Journal of
Oral Health and Oral Epidemiology

https://johoe.kmu.ac.ir
10.34172/johoe.2505.1736
JOHOE. 2026;15:2505.1736

Review Article

Prevalence of Molar Incisor Hypomineralization Among Iranian Children: Systematic Review and Meta-Analysis

Melika Ghasemi[1#], Razieh Jabbarian[2#], Mehdi Ranjbaran[3*]

[1]Student Research Committee, Qazvin University of Medical Sciences, Qazvin, Iran
[2]Department of Pediatric Dentistry, Dental School, Qazvin University of Medical Sciences, Qazvin, Iran
[3]Non-Communicable Diseases Research Center, Research Institute for Prevention of Non-Communicable Diseases, Qazvin University of Medical Sciences, Qazvin, Iran

*Corresponding Author: Mehdi Ranjbaran, Email: mehdiranjbaran90@yahoo.com, m.ranjbaran@qums.ac.ir
#Melika Ghasemi and Razieh Jabbarian should be considered joint first author.

Abstract

Background: Molar incisor hypomineralization (MIH) represents a qualitative developmental defect of the enamel that most commonly manifests in the permanent first molars, with possible extension to the permanent incisors. Several studies have investigated MIH across different regions of Iran. The aim of this systematic review and meta-analysis was to determine the overall prevalence of MIH in Iran.

Methods: Scientific databases such as PubMed, Scopus, and ISI Web of Science, as well as Iranian databases including Magiran (Magiran.com) and Idml.research.ac.ir, were searched until April 2025. Studies with a cross-sectional design on the prevalence of MIH were included. To calculate the pooled prevalence, random effects models were used. Assessment of heterogeneity was performed using meta-regression and sensitivity analyses.

Results: Fourteen eligible studies were included in the quantitative analysis. The pooled prevalence of MIH in Iran was calculated at 21.6% (95% CI, 15.5 to 27.7%). The prevalence was 23.5% (95% CI, 12.8 to 34.2%) in girls and 22.4% (95% CI, 15.9 to 24.9%) in boys. According to meta-regression, MIH prevalence increased with increasing age, but this was not statistically significant ($P=0.518$).

Conclusion: We observed high heterogeneity in the reported prevalence of MIH among the primary studies. MIH is a widespread dental condition in Iran, with a pooled prevalence of 21.6%, which appears higher than the global prevalence. Therefore, it is necessary to improve dental healthcare providers' awareness regarding this condition and to consider MIH during routine dental examinations.

Keywords: Dental-enamel hypoplasia, Meta-analysis, Prevalence, Epidemiology, Molar hypomineralization

Citation: Ghasemi M, Jabbarian R, Ranjbaran M. Prevalence of molar incisor hypomineralization among Iranian children: systematic review and meta-analysis. *J Oral Health Oral Epidemiol*. 2026;15:2505.1736. doi: 10.34172/johoe.2505.1736

Received: May 5, 2025, **Revised:** August 31, 2025, **Accepted:** December 6, 2025, **ePublished:** January 31, 2026

Introduction

Molar incisor hypomineralization (MIH) represents a qualitative developmental defect of the enamel that most commonly manifests in the permanent first molars, with possible extension to the permanent incisors.[1] The concept of MIH was originally introduced by Weerheijm et al as "systemic-origin hypomineralization" in 2001.[2] These defects are caused by changes in the characteristics of enamel crystals,[3] which can result in a spectrum ranging from enamel discoloration to breakdown of the affected teeth.[4] Well-defined areas of hypomineralized enamel may involve at least one first permanent molar. Accordingly, these teeth can exhibit marked sensitivity, are prone to posteruptive tissue breakdown, and have a higher risk of developing dental caries. When present on anterior teeth, associated opacities are less likely to cause functional impairment; however, they may lead to aesthetic concerns and negative psychosocial impacts.[5,6]

Although the etiology of MIH remains unknown, the synchronicity of molar and incisor development with the period between late pregnancy and early childhood suggests a correlation between the defects and events during the first three to four years of life.[7,8] As a result, recent research has investigated the relationship between prenatal factors—including medications used during pregnancy and maternal smoking—perinatal factors such as preterm birth and low birth weight, and postnatal factors such as asthma, high fever episodes, infections/illnesses, chickenpox, antibiotic use, diarrhea, and pneumonia, with the occurrence of MIH.[9-12]

Clinically, the ideal time for the diagnosis of MIH is during the eruption of primary and permanent teeth. The

clinical manifestations of MIH depend on its severity and are highly variable. The most prominent presentation is well-defined white to brown opaque lesions of different sizes (larger than 1 mm). Due to defective enamel structure, the mechanical properties are reduced compared to sound enamel, and the modulus of elasticity is lower.[3] In severe cases, where the enamel structure is highly porous, there can be a loss of integrity and even fracture of the enamel under masticatory forces; this may result in dentin exposure followed by tooth sensitivity, dental caries, breakdown of enamel structure, and even tooth loss. Atypical caries are usually found in these teeth. Dental treatment also faces challenges such as difficulty in achieving sufficient anesthesia, compromised bonding, and failure of previous restorations.[7,13] Resin composite has emerged as the predominant restorative material for MIH-affected teeth, with adhesion being the most consistently reported determinant of material choice.[14] Briefly, early identification of MIH teeth prevents the condition from worsening and improves their clinical management.[4,15]

The prevalence of MIH varies worldwide. In 2018, Zhao et al[16] reported a global prevalence of 14.2%, with the highest prevalence in South America and the lowest in Africa. However, in a recent meta-analysis published in 2021 by Lopes et al,[17] the prevalence of the disease was reported as 13.5%, of which 36.3% were moderate to severe cases and 36.6% showed incisal involvement. The high prevalence of this disease is a warning sign for dentists to consider MIH in their routine clinical examinations.

