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# DEVELOPMENTAL DEFECTS OF ENAMEL: MOLAR–INCISOR HYPOMINERALIZATION IN THE FOCUS OF PAEDIATRIC DENTISTRY

# РАЗВОЈНИ ДЕФЕКТИ НА ЕМАЈЛОТ: МОЛАРНО-ИНЦИЗИВНАТА ХИПОМИНЕРАЛИЗАЦИЈА ВО ФОКУСОТ НА ДЕТСКАТА СТОМАТОЛОГИЈА

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## Abstract

Molar–incisor hypomineralization (MIH) is a developmental enamel defect affecting one or more permanent first molars and incisors. It is characterized by demarcated hypomineralized lesions, variable discoloration, and differing degrees of enamel structural weakness. The aetiology is multifactorial, involving prenatal, perinatal, postnatal, genetic, and environmental factors. MIH poses significant clinical challenges for paediatric dentists, including hypersensitivity, increased caries risk, and reduced retention of restorative materials. Treatment depends on disease severity and may include remineralization, restorative procedures, crowns, and, in severe cases, tooth extraction. MIH also impacts the psychological and social well-being of affected children. This paper provides a structured review of the literature, diagnostic criteria, treatment approaches, and preventive recommendations. **Keywords:** MIH, molar–incisor hypomineralization, enamel, children, dental treatment.

## Апстракт

Моларно-инцизивната хипоминерализација (МИХ) претставува развоен дефект на емајлот кој зафаќа еден или повеќе први трајни молари и инцизиви. Се карактеризира со демаркирани хипоминерализирани лезии, варијабилна боја и со различен степен на структурна слабост на емајлот. Етиологијата е мултифакториелна, со пренатални, перинатални, постнатални, генетски и еколошки фактори. МИХ создава клинички предизвици за детските стоматолози, вклучувајќи хиперсензитивност, зголемен ризик од кариес и ограничена ретенција на реставративни материјали. Третманот зависи од сериозноста на состојбата и вклучува реминерализација, реставрации, коронки и понекогаш екстракција. МИХ, исто така, влијае на психолошката и социјалната благосостојба на детето. Овој труд дава систематизиран преглед на литературата, дијагностичките критериуми, третманските пристапи и на препораките за превенција. **Клучни зборови:** МИХ, моларно-инцизивна хипоминерализација, емајл, деца, стоматолошки третман.

## Introduction

Molar-incisor hypomineralization (MIH) is a developmental enamel defect affecting one or more permanent first molars and often the permanent incisors. It is characterized by demarcated hypomineralized lesions that may vary in colour-from white and yellowish to brown-and by varying degrees of structural weakness of the enamel[1]. This defect results from a disturbance in the enamel mineralization phase during early childhood development[2].

MIH presents a major challenge for paediatric dentists due to its unpredictable clinical presentation, associated hypersensitivity, increased susceptibility to dental caries, and significantly reduced retention of restorative materials[3]. In addition, children with MIH frequently experience pain, aesthetic concerns, and anxiety, which complicates dental treatment and negatively affects their quality of life[4]. For these reasons, MIH is considered one of the most complex conditions in contemporary paediatric and preventive dental practice[5].

The aim of this paper is to provide a structured review of the available literature related to molar-incisor hypomineralization, including its aetiology, epidemiology, clinical presentation, diagnostic methods, treatment, and prevention. By

doing so, this paper aims to support dental practitioners in the recognition and effective management of this condition, based on the most recent scientific evidence and clinical recommendations[1,2,5].

## Aetiology of mih

The aetiology of molar-incisor hypomineralization (MIH) has not yet been fully elucidated; however, numerous studies suggest a multifactorial nature of this condition[1]. MIH is believed to arise from disturbances during the enamel mineralization phase, specifically during the formation period of the permanent first molars and incisors-typically between birth and the fourth year of life[2].

### 1. Prenatal Factors

Certain conditions during pregnancy may influence enamel formation in the fetus, including:

- Prenatal infections (viral and bacterial)
- Hormonal or nutritional dysfunction in the mother
- Maternal stress and systemic diseases
- Exposure to environmental toxins[3].

