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MINI-REVIEW

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Dental caries prevention in pediatric patients with molar incisor hypomineralization: a scoping review

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Abstract

This scoping review aims to summarize the available evidence on strategies employed in preventing caries in patients with molar incisor hypo-mineralization (MIH). MIH refers to an enamel defect involving opacities, and sometimes post-eruptive degradation due to enamel porosity; resulting in outcomes ranging from a mild atypical caries to severe coronary destruction. A systematic review was conducted for literature in PubMed, Cochrane Library, Epistemonikos and Literatura Latinoamericana y del Caribe en Ciencias de la Salud (LILACS). The search was aimed at studies published between January 2010 and February 2022. Data were independently selected and extracted. 989 studies were found from the systematic search and 8 studies met the eligibility criteria. Most studies evaluated remineralization and cariogenic risk, both of which are crucial elements in caries prevention, as well as decreased sensitivity. The included studies investigated fluoride varnish, dental sealants, giomers, casein, and Icon as preventative methods for dental caries. Several methods for preventing dental caries in paediatric patients with MIH exist, but more research is needed to determine their effectiveness and safety. Any preventive intervention should consider the etiological aspects of the disease, the risk of caries, the type and extent of lesions, hypersensitivity level and patient's age. Collaboration between patients and carers is critical for disease diagnosis and caries prevention.

Keywords

Dental caries; Molar incisor hypo-mineralization; Prevention; Pediatric dentistry

1. Introduction

Molar Incisor Hypo-mineralization (MIH) has been described as an inadequate mineralization of the enamel, affecting one or more of the first permanent molars or permanent incisors [1]. Enamel defects can develop as a consequence of decreased activity of the enamel-forming ameloblasts, resulting in linearly distributed pits or grooves. These changes can be found in two phases: the secretion phase (Enamel matrix formation), and the maturation phase (enamel mineralization). If an unbalance occurs during the former, the enamel defect is called hypoplasia, but if it occurs during the latter, a defect in the enamel translucence can occur and it is known as hypo-mineralization [2, 3]. Although the etiology of MIH remains unknown, its clinical presentation, localization and the asymmetry of the associated lesions, suggests a systemic etiology [4].

MIH is effectively diagnosed in children around the age of eight, when both incisors and permanent molars have erupted [5, 6]. Enhanced understanding and diagnosis of MIH have enabled in determining the disease's prevalence in various regions and countries. In Europe, its prevalence ranges between 2.4% and 40.2% [7]. In South American countries, the prevalence of MIH is higher than in Europe, and varies among countries with levels of 19.8% in Brazil, 14% in Mexico, 15.9% in Argentina, 16.1% in Uruguay and 16.8% in Chile [8].

Teeth affected by MIH can undergo post-eruptive degradation due to enamel porosity, resulting in outcomes ranging from mild atypical caries to severe coronary damage [5, 9]. Therefore, during the analysis of patient's clinical history for MIH diagnosis, it is essential to assess the family history for the first three years of life. This period corresponds to the formation of first molars' crown, incisors, and permanent canines [9–11]. Although the prediction of the rate of caries progression in patients with MIH remains difficult, teeth affected by MIH experience a high proclivity to develop caries due to their structural morphology and inappropriate tooth brushing associated to hypersensitivity [12, 13].

The presence of extensive caries with opacities in the surroundings or carious lesions in non-susceptible areas in children with low cariogenic risk allows to diagnose MIH [14, 15]. There are cases in which certain areas of healthy enamel are hyper-mineralized, which are helpful for the diagnosis [14]. It is essential to initiate caries preventive interventions as soon as MIH is diagnosed at an early age by giving recommendations to parents or caregivers [12, 15]. For instance,

recommendations may include the use of toothpaste containing a fluoride concentration of at least 1000 parts per million (ppm) [14, 16] or other topical fluorides to reduce sensitivity and improve mineralization such as varnishes containing 22,600 ppm [15, 17].