In Iran, various studies have been conducted on the prevalence of MIH among children, with differing results. In 2011, Ahmadi et al[18] reported the prevalence of MIH as 12.7% in Zahedan. In a similar study, authors calculated a prevalence of 23% in Yazd,[19] and a recent study found a 24% prevalence in Ardabil.[20]

Due to the highly variable reported prevalence of MIH in different regions of the country, the aim of the current systematic review and meta-analysis is to investigate the prevalence reported in all studies conducted in Iran, as well as possible etiological factors, which have not been reviewed to date.

Methods

Study Design

This systematic review and meta-analysis was registered in the PROSPERO International system (PROSPERO CRD42022328055), and all study steps were designed according to the PRISMA 2020 standard guidelines.[21] The main question of this study was formulated using the PEO framework: P (population): Population of Iranian children; E (exposure): Predisposing factors for molar incisor hypomineralization (MIH); O (outcome): Prevalence of MIH.

Eligibility Criteria

Inclusion criteria comprised studies with a cross-sectional design that examined the prevalence of MIH among Iranian children, published in either Persian or English. Exclusion criteria included studies in non-eligible populations, studies with duplicate content, studies reporting other outcomes, review studies, and those for which the full text was unavailable.

Search Strategy

We searched scientific databases such as PubMed, Scopus, and ISI Web of Science, as well as Iranian local scientific databases Magiran (Magiran.com) and Idml. research.ac.ir, with no time limits up to 30 April 2025. Various combinations of relevant keywords were used with Boolean operators (AND, OR): "Molar Incisor Hypomineralization," "MIH," "enamel hypoplasia," "enamel opacities," "enamel defects," "prevalence," "epidemi*," "cross sectional," "Iran," "Iranian." In PubMed, the Medical Subject Headings (MeSH) term was also applied in combination with other keywords. Detailed search strategies for each database are provided in Table 1.

Quality Assessment

Two independent reviewers assessed study quality using the Joanna Briggs Institute (JBI) Checklist.[22] To calibrate the reviewers, a random sample of 10 studies was checked twice at a one-week interval (Cohen's kappa was calculated). Studies were categorized as low quality (fewer than 6 stars), moderate quality (6–7 stars), and high quality (8 or 9 stars). Any discrepancies were resolved with the involvement of a third reviewer. Only studies rated as high or moderate quality were included in the meta-analysis.

Data Extraction

In the first stage, two researchers independently screened the titles and abstracts of studies. After resolving disagreements with the help of a third reviewer, the full texts of eligible studies were reviewed, and the final set of studies was selected. Data extracted included: First author name, study year, publication year, place of study, sample size, participants' age, prevalence of MIH, prevalence by gender, prevalence by type of tooth involved, diseases and events during the first three years of life reported in the samples, and MIH prevalence by reported diseases.

Statistical Analysis

Data were analyzed using Stata 11 (StataCorp LP, TX, USA). An inverse variance random effects model meta-analysis was conducted to estimate the pooled prevalence of MIH and the 95% confidence interval. Heterogeneity between primary studies was assessed using the Chi-squared test and the I-squared (I^2) statistic. To identify

Table 1. Search Strategy in Different Databases for Systematic Review of MIH Prevalence in Iran

PubMed		Results
1	((prevalence) OR (epidemi*)) OR (cross sectional)	4,636,285
2	("Dental Enamel Hypoplasia"[Mesh]) OR (MIH OR "Molar Incisor Hypomineralization" OR enamel hypoplasia OR enamel opacities OR enamel defects)	7,831
3	((("Dental Enamel Hypoplasia"[Mesh]) OR (MIH OR Molar Incisor Hypomineralization OR enamel hypoplasia OR enamel opacities OR enamel defects)) AND (((prevalence) OR (epidemi*)) OR (cross sectional))) AND (Iran OR Iranian)	25
Web of science		
3	ALL FIELDS: (Prevalence) OR ALL FIELDS: (Epidemi*) OR ALL FIELDS: (Cross sectional) AND ALL FIELDS: (Dental Enamel Hypoplasia) OR ALL FIELDS: (MIH) OR ALL FIELDS: (Molar Incisor Hypomineralization) OR ALL FIELDS: (Enamel hypoplasia) OR ALL FIELDS: (Enamel opacities) OR ALL FIELDS: (Enamel defects) AND ALL FIELDS = (iran)	32
Scopus		
1	TITLE-ABS-KEY(prevalence) OR TITLE-ABS-KEY(epidemi*) OR TITLE-ABS-KEY(cross AND sectional)	3,422,249
2	TITLE-ABS-KEY(molar AND incisor AND hypomineralization) OR TITLE-ABS-KEY(mih) OR TITLE-ABS-KEY(dental AND enamel AND hypoplasia) OR TITLE-ABS-KEY (enamel AND hypoplasia) OR TITLE-ABS-KEY (enamel AND defects) OR TITLE-ABS-KEY (enamel AND opacities	9,943
3	AFFLICOUNTRY (iran)	1,010,164
4	TITLE-ABS-KEY(prevalence) OR TITLE-ABS-KEY(epidemic) OR TITLE-ABS-KEY(cross AND sectional) AND TITLE-ABS-KEY(molar AND incisor AND hypomineralization) OR TITLE-ABS-KEY(mih) OR TITLE-ABS-KEY(dental AND enamel AND hypoplasia) OR TITLE-ABS-KEY (enamel AND hypoplasia) OR TITLE-ABS-KEY (enamel AND defects) OR TITLE-ABS-KEY (enamel AND opacities AND AFFLICOUNTRY (iran)	32
Magiran.com		
1	Molar-incisor-hypomineralization OR dental-enamel-hypoplasia OR enamel-deffects	13

possible sources of heterogeneity, including age, sample size, and year of studies, meta-regression was performed. Subgroup analyses by gender (male, female) and type of tooth (molar, incisor) were also conducted. Sensitivity analysis was used to examine the effect of excluding individual studies on the pooled prevalence.