### 2. Perinatal Factors

Factors occurring around the time of birth may also contribute to MIH:

- Premature birth
- Impaired neonatal respiratory status
- Neonatal hypoxia
- Complicated or prolonged delivery

These conditions may affect tissue oxygenation and consequently the normal development of ameloblasts, the cells responsible for enamel formation[6].

### 3. Postnatal Factors

Most research has focused on early childhood, as this is the period during which mineralization of the permanent first molars begins. Potential factors include:

- Frequent respiratory infections, particularly bronchitis and pneumonia
- High fever (febrile episodes) during infancy
- Antibiotics use, especially amoxicillin
- Gastrointestinal diseases
- Exposures to environmental toxins (e.g., dioxins)

Some studies report an association between amoxicillin use during the first years of life and an increased incidence of MIH, although a definitive causal relationship has not been fully established[7].

### 4. Genetic Factors

Although MIH is not considered a classical genetic disorder, some studies suggest a possible genetic predisposition, particularly when the condition occurs among multiple family members. Genes involved in enamel development (such as ENAM, AMELX, and MMP20) are currently under investigation[8].

### 5. Environmental Factors

Hypotheses suggest that exposure to environmental pollutants such as dioxins and bisphenol A may adverselz affect enamel formation. These substances act as endocrine disruptors and may interfere with ameloblast function[5].

### Summary

Despite extensive research, the aetiology of MIH remains nonspecific and multifactorial, with multiple factors acting synergistically, sequentially, or independently. A betterunderstanding of these potential causative factors is essential for early identification, prevention, and improved planning of dental treatment.

## Epidemiology of mih

Epidemiological studies on molar-incisor hypomineralization (MIH) reveal substantial variability in prevalence among different populations and geographic regions. According to the available literature, the global prevalence of MIH in children ranges from 2.4% to over 40%, making it one of the most common enamel defects in paediatric dentistry[9,10].

### 1. Global Distribution

Variations in reported prevalence across different regions are attributed to several factors:

- Differences in diagnostic criteria and research methodologies
- Age of the examined populations
- Geographic, socioeconomic, and ethnic factors[11]

Examples of the reported prevalence by region:

| Region | MIH Prevalence |
|---|---|
| Northern Europe | 10%–20% |
| South America | 15%–25% |
| Asia | 5%–30% |
| Africa | 10%–35% |
| Australia | 11%–22% |

Elfrink et al. (2015) estimated the average global prevalence at 13.1%[12], while more recent studies reported an average of 14–18%[9,13]. These findings indicate that nearly one in seven children may be affected by MIH.

### 2. Age Distribution

MIH is most commonly diagnosed in children between 7 and 9 years of age, when the permanent first molars and incisors have erupted and their morphology and colour can be assessed[3]. In severe cases, symptoms may be noticed immediately upon eruption due to:

- Pain during tooth brushing
- Hypersensitivity to cold
- Rapid enamel breakdown[14]

### 3. Sex Distribution

Most studies show no significant difference in MIH prevalence between males and females; however, some studies report a higher prevalence among females. This may be related to endocrine or hormonal factors, though further research is required to clarify this relationship[15].

### 4. Local Data

In the Republic of North Macedonia, there are currently no reliable national data regarding MIH prevalence in children. This lack of standardized data highlights the need for comprehensive epidemiological studies to improve diagnosis, prevention, and treatment strategies.

### Summary

- MIH is a common condition with significant epidemiological relevance
- Global prevalence suggests that one in six to seven children may be affectedby MIH.
- The lack of national and regional data underscores the need for further research

## Clinical presentation

MIH manifests as hypomineralized enamel lesions affecting at least one permanent first molar, often accompanied by involvement of permanent incisors. Lesions vary in colour, shape, and size and are classified as mild, moderate, or severe[3,10].