Toothpastes are a commonly recommended as an MIH preventative method. Those containing hydroxyapatite were further considered due to hydroxyapatite's ability to reduce the formation of bacterial biofilms and enhance enamel surface repair through the formation of a protective coat that acts as a calcium and phosphate reservoir [18]. Nonetheless, results from a clinical trial comparing the use of toothpaste containing hydroxyapatite and amine fluoride in children suggest comparable effectiveness in terms of preventing hypersensitivity in MIH teeth [18]. A similar randomized trial in which biomimetic zinc-hydroxyapatite-based paste was applied to a group of children, showed a desensitizing effect and a slight reduction of MIH Treatment Need Index scores, in teeth affected from mild MIH defects [19].

Other recommendations for caries prevention in MIH-affected teeth include the application of compounds such as amorphous calcium phosphopeptide phosphocaseinate phosphopeptide (CPP-ACP). Such compounds produce a stable supersaturated solution of calcium and phosphate, which is deposited on the enamel surface, allowing mineral recovery and improved sensitivity [16, 17]. Furthermore, pit and fissure sealants were recommended, especially in the presence of brown opacities. A pretreatment with 5% sodium hypochlorite allows the removal of intrinsic proteins of the enamel, enhancing the adhesion and the right placement of sealants for caries prevention [9, 12, 17].

The presence of various recommendations for caries prevention methods for paediatric patients diagnosed with MIH can be associated with the rising prevalence of MIH among children. It is important to know what preventive methods are currently applied in this population to prevent dental caries. The aim of his scoping review is to summarize the available literature evidence on caries preventive methods in pediatric patients with MIH. The paper analyses literature data to assess MIH prevent approaches alongside patients' characteristics such as age. The duration of the intervention, the type of preventive treatment that has been applied and the effectiveness of the approach are critically analyzed.

2. Methods

The protocol for this scoping review was conducted based on the JBI (Joanna Briggs Institute's Reviewers) manual. This protocol was registered on Open Science Framework on 25 November 2020, and is available at https://osf.io/upd4h/.

2.1 Eligibility Criteria

Observational studies were included in the present research (cohort, case-control, cross-sectional, longitudinal and case series/reports), clinical trials and systematic reviews that evaluate methods to prevent dental caries in pediatric patients aged 6 to 12 years with MIH in permanent dentition. Only studies published in English and Spanish were included.

Studies that evaluated MIH in primary teeth or in teeth with caries; and studies with populations that had other enamel defects or pulp injury were excluded.

2.2 Search strategy

A systematic search was performed in the following databases: PubMed, Cochrane Library, Epistemonikos, LILACS and in the gray literature (Google Scholar) (Table 1). The search was restricted to studies published between January 2010 and February 2022.

2.3 Selection of studies

Two reviewers (AP, VA) first screened a few articles and discussed about their selection for calibration. Subsequently the same two reviewers independently screened all the other articles by title and abstract. Studies that did not meet the selection criteria were excluded. Then, included articles were independently reviewed by full-text. Discrepancies were initially solved by discussion between the two reviewers. However, if consensus was not reached, a third reviewer (CMG) intervened and the study selection was discussed among all authors. Rayyan Systems Inc. was used for the articles screening and selection process.

2.4 Data extraction

Two reviewers (AP, VA) extracted data into an Excel spreadsheet, including: author(s), year of publication, study design, age of patients, duration of intervention, MIH concept, key findings and conclusions. If there was any hesitation with data extraction, a third reviewer (CMG) intervened.

3. Results

989 studies were found from the systematic search. There were 940 studies remaining after duplicates were removed. A total of 914 studies were excluded by title and abstract, and 26 studies were reviewed by full-text. Finally, 8 studies met the selection criteria for this study (Fig. 1). Of the included articles, three were case reports [6, 16, 18]; three were longitudinal studies [5, 8, 9] and two studies were prospective clinical trials [5, 17]. These studies were published between 2015 and 2021. All selected studies focused on the preventive management of caries in children with MIH (Table 2).

3.1 MIH concept

The majority of studies affirmed that MIH is an enamel defect delimited by opacities. However, there were differences regarding the etiology of this disease. One study mentioned that MIH has a systemic origin [11], others described its etiology as congenital [5, 9], while others suggested the disease has an unknown origin [12, 14] (Table 2).

