene and high risk to dental caries. The initiation of caries results into atypical caries, on the areas usually not susceptible to dental caries, often with no caries in the unaffected teeth.<sup>31</sup> In posterior teeth, a rapid wear-off followed by ultimately posteruptive breakdown (PEB) with the exposure of underlying porous enamel and the dentine are seen once the teeth come in contact with the

**Table 1:** Charting criteria for MIH grading in index teeth<sup>27</sup>

### *Eruption status criteria:*

- Not visible or less than one-third of the occlusal surface or of the crown length of incisor is visible

### *Clinical status criteria:*

- No visible enamel defect
- Enamel defect, non-MIH/HSPM
- White, creamy demarcated, yellow or brown demarcated opacities
- Posteruptive enamel breakdown (PEB)
- Atypical restoration
- Atypical caries
- Missing due to MIH/HSPM
- Cannot be scored

### *Lesion extension criteria (only after diagnosing MIH/ HSPM, i.e., scores 2–6):*

- Less than one-third of the tooth affected
- At least one-third but less than two thirds of the tooth affected
- At least two-thirds of the tooth affected

**Table 2:** Distribution of MIH according to age

		MIH		Total
		Yes	No	
Age (yrs)	8	11 2.8%	383 97.2%	394 100.0%
	9	3 0.8%	389 99.2%	392 100.0%
	10	11 2.7%	404 97.3%	415 100.0%
	11	16 3.3%	465 96.7%	481 100.0%
	12	50 8%	568 91.9%	618 100.0%
Total		91 4%	2209 96%	2300 100.0%

**Table 3:** Prevalence of MIH according to index teeth

Index tooth	MIH		
		Frequency	Percentage (%)
Maxillary	16	47	2.04
	12	13	0.57
	11	31	1.35
	21	37	1.61
	22	14	0.61
	26	45	1.96
Mandibular	36	59	2.57
	32	25	1.09
	31	30	1.30
	41	30	1.30
	42	25	1.09
	46	64	2.78

opposing teeth. Such teeth if left untreated might lead to pulp involvement and subsequently early loss of tooth.

MIH lesions can affect the overall health and quality of life of the patient. The treatment is often challenging for both the dentist and patient.<sup>32</sup> Symptomatic restorative care and repeated treatments are often required for affected teeth with advanced carious lesions.<sup>7</sup> Moreover these teeth are difficult to anesthetize since there is subclinical pulpal inflammation due to increased enamel porosity which may result into hypersensitivity experienced by some of the individuals.<sup>33</sup>

Since, the calcification of the crown of the FPM and that of the SPM occur at the same time if some factor were to operate during the prenatal and perinatal period, SPM could also be affected by hypomineralization.<sup>34</sup> The clinical features of HSPM are almost similar to MIH: demarcated white, yellow, and brown opaque stains, atypical restorations, and/or atypical caries with opacities at the margins, PEB, sensitivity, tenderness, and difficult to treat.<sup>34</sup>

Epidemiological data pertaining to prevalence of MIH from several countries shows a remarkably high variation in the prevalence of MIH. The prevalence ranges from 2.8% in Hong Kong,<sup>10</sup> 7% in Graz (Austria),<sup>35</sup> 10.2% in Athens (Greece),<sup>36</sup> 12.7% in Zahedan (Iran),<sup>37</sup> 13.7% in Kenya,<sup>11</sup> 13.9% in Northern Norway,<sup>38</sup> 15.8% in Mexico,<sup>39</sup> 21.8% in Spain,<sup>40,41</sup> 24% in Turkey,<sup>44</sup> to 42%

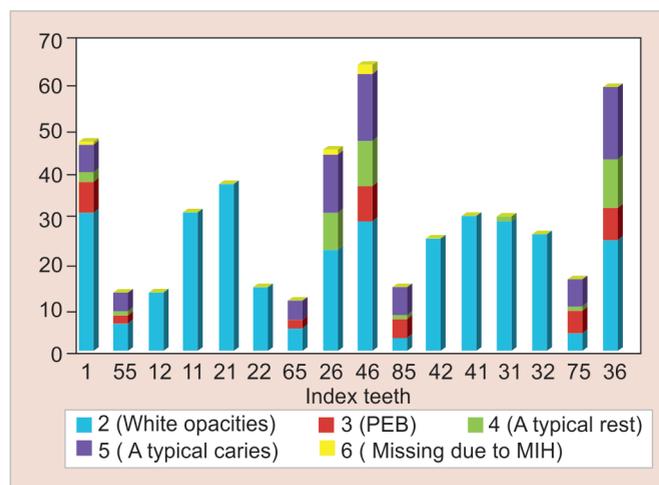
in Brazil.<sup>42</sup> Most surveys determining the prevalence are carried European countries while Asian countries are running lack of data. Attributed to its diverse ethnic population, India shows great variation in the prevalence of MIH. Anjum et al.<sup>18</sup> Krishnan et al.<sup>24</sup> established a prevalence of 7.3% in Tamil Nadu. Despite the essentiality of early diagnosis, MIH prevalence data are lacking from Moradabad. Literature shows two studies have been conducted in Uttar Pradesh to determine the prevalence. Mittal et al.<sup>25</sup> observed a prevalence of 10.48% in Noida and Mishra et al.<sup>24</sup> determined a prevalence of 13.9% in Lucknow. Thus, this study was undertaken to assess the prevalence, pattern, and severity of MIH in 8 to 12 years old school children in Moradabad city.