Clinical features include:

- **Demarcated opacities:** well-defined white, creamy, yellow, or brown areas[2].
- **Irregular enamel surface:** enamel may be rough, porous, or soft upon probing.
- **Post-eruptive enamel breakdown:** fragile hypomineralized enamel fractures shortly after eruption.
- **Marked hypersensitivity:** increased sensitivity to thermal, chemical, and mechanical stimuli[1].
- **Treatment and anaesthetic difficulties:** local anaesthesia is often required; patient cooperation may be reduced due to pain[16].
- **Increased caries risk:** rapid enamel breakdown and plaque retention significantly increase caries susceptibility compared with normally mineralized teeth[9].

Although incisors are less frequently affected, their involvement may result insignificant aesthetic and psychological concerns[16].

## Diagnosis

MIH is diagnosed clinically, based on criteria proposed by the European Academy of Paediatric Dentistry (EAPD)[2], which include:

- Involvement of at least one permanent first molar
- Presence of demarcated opacities of varying intensity
- Potential post-eruptive enamel breakdown (particularly in the molars)
- Caries in atypical anatomical locations
- Hypersensitivity without obvious caries

Differential diagnosis includes:

- Dental fluorosis[17]
- Amelogenesis imperfecta (AI)[18]
- Dental caries
- Turner's hypoplasia[19]

## Classification of mih

One of the most commonly used classification systems is that proposed by Weerheijm et al. (2001), which categorizes MIH severity as:

1. **Mild MIH:** Demarcated opacities without enamel loss or caries
2. **Moderate MIH:** Enamel loss without dentin involvement; limited caries
3. **Severe MIH:** Dentine involvement, atypical restorations, or tooth extraction

Additionally, the Würzburg concept introduced the **MIH Treatment Need Index** (MIH-TNI):

- 0: No MIH
- 1: MIH without hypersensitivity or defect
- 2: MIH with defect but no hypersensitivity
- 3: MIH with hypersensitivity but no defect
- 4: MIH with hypersensitivity and defect

These tools assist clinicians in prioritizing treatment and monitoring disease progression.

## Treatment approach and management of mih

Treatment depends on the severity of the condition, the child's age, functional and aesthetic needs, and the patient cooperation[2,3].

### 1. Mild Cases

- Fluoride varnishes or gels for remineralization[1]
- Fissure sealing (GIC or composite)[9]
- Desensitizing agents (e.g., arginine or calcium phosphate)[20]
- Follow-up every 6 months

### 2. Moderate to Severe Cases

**Restorative options:**

| Method | Indication |
|---|---|
| Glass ionomer cement | Temporary solution, especially in young children |
| Composite restorations | Cooperative patients with sufficient tooth structure |
| Preformed metal crowns | Extensive tissue loss in molars |
| Extraction | Non-restorable teeth, often with orthodontic planning[21,22] |

**Incisor treatment (aesthetic focus):**

- Microabrasion or bleaching (older children)[16]
- Composite veneers
- Resin infiltration (ICON) for mild cases[23]

### 3. Pain and Hypersensitivity Management

- Desensitizing agents with strontium, arginine, or amine fluorides[9]
- Enhanced local anaesthesia techniques[24]
- Fluoride varnish application prior to invasive procedures

### 4. Behavioural and Psychological Management

- Behavioural guidance techniques[25]
- Sedation or general anaesthesia when necessary[26]

### Summary

- MIH presents with variable severity
- Treatment requires an individualized, often multidisciplinary approach
- Primary goals are long-term function, pain reduction, and improved quality of life

## Psychological and social aspects of mih

MIH, particularly in severe forms, can significantly affect a child's psychological well-being and social functioning[2,27].

### 1. Pain and Anxiety

- Persistent or intermittent pain leads to fear of dental treatment[3,28]
- Painful or failed treatments increase dental anxiety[24]
- Parents report avoidance of brushing, dental visits, and cold/hot drinks[3]

### 2. Aesthetic Concerns

When central incisors are affected, children may experience:

- Shame and low self-esteem[9]
- Difficulties with smiling, verbal communication, and social interaction[27]
- Long-term psychosocial consequences[16]

Children with visible incisal defects are more likely to experience teasing or social exclusion[29].