Results

Study Selection

A total of 111 studies were identified from various databases and other sources in the initial search. After reviewing titles and abstracts and removing duplicates, 24 eligible studies were extracted. In the final stage, applying the eligibility criteria, 14 studies were included in the meta-analysis (Figure 1 and Table 2)

The total sample size across the 14 studies was 48,585. Participants in the studies ranged from 6 to 13 years old. The highest reported prevalence of MIH was observed in the study by Owlia et al[29] in Yazd (52.9%), and the lowest was in the study by Hekmatfar et al in Ardabil (2.3%).[34]

Overall Prevalence of MIH among Iranian Children

The results of the heterogeneity chi-squared test and I-squared (I^2) statistic indicated high heterogeneity among the studies (chi-squared = 2789.58, $P < 0.001$; $I^2 = 99.5\%$). The Forest plot is presented in Figure 2. The overall prevalence of MIH among Iranian children was estimated to be 21.6% (95% CI, 15.5 to 27.7%).

Quality Assessment Results

As previously mentioned, the included published papers were rated using the Joanna Briggs Institute (JBI) checklist tool for prevalence studies. Six studies received a full score of nine and six studies received a score of eight; both categories were defined as high quality. The remaining two studies were considered of medium quality with a score of seven. None of the studies scored below seven.

Subgroup and Meta-Regression Analysis

According to the meta-regression results, the prevalence of MIH decreased over time, but this was not statistically significant ($P = 0.679$, Figure 3). Additionally, as the sample size increased, the prevalence of MIH showed a slight decrease, but this was not statistically significant ($P = 0.154$). Regarding the age of participants, because the mean or median age was not reported in the studies, the midpoint of the reported age range was used. Meta-regression results indicated an increase in the prevalence of MIH with age, but this was not statistically significant ($P = 0.518$, Figure 4). Subgroup analysis by gender showed an estimated MIH prevalence of 23.5% (95% CI, 12.8 to 34.2%) in girls and 22.4% (95% CI, 15.9 to 24.9%) in boys.

Sensitivity Analysis

The highest overall prevalence of MIH was estimated after excluding the study by Hekmatfar et al,[34] at 23.1% (95% CI, 15.6 to 30.6%). The lowest prevalence was estimated after excluding the study by Owlia et al,[29] at 19.2% (95% CI, 13.5 to 24.8%, Figure 5).

Discussion

In this meta-analysis, by collecting data from 14 original studies, the pooled prevalence of molar incisor hypomineralization (MIH) was estimated to be 21.6% in Iran, which is higher than the global average. MIH is a

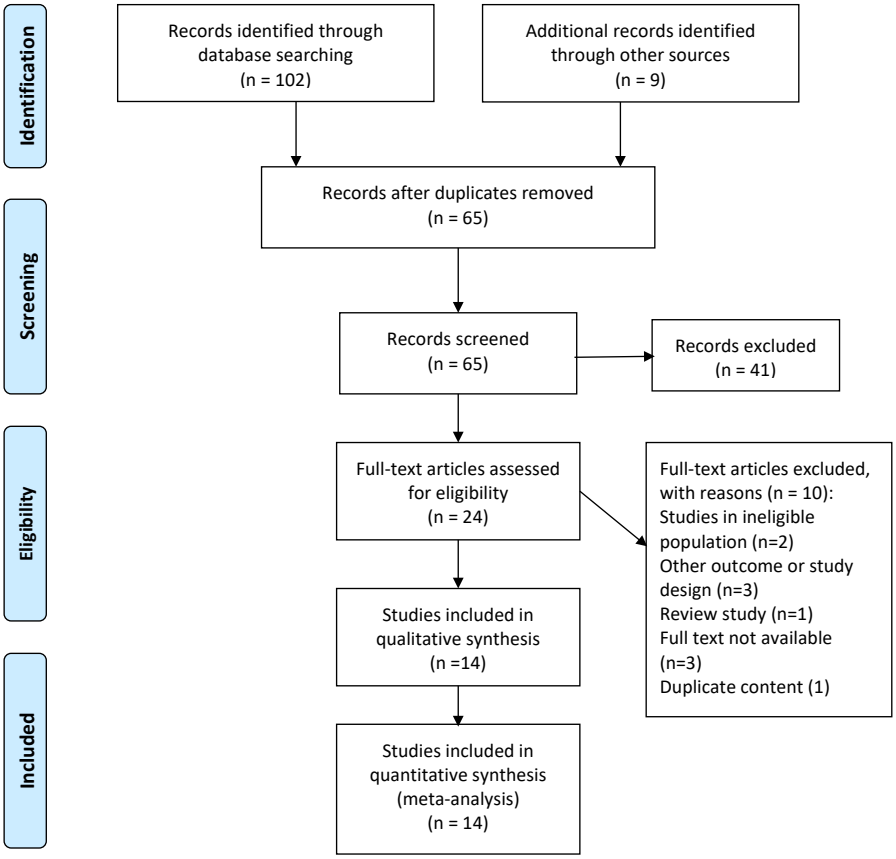

Figure 1. PRISMA Flow Diagram showing included articles in the meta-analysis of MIH prevalence in Iranian children