3.2 Population

Most of the studies included children between 6 and 12 years of age. This age range corresponds to the period for tooth loss and was reported to be the appropriate time to start preventive treatment [5, 6, 9, 16, 20, 21]. Regarding the countries of

TABLE 1. Search strategy performed in different databases.

Database	Search strategy
PubMed/Medline	(Molar Incisor Hypomineralization) OR (Molar Incisor Hypomineralization (MeSH Terms)) AND ((Child*) OR (pediatric patients)) AND ((teeth caries) OR (Dental caries (MeSH Terms)))
Epistemonikos	(title: ((title: (Child*) OR abstract: (Child*))) OR (title: (pediatric patients) OR abstract: (pediatric patients))) OR abstract: ((title: (Child*) OR abstract: (Child*)) OR (title: (pediatric patients) OR abstract: (pediatric patients)))) AND (title: ((title: (deep caries) OR abstract: (deep caries)) OR (title: (dental caries) OR abstract: (dental caries))) OR abstract: ((title: (deep caries) OR abstract: (deep caries)) OR (title: (dental caries) OR abstract: (dental caries)))) AND (title: ((title: (Hypomineralization, Molar Incisor) OR abstract: (Hypomineralization, Molar Incisor))) OR abstract: ((title: (Hypomineralization, Molar Incisor) OR abstract: (Hypomineralization, Molar Incisor)))
Cochrane library	(Child*): ti,ab,kw OR (pediatric patients): ti,ab,kw AND (Molar Incisor Hypomineralization): ti,ab,kw OR (Hypomineralization, Molar Incisor): ti,ab,kw AND (dental caries): ti,ab,kw
LILACS	tw: ((tw: (niños)) AND (hipomineralización incisivo molar)) AND (tw: (Caries dental))
Google scholar	“Molar incisor hypomineralization” AND “children” AND “Caries dental”

TABLE 2. Main characteristics of the included studies.

Author/year	Design	Objective	MIH concept
Arce, [20] 2020	Case Report	To describe the reconstruction, sealing of pits and fissures and eliminate sensitivity in a patient with MIH-affected teeth using giomer.	MIH is a developmental defect, a dysfunctional process of enamel mineralization.
Bakkal, [12] 2017	Longitudinal Study	To evaluate the effect of casein phosphopeptide-amorphous calcium phosphopeptide and amorphous calcium fluoride phosphopeptide-casein phosphopeptide on teeth with MIH.	Not described.
Bullio, [5] 2015	Longitudinal Study	To evaluate the clinical performance of glass ionomer restorations in MIH teeth at 12 months.	MIH is a qualitative enamel defect of systemic origin.
Fragelli, [9] 2017	Clinical Trial	To evaluate the clinical survival of sealants applied to permanent first molars with MIH.	MIH is a congenital dental enamel disorder affecting one or more permanent first molars as well as the incisors.
Giannetti, [16] 2018	Clinical Trial	To evaluate the effectiveness of surface infiltration with icon in teeth affected with MIH.	Not described.
Lopez, [21] 2019	Longitudinal Study	To explore data on MIH prevention and its relationship to dental caries.	MIH is an enamel pathology characterized by the appearance of enamel’s opacities.
Mejia, [6] 2018	Case Report	To explore possible rehabilitation options for MIH and apply preventative interventions for dental caries.	MIH is a defect in the quality of the enamel, of unknown origin.
Romo, [22] 2016	Case Report	To describe dental management options and restorative treatment for MIH and to apply preventative interventions for dental caries in a patient aged 8 years and 11 months with MIH.	MIH is a structural enamel defect of non-specific etiology.

MIH: molar incisor hypo-mineralization.