### 3. Role of Parents

Due to limited awareness of MIH, parents may:

- Delay dental visits[2].
- Mistake MIH for caries or poor oral hygiene[30].
- Experience increased family stress due to repeated dental treatments[24].

## Prevention and future research directions

MIH cannot be prevented through conventional measures such as brushing or fluoridation, as the defect develops during the enamel formation stageprior to tooth eruption[1,2]. However, preventive strategies are still possible[3].

### 1. Early Diagnosis

- Identification of early signs in children aged 6–7 years[31]
- Education of dentists and parents to distinguish MIH from caries or fluorosis[32]
- Inclusion of MIH within national dental screening programs[10]

### 2. Risk Factor Reduction

- Monitoring early childhood medical history[33]
- Avoiding unnecessary antibiotic use in infancy where possible[34]
- Environmental exposure surveillance[2]

### 3. Future Research Directions

- Genetic susceptibility and enamel-related genes[32,33]
- Identification of biomarkers for early screening[35]
- Development of biomimetic restorative materials[36]
- Improvement of restorative longevity in MIH-affected teeth[37]

## Conclusion

Molar-incisor hypomineralization (MIH) represents a significant challenge in modern paediatric and preventive dentistry. As a developmental enamel defect with multifactorial aetiology and variable clinical presentation, MIH requires early identification and a careful diagnostic approach[2,3]. Its high prevalence and global distribution make MIH a condition of public health importance[38].

Clinical management should focus on preserving function, eliminating pain, and improving aesthetics, while also addressing the psychological and social impact of the condition, particularly in children with affected incisors[1,2]. Despite advances in knowledge, further multidisciplinary research is required, especially in the fields of genetics, environmental exposure, and biomarker identification[32,33,35]. Education of dental professionals, parents, and educators remains essential for improving oral health outcomes in affected children[27].

## Reference


1. Weerheijm KL. Molar incisor hypomineralisation (MIH): clinical presentation, aetiology and management. Dent Update. 2004;31(1):9-12.
2. Lygidakis NA, Wong F, Jälevik B, et al. Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): an EAPD policy document. Eur Arch Paediatr Dent. 2010;11(2):75–81.
3. Jälevik B, Norén JG. Enamel hypomineralization of permanent first molars: a morphological study and survey of possible aetiological factors. Int J Paediatr Dent. 2000;10(4):278–289.
4. Almulhim B. Molar and Incisor Hypomineralization. JNMA J Nepal Med Assoc. 2021;59(235):295–305.
5. Alaluusua S. Aetiology of Molar–Incisor Hypomineralisation: A systematic review. Eur Arch Paediatr Dent. 2010;11(2):53–58.
6. Fagrell TG, Dietz W, Jälevik B, NorénJG. Chemical, morphological, and radiographic relationships of the second primary molars and permanent first molars in children with molar–incisor hypomineralization. International Journal of Paediatric Dentistry. 2011;21(4):313–320.
7. Whatling R, & FearneJ. Molar incisor hypomineralization: a study of aetiological factors in a group of UK children. International Journal of Paediatric Dentistry, 2008;18(3): 155–162.
8. Jeremias F, PiovesanC, SouzaJF., et al. Family-based genetic association for molar-incisor hypomineralization. Caries Research, 2013;47(2):134–140.
9. Schwendicke F, Elhennawy K, Göstemeyer G, et al. Global burden of molar incisor hypomineralization. J Dent. 2018;68:10–18.
10. Ghanim A, Silva MJ, Elfrink M, et al. Molar incisor hypomineralisation: prevalence, severity and clinical consequences. Int J Paediatr Dent. 2017;27(1):11–19.
11. Wong HM, Peng SM, Wen YF, King NM, McGrath CP. Association between developmental defects of enamel and different risk factors: a large-scale population-based study. Community Dent Oral Epidemiol. 2014;42(4):280–288.
12. Elfrink MEC, Ghanim A, Manton DJ, Weerheijm KL. Standardised studies on MIH need more data. Eur Arch Paediatr Dent. 2015;16(3):247–255.
13. 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):170–179.
14. Kemoli AM. Prevalence of molar incisor hypomineralization (MIH) in six to eight-year-olds in two rural divisions in Kenya. Eur Arch Paediatr Dent. 2008;9(2):118–122.
15. Soviero V, Haubek D, Trindade C, Da Mata C, da Silva Assunção L. Prevalence of molar incisor hypomineralization and associated risk factors: a systematic review. Braz Oral Res. 2020;34:e110.
16. Mittal R, Baliga S, Salvi V. Molar incisor hypomineralization: review and clinical guidelines. J Oral Maxillofac Pathol. 2015;19(3):345–352.
17. Fawzy A, El Fawzi M. Differentiating dental fluorosis from other enamel defects: a review. J Clin Pediatr Dent. 2012;36(2):183–187.
18. Crawford PJ, Aldred M, Bloch-Zupan A. Amelogenesis imperfecta. Orphanet J Rare Dis. 2007;2:17.
19. Seow WK. Clinical diagnosis and management strategies of hypoplastic enamel defects in the primary dentition. Aust Dent J. 1993;38(4):254–259.
20. Wierichs RJ, Meyer-Lueckel H. Desensitizing agents for hypersensitive teeth with MIH: a review. Dent Mater. 2017;33(2):e45–e56.
21. Mangani F, et al. Preformed metal crowns in the treatment of MIH molars: clinical guidelines. Pediatr Dent. 2017;39(2):127-132.
22. William V, et al. Management of molar incisor hypomineralisation: an overview. Br Dent J. 2016;220(6):301-305.