Table 2. Studies Included in the Meta-Analysis of MIH Prevalence in Iran

Firs author	Study year	Publication year	Location	Prevalence	Sample size	Participant age	Source
Ahmadi[18]	2011	2012	Zahedan	0.127	433	7 to 9	Article
Bahrololoomi[23]	2019	2019	Yazd	0.238	645	7 to 11	Article
Ghanim[24]	2013	2013	Shiraz	0.202	810	9 to 11	Article
Poureslami[25]	2015-2016	2017	Kerman	0.065	779	7 to 12	Article
Salem[26]	2016	2017	Rasht	0.199	1043	6 to 13	Article
Salem[27]	2016	2016	Northern Iran	0.184	553	6 to 13	Article
Shojaeepour[28]	2020	2020	Kerman	0.051	2507	8 to 12	Article
Owlia[29]	2020	2020	Yazd	0.529	606	8 to 9	Article
Memarpour[30]	2013	2013	Shiraz	0.482	1000	9 to 11	Article
Vejdani[31]	2007	2007	Rasht	0.234	538	8 to 9	Article
Einollahi[20]	2020	2020	Ardabil	0.24	520	8 to 10	Article
Hali[32]	2020	2020	Sari	0.202	700	7 to 12	Article
Khanmohammadi [33]	2017	2018	Tehran	0.256	1028	7 to 12	Article
Hekmatfar [34]	2023	2025	Ardabil	0.023	37423	6 to 8	Article

widespread dental condition in children and a growing global oral health concern.[15] Raising clinicians' awareness about MIH facilitates early diagnosis during routine dental examinations, which is critical for preventing the progression of primary lesions into more severe ones with structural breakdown of teeth. The involvement of permanent first molars and incisors highlights the importance of addressing this issue.[35]

A systematic review by Jälevik et al in 2010[7] found the lowest prevalence in Germany and Bulgaria, and the highest in Rio de Janeiro. In a meta-analysis by Schwendicke et al in 2018,[5] the prevalence was reported as 13.1%, with strong influence from high-population countries such as India and China. Only three studies from