In the present study, the minimum and the maximum age limit were decided to be 8 and 12 years. The study selected children aged between 8 and 12 years so that the assessment of MIH can be done as at this age usually children have all four FPM, and most of PIs erupted. Owing to masticatory forces, the severity of lesion increases after the eruption and thus, younger subjects were included. Teeth were examined soon after eruption so that no other condition like dental caries, restorations, or posteruptive breakdown could interfere with diagnosis of MIH.

Recently a systematic review on the prevalence of molar incisor hypomineralization showed a lack of standardization because

**Table 4:** Number of incisors to molars affected

Number of affected Incisors	Number of affected molars				Total n (%)
	1 n %	2 n %	3 n %	4 n %	
0	9 31%	9 31%	3 10.3%	8 27.6%	29 100.0%
1	10 45.5%	7 31.8%	2 9.1%	3 13.6%	22 100.0%
2	4 30.8%	4 30.8%	1 7.7%	4 30.8%	13 100.0%
3	1 33.3%	2 66.7%	0 0.0%	0 0.0%	3 100.0%
4	1 7.7%	5 38.5%	2 15.4%	5 38.5%	13 100.0%
5	0 0.0%	0 0.0%	1 100.0%	0 0.0%	1 100.0%
6	1 16.7%	1 16.7%	1 16.7%	3 50.0%	6 100.0%
7	1 50.0%	0 0.0%	0 0.0%	1 50.0%	2 100.0%
8	0 0.0%	1 50.0%	0 0.0%	1 50.0%	2 100.0%
Total	27 29.7%%	29 31.9%%	10 11%	25 27.5%	91 100.0%



**Fig. 1:** Distribution of index teeth according to clinical status criteria

there was no unified standardized tool to record MIH.<sup>43</sup> The review indicated development of a uniform well-defined tool for recording data on MIH was of paramount importance for better consistency and comparisons of results from different studies.<sup>43</sup>

As a result, a unified standardized recording sheets based on the EAPD evaluation criteria were formulated by Ghanim et al.<sup>27</sup> in 2015. Hence, the diagnostic criterion recommended by the EAPD was used to determine the true prevalence of MIH in Moradabad. Short data recording sheets of the EAPD diagnostic criteria 2015 were used for scoring MIH defects on index teeth.

This cross-sectional study shows a prevalence rate of 3.96% in Moradabad city as 91 out of 2,300 children were affected. A wide disparity in the prevalence of MIH in India has been reported as 6.3%

by Mittal et al.<sup>16</sup> in Chandigarh, 9.2% by Parikh et al.<sup>15</sup> in Gandhinagar, and 10% by Bhaskar et al.<sup>19</sup> in Udaipur. This reported variation in the rate of prevalence could be because of the actual differences in prevalence or differences in methodology such as sampling of the study population (different age groups in their studies, recruitment of population or convenience samples) or nonunified and standardized methods used for clinical examination.<sup>44</sup> Attributed to the inclusion of diverging indications for the determination of MIH in the DDE index might lead to variation in the prevalence.<sup>45</sup>

In accordance with the previous studies,<sup>14,24</sup> an increase in the prevalence was observed with age. This age-determined increase in the severity level of the hypomineralized tooth shows the dynamic properties of the defect. It has been proved that enamel affected by MIH possesses inferior structural characteristics leaving the diseased tooth highly susceptible to dental caries and posteruptive breakdown.

According to previous studies,<sup>13,15,16,40,46,47</sup> gender was not significantly associated with the MIH. In the present study, we observed a slight male predilection as 52 out of 1,574 girls (3.3%) whereas 39 out of 726 boys (4%) were affected by MIH which was statistically nonsignificant.