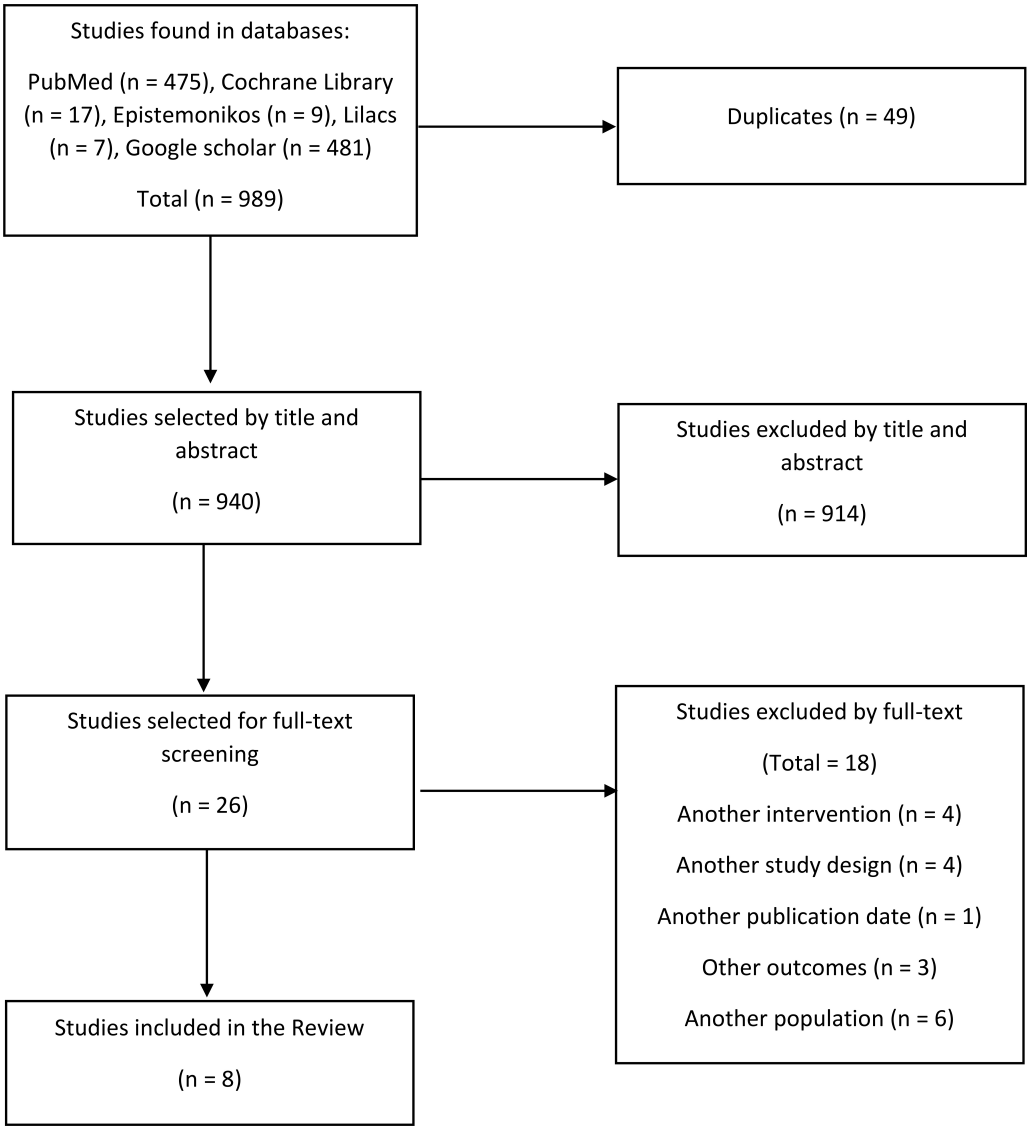

FIGURE 1. Prisma flowchart of the review selection process.

publication, two studies were published in Brazil [5, 9] one study in Chile [17] and one study in Ecuador [22].

3.3 Intervention

In terms of treatment, three studies focused on fluoride varnish [6, 12, 22]; two evaluated dental sealants [5, 10] and one study evaluated giomers [18]. Another study assessed casein [12] and another evaluated Icon [16]. The selected studies lasted between six and 18 months (**Supplementary Table 1**).