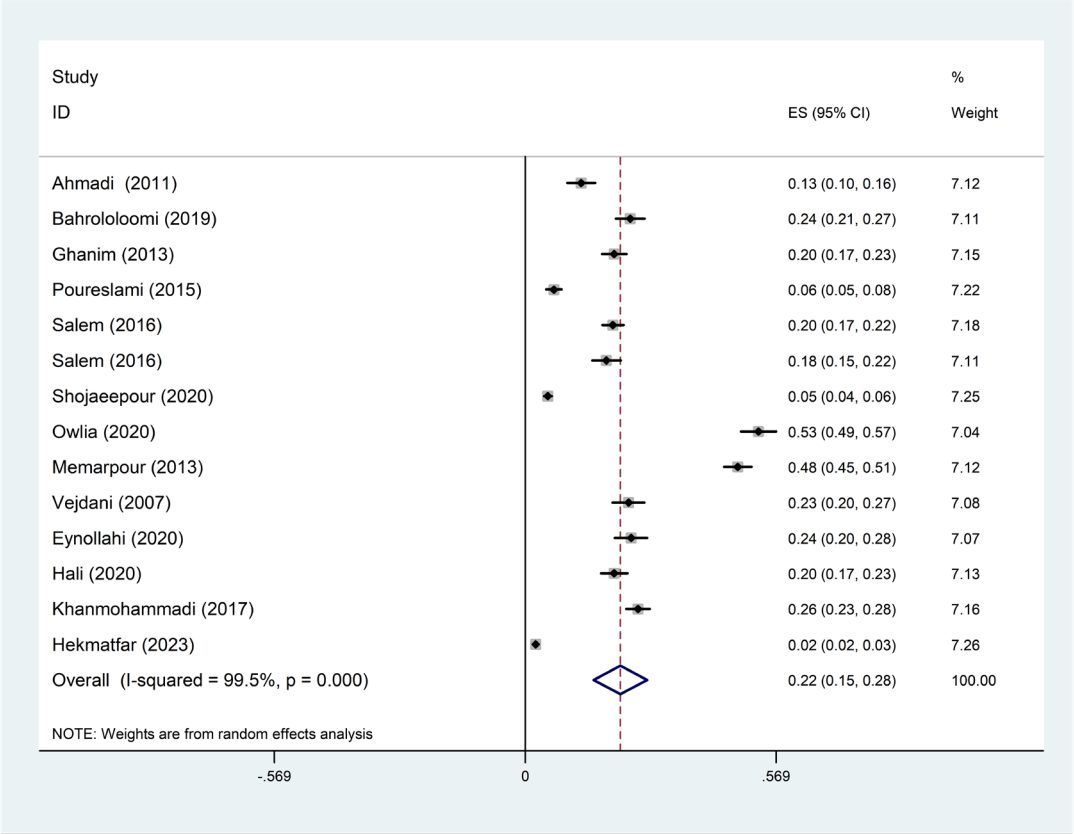

Figure 2. Prevalence and 95% confidence interval of MIH among Iranian children

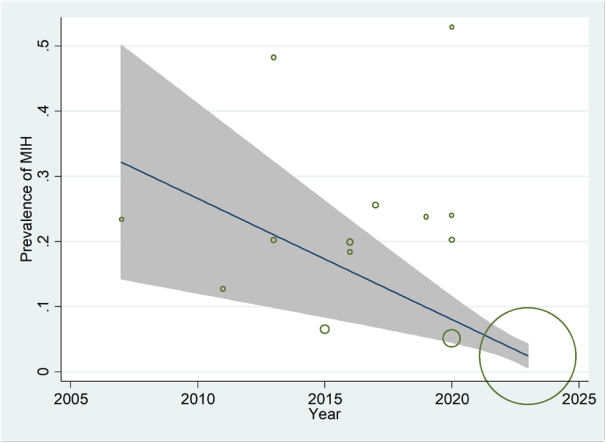

Figure 3. Meta-regression diagram of MIH prevalence by study year

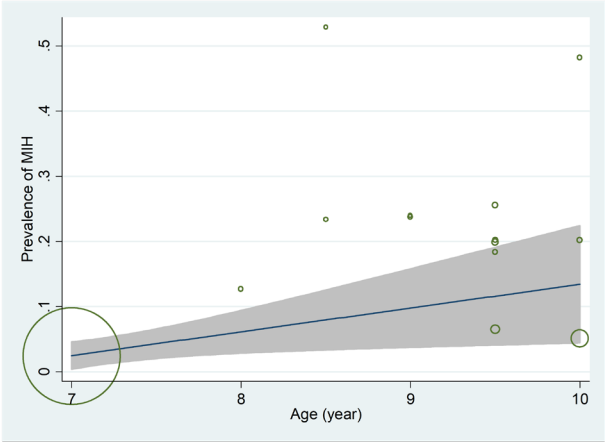

Figure 4. Meta-regression diagram of MIH prevalence by age of participants

Iran in the Middle East group were included in that meta-analysis. By contrast, our study, which reports pooled prevalence from 14 studies with broader geographic distribution, provides a more reliable estimate for Iran. In the same year, Zhao et al[16] reported a global prevalence of 14.2%, with the lowest in Africa and the highest in South America. The latest meta-analysis published in 2021 by Lopes[17] reported the global prevalence of MIH as 13.5%, with the lowest in Asia (10.7%). Of the 116 articles included in that analysis, only two studies were from Iran. In the Americas, MIH prevalence was reported to range from 2.5% to 40.2%, most commonly 10% to 20%.[36] In Europe, prevalence was 18.2% in Italy[37] and 6.6% in Switzerland.[38] Among Sudanese children, prevalence was 20.2%, similar to other regions.[39]

The diversity in reported prevalence rates across studies may be due to different methodological aspects, such as sample size and diagnostic tools. In some analyses, only studies using the European Academy of Paediatric Dentistry (EAPD) definition were included to control for variability introduced by alternative diagnostic criteria. Inclusion of low-quality articles in some analyses could

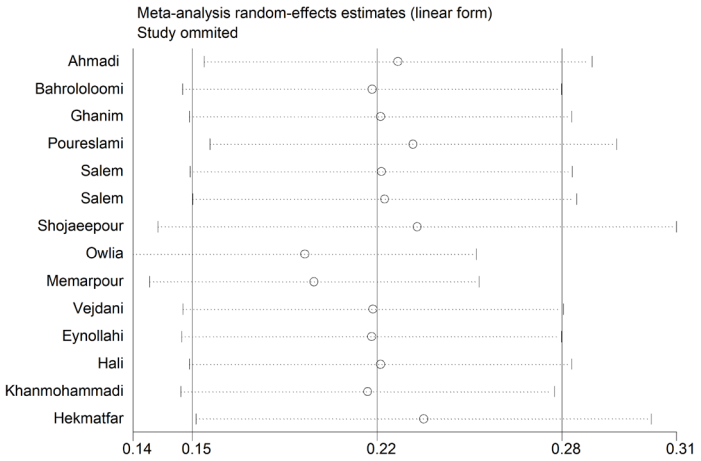

Figure 5. Sensitivity analysis for estimating pooled prevalence (95% confidence interval) of MIH after omitting each study

also contribute to heterogeneity. Furthermore, in the design of some primary studies, sample groups were not representative of the target population—reporting frequency in a specific group rather than true prevalence. Racial variations, age groups, and environmental factors should also be considered.

The prevalence estimated in the studies used in this meta-analysis ranged from the lowest, reported by Hekmatfar et al[34] in Ardabil at 2.3%, to the highest, reported by Owlia et al[29] in Yazd at 52.9%. According to the chi-squared and I-squared (I^2) tests, high heterogeneity existed among the studies. Possible sources of heterogeneity in the Iranian studies include participant age and gender, study sample size, study year, geographical and ethnic distribution, and the clinician's diagnostic skill. Below, we discuss the results of meta-regression, sensitivity analysis, and subgroup analysis in relation to these variables.

One potential source of heterogeneity is individual variation in MIH diagnosis. Sensitivity analysis showed that excluding the Owlia study in Yazd[29] reduced the prevalence estimate to 19.2%. According to the methods in that study, the high value might be related to clinician bias, as the examiner was a final-year dental student and the calibration method was unknown. Clinical expertise is required to distinguish between different grades of MIH and carious lesions. The diagnostic criteria for MIH are critical; as in previous global prevalence studies, most reviewed studies here used the EAPD definition for clinical examinations. Otherwise, heterogeneity in reporting increases. Sensitivity analysis also showed that the highest prevalence, 23.1%, would be obtained after omitting the study by Hekmatfar in Ardabil.[34]

Participant age range can also cause heterogeneity. Our analysis used the median age of participants, and results showed that MIH prevalence increased with age, though not significantly. This trend may be due to restoration or breakdown of MIH-affected teeth over time and the difficulty in precisely identifying the number of affected teeth per individual.