Right lower FPM (46) was the most commonly affected tooth followed by the left lower FPM (36). This was in accordance with the previous studies done by Parikh et al.,<sup>15</sup> Bhaskar et al.,<sup>19</sup> and Jasulaityte et al.<sup>48</sup> who observed mandibular teeth to be more affected. However, surveys conducted by Weerheijm et al.<sup>4</sup> and Chawla et al.<sup>49</sup> reported minimal difference between mandibular and maxillary teeth whereas, Leppaniemi et al.<sup>7</sup> and Ghanim et al.<sup>50</sup> reported a higher prevalence in maxillary molars. The differences in examination conditions reduce the visibility of maxillary teeth as compared to their mandibular counterparts. Additionally, the early eruption of mandibular molars with

**Table 5:** Distribution of Index teeth with scores 2–6 according to lesion extension criteria

Index tooth (with scores 2–6)	Lesion extension criteria		
	Grade I	Grade II	Grade III
16	28	9	9
55	4	4	5
12	12	1	0
11	25	6	0
21	29	8	0
22	12	2	0
65	4	3	4
26	20	12	12
36	30	18	11
75	5	5	6
32	21	5	0
31	25	4	1
41	22	7	1
42	17	8	0
85	3	5	6
46	33	15	14
Total	290/475 61.5%	112/475 23.8%	69/475 14.5%

resultant early PEB or caries makes them more susceptible than maxillary molars.

The most commonly observed lesion was white, creamy to brown opacities which are considered the mildest of all defects. This was in agreement with the previous studies.<sup>16,24</sup> This type of lesion has an esthetic concern, especially when present on incisors. The majority of the affected cases were of grade I (<1/3rd of the tooth structure was affected) (61.5%) which is the least severe followed by grade II (at least 1/3rd but <2/3rd of the tooth structure affected) and then grade III (at least 2/3rd of the tooth structure affected). The majority of researchers could not record MIH teeth with extensive PEB that required atypical restorations or even extraction and thus, underestimating the prevalence substantially.<sup>19</sup>

The term MH is given to the condition where only molars were involved without the involvement of incisors.<sup>49</sup> The prevalence for MH was 1.3% as 29 out of 2,300 children had MH. In previous studies, the reported prevalence of MH phenotype ranged from 17.4–35%.<sup>26,36,49,51</sup>

Out of 2,300 children, 1,620 had second primary molars and the prevalence for HSPM was observed to be 1.4% as 22 out of 1,620 children showed affected second molar. Mittal et al.<sup>52</sup> in 2015 established the prevalence of HSPM in Gautam Buddha Nagar to be 5.6% while Ghanim et al.<sup>53</sup> in 2013 showed a prevalence of HSPM to be 6.6% in Iraqi children. HSPM showed no gender predilection as 12 out of 1,153 (1.0%) girls whereas 10 out of 467 (1.4%) boys were affected. It was difficult to observe developmental disturbances of the deciduous molars at 8–12 years of age since caries, restorations, and wearing off often mask the effects of developmental disturbances. Various reasons like normal exfoliation may lead to loss of second primary molar. This may not only result in under-estimation of the prevalence, but may also alter the true profile of the severity of the defect as many affected teeth would have broken down posteruption because of prolonged exposure to the oral environment or would have been extracted.

Previous studies have shown that simultaneous involvement of both molars and incisors, increases the severity of lesions

especially in molars.<sup>42,50,54</sup> In this study a higher prevalence of MIH phenotype over MH was observed. The number of children with hypomineralized molars only was 29 whereas 62 children showed hypomineralized molars with incisors. The possible explanation to this could be that when PIs are simultaneously affected with the FPM, the etiological disturbance is more severe. The increased severity of disturbance leads to more severe lesions. It has also been reported that with an increase in the number affected incisors number of affected molars increase.

It has been postulated that due to the coinciding periods of calcification of SPM and FPM, a similar group of etiological factors like preterm birth, low birth weight, and/or poor gestational health may influence the development of HSPM and MIH.<sup>34</sup> Thus, the presence of HSPM can be considered as a predator for MIH. Barber et al.<sup>55</sup> in 2016 and Mittal et al.<sup>52</sup> in 2015 postulated that the presence of HSPM was an indication for the development of MIH in the future. However, the present study showed statistically no significant association between MIH and HSPM. This was in accordance with a study done by Ghanim et al.<sup>53</sup> in 2013.

Etiological factors which might have an influence on the development of MIH were not recorded in this study. Future studies assessing the possible etiological factors of MIH are recommended so that intervention and treatment could be planned in the early stages. The present study was carried out in Moradabad, which represents a small part of the country. The data gained from this cross-sectional study is not supposed to represent the entire nation. Previous reports regarding the prevalence of molar incisor hypomineralization in the Indian population are scarce and thus, a nation-wide study to record the prevalence of MIH is recommended. Further studies are also recommended to acquire knowledge of the etiology and to evaluate the prognostic outcomes of MIH.

## CONCLUSION

The overall prevalence of MIH in 8–12 years old school children in Moradabad city is 3.96%. without any gender predilection. The most

common type of defect was type 2 and most of the affected teeth were of grade I. Mandibular teeth are more commonly affected. A higher prevalence of MIH phenotype over MH was observed. Frequent dental screening camps should be organized in schools at the community level for the enhancement of early diagnosis of MIH. Educating and motivating sessions should be organized to raise general awareness to reduce further degradation of the already weak enamel.

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