Five of the selected studies proposing interventions for the prevention of dental caries in patients with MIH were considered beneficial in their conclusions [6, 10, 12, 17, 20]; 3 proposed interventions were considered to have no clinical relevance [5, 11, 22] and no study reported the proposed intervention to be harmful or detrimental in preventing caries in patients with MIH.

3.4 Outcomes

The outcomes that were assessed in the included studies consisted of: 1. Remineralization, measured by changes of teeth appearance over time and acquired hardness assessed by a World Health Organization (WHO) probe [12, 16, 20, 21]; 2. Dental sensitivity measured by applying a stimulus and using the scale of Wong and Baker [7, 10, 16–18]; 3. Cariogenic risk that was clinically measured using International Caries Detection and Assessment System (ICDAS) and Decay, Missed and Filled (DMF) index for caries diagnosis [6, 19].

4. Discussion

MIH is currently considered a potential worldwide public oral health problem. Its origin is not exclusively systemic, but a condition of complex etiology that may involve genetic al and environmental interactions [23]. In a systematic review Silva *et al.* [24] found significant associations between MIH and pre-natal and peri-natal factors. Among these maternal illness, the use of medications in pregnancy, prematurity and birth complications were enumerated. The authors proposed that diseases from early childhood (*e.g.*, fever, asthma and pneumonia) were considered a risk factor for the development of MIH. Other factors such as maternal alcohol consumption and ethnicity were also reported [24, 25].

The European Academy of Pediatric Dentistry (EAPD) [23] conducted an update in 2022 of its clinical practice guideline for dentists and pediatric dentists dealing with children diagnosed with MIH. In this guideline, MIH has been considered to be of multifactorial etiology, which depends on the duration, intensity, and timing of its etiological factors. Furthermore, perinatal hypoxia, prematurity, and other hypoxia-related perinatal problems, including cesarean section, were considered as factors that increase the risk of MIH. Moreover, the EAPD [26] postulates that etiologic, systemic, genetic factors along with environmental influences may explain more severe forms of MIH.

Regarding the main findings of this scoping review, caries preventive methods in pediatric patients with MIH that were mainly reported were remineralization [10, 12, 17–19] and pit and fissure sealants [27]. Fragelli *et al*. [9] (2017) evaluated the clinical performance of the application of glass ionomer for 18 months, as a caries preventative method in teeth with MIH. The authors reported that 72% of the applied sealants remained unchanged after the follow-up. Similarly, Dulla and Meller, [28] in their research recommended using glass ionomer cement as an intermediate covering, or composite resins for preventative treatment of MIH-affected teeth.

Agreeing with these results, Schraverus *et al*. [29] (2021) clinical trial conducted on 77 children aged between five and nine years old who had at least one molar affected by MIH and without post-eruptive breakage (PEB) or caries lesions in the dentin. The authors found that molars affected by MIH from a group with the application of ionomer glass sealant were less likely to develop dental caries compared to those assigned to a control group (Odds Ratio (OR) = 0.23; 95 % Confidence Interval (CI): 0.06–0.95). Conversely, the authors did not observe the same protective effect for PEB; concluding that glass ionomer sealants can prevent dental caries in MIH-affected molars. Nonetheless, PEB has exhibited little effectiveness in MIH-affected molars with post-eruptive breakage [29].

Dulla and Meller [28] reported that an intensive prophylactic protocol should be administered as soon as MIH is diagnosed in order to delay enamel breakdown and prevent the development of dental caries. Nogueira *et al*. [30] (2021) highlighted that the application of flowable glass ionomer cement is recommended as an intermediate protection to stabilize the porous structure of hypo-mineralized molars in patients at high risk of developing caries. In addition, Nogueira *et al*. [30] recommended resin infiltration to prevent enamel breakage to a greater extent.

In patients with MIH, the use of topical fluoride varnish to prevent dental caries in permanent teeth has been suggested in conjunction with frequent dental check- up intervals (3 to 6 months) and a healthy diet with sugar intake controls, so the affected teeth can be effectively monitored for fissures [26].