Geographical differences significantly impact prevalence rates. Variability may be attributed to differences in ethnic and racial backgrounds, as well as environmental factors.[40]

Sample size is another factor that may affect heterogeneity. Meta-regression analysis showed that as sample size increased, prevalence decreased, though not significantly. In a recently published article, a minimum sample size of 300 participants was suggested for studying MIH prevalence, and 1,000 participants for investigating possible etiological factors.[41]

Gender-based subgroup analysis revealed that the prevalence of molar incisor hypomineralization (MIH) was 23.5% in girls and 22.4% in boys, with no significant difference between the genders. All previous studies, except for Schwendicke et al,[5] confirm our finding of no significant gender difference, whereas that study reported a higher prevalence in girls. Nevertheless, differences in eruption and crown completion times, as well as varying oral hygiene habits between genders, can affect clinical manifestations.

Subgroup analysis based on the type of tooth involved was not feasible due to the limited number of primary studies; however, MIH primarily affects permanent molars, with incisors tending to have less severe lesions. In the study by Lopes,[17] the prevalence of incisal involvement was 38.7%, which is consistent with our review. According to some reports, there is a possibility of involvement of other teeth, but this is very rare.[25] Enamel formation is a complex and delicate process and can be influenced by numerous individual and environmental factors. According to a previous study,[41] a minimum of 1,000 samples is needed for reliable estimation of etiological factors. In the present search strategy framework, we did not identify studies with a sufficient sample size to investigate predisposing factors in detail. However, the latest meta-analysis by Garot et al[42] on possible etiological factors in MIH—which included

two studies from Iran[18,24] concluded that perinatal and postnatal factors are more involved in the development of this condition than prenatal factors. Fever and antibiotic use, both due to various conditions, may also influence MIH.[8] It should be noted that information regarding the history of the child's exposure to systemic or maternal diseases during pregnancy is typically collected through questionnaires; thus, parental recall bias may result in incorrect or incomplete data.

Conclusion

We observed high heterogeneity in the reported prevalence of MIH among primary studies. The overall prevalence of MIH among Iranian children was estimated at 21.6%, which is higher than the global prevalence. Therefore, it is necessary to raise dental healthcare providers' awareness of this condition and to include MIH in routine dental examinations. Early diagnosis can prevent breakdown and loss of affected teeth. Additionally, MIH prevalence was estimated at 22.4% in boys and 23.5% in girls, and we found a non-significant decrease in prevalence with increasing age.

Limitations and Suggestions

One limitation of our study was the lack of reporting of MIH by variables such as gender, age, and predisposing factors in some primary studies. Future cross-sectional research should consider factors such as gender, the type of tooth involved, and potential predisposing factors. To collect information about predisposing factors more accurately, prospective cohort studies should be designed, with comprehensive medical and dental histories recorded to minimize personal bias. Expanding the geographic scope and age range of participants, as well as collecting more detailed information on environmental, genetic, and medical risk factors, would provide a more comprehensive understanding of MIH epidemiology. It is recommended to perform analytic meta-analyses regarding predisposing factors.

For MIH diagnosis in research, it is best to use pediatric dentists experienced in a variety of MIH lesions to avoid clinician bias, as mild cases or teeth with caries can be difficult for less experienced dentists to diagnose. Calibrating clinicians and using multiple examiners to confirm diagnoses can also be beneficial. Detailed diagnostic criteria should be taught to all examiners. The European Academy of Paediatric Dentistry (EAPD) definition is the most valid diagnostic tool for MIH and its use reduces heterogeneity among studies. Another problem is the lack of a standardized classification of lesion severity; this should be addressed in future research. One important aspect of clinical examination, noted in only some studies, is to dry the tooth and then moisturize it with wet gauze, since excessive dryness can result in misdiagnosis and overestimation of lesions.

Another limitation of our study was the inability to investigate the effects of variables such as geographic differences and ethnicity in subgroup analysis. The EAPD recommends age eight years for MIH diagnosis, as by this age all defined teeth have erupted but have not yet undergone breakdown or restoration.[30] To assess the role of age, prospective studies can be conducted in a specific population from a young age, with clinical examinations performed annually by calibrated clinicians. By comparing results at successive ages, the relationship between age and MIH incidence can be examined. To address geographical differences, it is suggested to conduct cross-sectional studies in various regions, especially large cities, to yield more reliable national prevalence estimates.

Acknowledgments

We appreciate Qazvin University of Medical Sciences for approving and financially supporting this study.

Authors' Contribution

Conceptualization: Melika Ghasemi, Razieh Jabbarian.
Data curation: Melika Ghasemi, Razieh Jabbarian.
Investigation: Melika Ghasemi, Razieh Jabbarian, Mehdi Ranjbaran
Formal analysis: Mehdi Ranjbaran.
Methodology: Melika Ghasemi, Razieh Jabbarian, Mehdi Ranjbaran.
Project adminstration: Razieh Jabbarian.
Supervision: Mehdi Ranjbaran, Razieh Jabbarian.
Software: Melika Ghasemi, Mehdi Ranjbaran.
Resource: Melika Ghasemi, Razieh Jabbarian, Mehdi Ranjbaran.
Validation: Melika Ghasemi, Razieh Jabbarian, Mehdi Ranjbaran.
Visualization: Melika Ghasemi, Razieh Jabbarian, Mehdi Ranjbaran.
Writing- original draft: Melika Ghasemi.
Writing- review & editing: Razieh Jabbarian, Mehdi Ranjbaran.

Competing Interests

The authors report no conflict of interest.

Data Availability Statement

The data used in this study came from primary studies, which are available in the full text of the article.