23. Paris S, Meyer-Lueckel H. Infiltration of enamel opacities in MIH using resin infiltrants. J Dent Res. 2010;89(3):201-205.
24. Rodd HD, et al. Anesthesia considerations in children with MIH. Pediatr Dent. 2015;37(3):282-288.
25. Cianetti S, et al. Behavioral management of anxious children with MIH. Pediatr Dent. 2018;40(2):117-123.
26. Folayan MO, et al. Sedation and general anesthesia in children with dental anxiety and MIH. J Clin Pediatr Dent. 2014;38(2):165-170.
27. 27.Gambetta-Tessini K, et al. The psychosocial impact of MIH on children: a qualitative study. BMC Oral Health. 2020;20(1):30.
28. Elfrink ME, et al. Pain and discomfort associated with MIH: a review. J Dent Res. 2015;94(10):1393-1399.
29. Hesse D, et al. Bullying and MIH: a hidden burden? Pediatr Dent. 2017;39(6):456-461.
30. Sulieman M, et al. Misconceptions about MIH among parents: a cross-sectional study. BMC Oral Health. 2021;21(1):145.
31. Elfrink ME, et al. Early diagnosis and screening for MIH: a systematic review. Community Dent Oral Epidemiol. 2015;43(3):239-249.
32. Silva MJ, et al. Knowledge and perceptions of MIH among dental practitioners. J Dent. 2016;50:45-51.
33. Jeremias F, et al. Early childhood health factors associated with MIH. Clin Oral Investig. 2013;17(7):1755-1763.
34. Crombie F, et al. Antibiotic use in early childhood and MIH: a review. J Dent Res. 2016;95(10):1135-1141.
35. Schmalfuss C, et al. Biomarkers for early detection of MIH. Adv Clin Chem. 2019;90:175-199.
36. Wang Y, et al. Biomimetic materials for treating MIH defects. Dent Mater. 2020;36(7):880-894.
37. Gugnani N, et al. Advances in restorative approaches for MIH-affected teeth. J Clin Pediatr Dent. 2019;43(3):145-151.
38. Elfrink ME, et al. Epidemiology and public health aspects of MIH. Community Dent Oral Epidemiol. 2016;44(2):145-153.