Early identification of teeth affected by MIH is key to preventing further complications due to the higher risk of caries development. Though since hypersensitivity is another feature of MIH-affected teeth, children's dental hygiene practices may be curtailed; therefore, it is advised that their carers ensure adequate dental hygiene. Individual preventive measures can postpone restorative treatments and reduce patient discomfort in the long term. Furthermore, early diagnosis enables the follow-up and implementation of such preventive measures as soon as the affected surfaces are accessible [27].

Although the most common preventive methods recommended for caries prevention in MIH are applied chairside such as Fluoride varnish, Pits and fissure Sealant, Giomer, Casein and Icon; there are other methods that can be applied at home such as fluoride toothpaste and hydroxyapatite-tooth pastes. The latter have shown positive results in terms of reducing hypersensitivity and supporting remineralization. Although home-based methods still need the control of a professional to ensure their effectiveness, they have the advantage of being affordable. The opposite occurs with chairside methods, which tend to be more effective since they are under control of a professional. However, their duration is longer and the costs are higher compared to home-based prevention [18–20, 27].

Successful management of dental caries in MIH-affected teeth begins with a focus on oral health promotion and prevention. The earlier the implementation, the more effective are the approaches. Thanks to the progress in the diagnosis and management for MIH as well as the advances in dental materials, clinical solutions have been provided in cases previously considered non manageable. However, long-term randomized clinical trials (RCTs) have yet to be conducted to find more reliable results [26]. One of the limitations of this study is that only two RCTs were included the conclusions are mainly based on observational studies with small sample sizes, especially case reports constituting half of the selected studies in this review. Therefore, more RCTs should be conducted on this topic to improve the robustness of the outcomes.

Another limitation of this review is that only articles written in English and Spanish were included, which may have resulted in a selection bias since studies written in other languages were not included. Additionally, restricting the search to the period between January 2010 and February 2022 leaves a gap in which possible earlier publications that could have been included.

Despite these limitations this scoping review, there were also several strengths, such as the extensive systematic search in several databases that was performed, which resulted in a variety of study designs published in the last two decades, conducted in different countries and describing different methods or types of caries preventive interventions in pediatric patients with MIH. Available evidence was concisely summarized based on the most relevant arguments in literature.

Finally, the same keywords indicated in the methods section were used to search for studies on this topic in the International Clinical Trials Registry Platform of the World Health Organization and in `Clinicaltrials.gov`; but no ongoing studies were found. No systematic reviews were found in the International Prospective Register of Systematic Reviews (PROSPERO) of the National Institute for Health Research at the date of this review. However, during the revision process of this study, a new randomized clinical trial on this topic was published in which three groups of patients received either calcium glycerophosphate (CaGP), casein phospho-peptide amorphous calcium fluoride phosphate (CPP-ACFP), or served as a control. Results suggest a significant improvement in MIH-lesions over time across all groups. Although that the authors suggest the additional use of CaGP and CPP-ACFP improved

the hypo-mineralized lesions with mineral deposition, future studies were still recommended to evaluate the long-term effect of these agents [31].

Further studies are needed to understand the effectiveness and safety of caries preventative methods in MIH, especially, more longitudinal studies and randomized controlled clinical trials that address larger population groups. Studies should focus on children diagnosed with MIH, which is the most affected population. This could improve the reliability of reported arguments on caries preventive methods in children with MIH.

5. Conclusions

Several preventive methods for dental caries management in pediatric patients with MIH have been investigated in literature. In addition, for the management of dental caries in children, it is crucial to consider the etiological aspects of the disease and develop an accurate diagnosis approach that evaluates the risk of caries, the type and extent of the lesions. Other factors such as hypersensitivity, the age of the patient and the collaboration of both the patients and their parents or carers are fundamental to achieving adequate results.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

ADPJ—design and implement the research, to perform data extraction, and synthesize the results, to write the manuscript; VSAM—implement the research, to perform data extraction and to revise the final manuscript; MD—implement the research and to revise the final manuscript; CMG—design and implement the research to write and revise the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/1675738751607685120/attachment/Supplementary%20material.docx

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