Ethical Approval

Study protocol was approved by Research Ethics Committees of Qazvin University of Medical Sciences (IR.QUMS.REC.1401.003).

Funding

The Qazvin University of Medical Sciences, under Grant 400000582, supported this work.

References

1. Wu X, Wang J, Li YH, Yang ZY, Zhou Z. Association of molar-incisor hypomineralization with premature birth or low birth weight: systematic review and meta-analysis. J Matern Fetal Neonatal Med. 2020;33(10):1700-8. doi: 10.1080/14767058.2018.1527310
2. Weerheijm KL, Jälevik B, Alaluusua S. Molar-incisor hypomineralisation. Caries Res. 2001;35(5):390-1. doi: 10.1159/000047479
3. Xie Z, Kilpatrick NM, Swain MV, Munroe PR, Hoffman M. Transmission electron microscope characterisation of molar-incisor hypomineralisation. J Mater Sci Mater Med.

2008;19(10):3187-92. doi: 10.1007/s10856-008-3441-2
4. Weerheijm KL, Duggal M, Mejàre I, Papagiannoulis L, Koch G, Martens LC, et al. Judgement criteria for molar-incisor hypomineralisation (MIH) in epidemiologic studies: a summary of the European meeting on MIH held in Athens, 2003. Eur J Paediatr Dent. 2003;4(3):110-3.
5. Schwendicke F, Elhennawy K, Reda S, Bekes K, Manton DJ, Krois J. Global burden of molar-incisor hypomineralization. J Dent. 2018;68:10-8. doi: 10.1016/j.jdent.2017.12.002
6. American Academy of Pediatric Dentistry (AAPD). Molar-incisor hypomineralization. In: The Reference Manual of Pediatric Dentistry. Chicago, Ill: AAPD; 2024. p. 444-51.
7. Jälevik B. Prevalence and diagnosis of molar-incisor hypomineralisation (MIH): a systematic review. Eur Arch Paediatr Dent. 2010;11(2):59-64. doi: 10.1007/bf03262714
8. Elzein R, Chouery E, Abdel-Sater F, Bacho R, Ayoub F. Molar-incisor hypomineralisation in Lebanon: association with prenatal, natal and postnatal factors. Eur Arch Paediatr Dent. 2021;22(2):283-90. doi: 10.1007/s40368-020-00555-5
9. Bandeira Lopes L, Machado V, Botelho J, Haubek D. Molar-incisor hypomineralization: an umbrella review. Acta Odontol Scand. 2021;79(5):359-69. doi: 10.1080/00016357.2020.1863461
10. Silva MJ, Scurrah KJ, Craig JM, Manton DJ, Kilpatrick N. Etiology of molar-incisor hypomineralization - a systematic review. Community Dent Oral Epidemiol. 2016;44(4):342-53. doi: 10.1111/cdoe.12229
11. Allazzam SM, Alaki SM, El Meligy OA. Molar-incisor hypomineralization, prevalence, and etiology. Int J Dent. 2014;2014:234508. doi: 10.1155/2014/234508
12. Koruyucu M, Özel S, Tuna EB. Prevalence and etiology of molar-incisor hypomineralization (MIH) in the city of Istanbul. J Dent Sci. 2018;13(4):318-28. doi: 10.1016/j.jds.2018.05.002
13. Kotsanos N, Kaklamanos EG, Arapostathis K. Treatment management of first permanent molars in children with molar-incisor hypomineralisation. Eur J Paediatr Dent. 2005;6(4):179-84.
14. Bagheri R, Ghanim A, Azar MR, Manton DJ. Molar-incisor hypomineralisation: discernment a group of Iranian dental academics. J Oral Health Oral Epidemiol. 2014;3(1):21-9.
15. Lygidakis NA, Garot E, Somani C, Taylor GD, Rouas P, Wong FSL. Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor hypomineralisation (MIH): an updated European Academy of Paediatric Dentistry policy document. Eur Arch Paediatr Dent. 2022;23(1):3-21. doi: 10.1007/s40368-021-00668-5
16. Zhao D, Dong B, Yu D, Ren Q, Sun Y. The prevalence of molar-incisor hypomineralization: evidence from 70 studies. Int J Paediatr Dent. 2018;28(2):170-9. doi: 10.1111/ipd.12323
17. Lopes LB, Machado V, Mascarenhas P, Mendes JJ, Botelho J. The prevalence of molar-incisor hypomineralization: a systematic review and meta-analysis. Sci Rep. 2021;11(1):22405. doi: 10.1038/s41598-021-01541-7
18. Ahmadi R, Ramazani N, Nourinasab R. Molar-incisor hypomineralization: a study of prevalence and etiology in a group of Iranian children. Iran J Pediatr. 2012;22(2):245-51.
19. Bahrololoomi Z, Mostafalu N, Shakib A. Relationship between molar-incisor hypomineralization with body mass index and dental caries index in 7-11-year-old children in Yazd city. J Shahid Sadoughi Univ Med Sci. 2017;25(1):11-9.
20. Einollahi M, Hekmatfar S, Molaei M. Association between molar-incisor hypomineralization and both prenatal and postnatal factors in 8-10-year-old children in Ardebil. J Evol Med Dent Sci. 2020;9(48):3606-11. doi: 10.14260/jemds/2020/793
21. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg. 2021;88:105906. doi: 10.1016/j.ijsu.2021.105906
22. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. Int J Evid Based Healthc. 2015;13(3):147-53. doi: 10.1097/xeb.0000000000000054
23. Bahrololoomi Z, Amrollahi N, Mostafaloo N. The prevalence and extent of molar-incisor hypomineralization by gender in a group of Iranian children. Iran J Public Health. 2020;49(8):1585-7. doi: 10.18502/ijph.v49i8.3911
24. Ghanim A, Bagheri R, Golkari A, Manton D. Molar-incisor hypomineralisation: a prevalence study amongst primary schoolchildren of Shiraz, Iran. Eur Arch Paediatr Dent. 2014;15(2):75-82. doi: 10.1007/s40368-013-0067-y
25. Poureslami H, Shojaiepour R, Abbaspour S, Aminizadeh M, Khademi M, Abbaspour S. Prevalence of the molar-incisor hypomineralization in seven to twelve-year-old students of Kerman, Iran, in 2015-2016. J Oral Health Oral Epidemiol. 2017;7(1):21-7. doi: 10.22122/johoe.v7i1.389
26. Salem K, Azarbaan S. An investigation of the prevalence and predictive factors of molar-incisor hypomineralization in Rasht, Iran. J Mashhad Dent Sch. 2017;41(1):31-40. doi: 10.22038/jmds.2017.8368
27. Salem K, Aziz D, Asadi M. Prevalence and predictors of molar-incisor hypomineralization (MIH) among rural children in northern Iran. Iran J Public Health. 2016;45(11):1528-30.
28. Shojaeepour S, Jalali F, Shokrizadeh M, Riahi Madvar R, Torabi-Parizi M, Shojaeipour R. Assessing the prevalence of molar-incisor hypomineralization and its effects on oral health-related quality of life in children aged 8-12 years in the city of Kerman, Iran. J Oral Health Oral Epidemiol. 2020;9(3):143-8. doi: 10.22122/johoe.2020.192030.1081
29. Owlia F, Akhavan-Karbassi MH, Rahimi R. Could molar-incisor hypomineralization (MIH) existence be predictor of short stature? Int J Prev Med. 2020;11:101. doi: 10.4103/ijpvm.IJPVM_459_18
30. Memarpour M, Golkari A, Ahmadian R. Association of characteristics of delivery and medical conditions during the first month of life with developmental defects of enamel. BMC Oral Health. 2014;14:122. doi: 10.1186/1472-6831-14-122
31. Vejdani J, Kaboodan M. Prevalence of enamel defects and associating factors in permanent incisors and first molars in 8-9 years-old children. J Guilan Univ Med Sci. 2010;19(73):13-9.
32. Hali H, Molania Jelodar T, Emadian M, Gohardehi S, Moosazadeh M, Salehi M. Prevalence of molar-incisor hypomineralisation among school children of Sari, Iran. J Pediatr Perspect. 2021;9(9):14341-7. doi: 10.22038/ijp.2020.51135.4068
33. Khanmohammadi R, Seraj B, Salari A, Alipour F. Etiological factors involved in molar-incisor hypomineralization in 7 to 12-year-old children in Tehran. Front Dent. 2022;19:16. doi: 10.18502/fid.v19i16.9962
34. Hekmatfar S, Kaffashchian S, Darabi F, Jafarzadeh M, Shabani M, Jafari Kaffash K. The responsiveness of the health system to MIH in children aged 6-8 years: the case of Ardabil province (a short communication). J Oral Health Oral Epidemiol. 2025;14(1):1-4. doi: 10.34172/johoe.2403.1634
35. Giuca MR, Lardani L, Pasini M, Beretta M, Gallusi G, Campanella V. State-of-the-art on MIH. Part. 1 Definition and aepidemiology. Eur J Paediatr Dent. 2020;21(1):80-2. doi: 10.23804/ejpd.2020.21.01.16
36. Martignon S, Bartlett D, Manton DJ, Martinez-Mier EA, Splieth C, Avila V. Epidemiology of erosive tooth wear, dental fluorosis and molar incisor hypomineralization in

the American continent. Caries Res. 2021;55(1):1-11. doi: 10.1159/000512483
37. Nisii F, Mazur M, De Nuccio C, Martucci C, Spuntarelli M, Labozzetta S, et al. Prevalence of molar-incisor hypomineralization among school children in Rome, Italy. Sci Rep. 2022;12(1):7343. doi: 10.1038/s41598-022-10050-0
38. Abdelaziz M, Krejci I, Banon J. Prevalence of molar-incisor hypomineralization in over 30,000 schoolchildren in Switzerland. J Clin Pediatr Dent. 2022;46(1):1-5. doi: 10.17796/1053-4625-46.1.1
39. Abdalla HE, Abuaffan AH, Kemoli AM. Molar-incisor hypomineralization, prevalence, pattern and distribution in Sudanese children. BMC Oral Health. 2021;21(1):9. doi: 10.1186/s12903-020-01383-1
40. Sönmez H, Yıldırım G, Bezgin T. Putative factors associated with molar-incisor hypomineralisation: an epidemiological study. Eur Arch Paediatr Dent. 2013;14(6):375-80. doi: 10.1007/s40368-013-0012-0
41. Elfrink ME, Ghanim A, Manton DJ, Weerheijm KL. Standardised studies on molar-incisor hypomineralisation (MIH) and hypomineralised second primary molars (HSPM): a need. Eur Arch Paediatr Dent. 2015;16(3):247-55. doi: 10.1007/s40368-015-0179-7
42. Garot E, Rouas P, Somani C, Taylor GD, Wong F, Lygidakis NA. An update of the aetiological factors involved in molar-incisor hypomineralisation (MIH): a systematic review and meta-analysis. Eur Arch Paediatr Dent. 2022;23(1):23-38. doi: 10.1007/s40368-021-00646-x