

Global research trends on molar-incisor hypomineralisation: a bibliometric analysis

Tendências globais de pesquisa sobre hipomineralização molar-incisivo: uma análise bibliométrica

Tendencias mundiales de investigación científica sobre la hipomineralización molar-incisivo: un análisis bibliométrico

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Abstract

This study aimed to give an overview on the international scientific production on molar-incisor hypomineralisation and to analyze the 100 most-cited articles. A search strategy was built to retrieve the international scientific production on molar-incisor hypomineralisation in the Web of Science database up to July 2020. The 100 most-cited MIH articles were also identified. Two researchers performed article selection and data extraction. Graphical bibliometric maps were created at VOSviewer. A total of 292 MIH studies were included. Australia (51.0%) and Brazil (47.0%) were the countries with most articles. The University of Melbourne had the highest number of publications (18.5%). The 100 most-cited molar-incisor hypomineralisation articles received a mean of 32.01 citations. Most articles were published between 2013 and 2016 (52.0%). The most frequent topic was about prevalence of molar-incisor hypomineralisation (30.0%) and cross-sectional (45%) was the most frequent study design. No significant correlations were found between the journal Impact Factor (2019) and the total citations on WoS ($p=0.076$) and Google Scholar ($p=0.411$). This bibliometric study identified the global trends about molar-incisor hypomineralisation research activity.

Keywords: Bibliometric analysis; Bibliometrics; Molar-incisor hypomineralisation.

Resumo

Este estudo teve como objetivo traçar um panorama da produção científica internacional sobre a hipomineralização molar-incisivo e analisar os 100 artigos mais citados. Foi construída uma estratégia de busca para recuperar os estudos científicos sobre hipomineralização molar-incisivo na base de dados Web of Science até julho de 2020. Também

foram identificados os 100 artigos mais citados sobre hipomineralização molar-incisivo. Dois pesquisadores realizaram a seleção dos artigos e extração dos dados. Gráficos bibliométricos foram criados no VOSviewer. Um total de 292 estudos sobre hipomineralização molar-incisivo foram incluídos. Austrália (51,0%) e Brasil (47,0%) foram os países com mais artigos publicados. A Universidade de Melbourne teve o maior número de publicações (18,5%). Os 100 artigos mais citados sobre hipomineralização molar-incisivo receberam uma média de 32,01 citações. A maioria dos artigos foi publicada entre 2013 e 2016 (52,0%). O tópico mais frequente foi a prevalência da hipomineralização molar-incisivo (30,0%), o desenho de estudo mais frequente foi o transversal (45%). Não foram encontradas correlações significativas entre o Fator de Impacto do periódico (2019) o total de citações no WoS ($p=0,076$) e Google Acadêmico ($p=0,411$). Este estudo bibliométrico identificou as tendências globais sobre a atividade de pesquisa sobre hipomineralização molar-incisivo.

Palavras-chave: Análise bibliométrica; Bibliometria; Hipomineralização molar-incisivo.

Resumen

Este estudio tuvo como objetivo dar una visión general de la producción científica internacional sobre hipomineralización molar-incisivo y analizar los 100 artículos más citados. Se construyó una estrategia de búsqueda para recuperar la producción científica internacional sobre hipomineralización molar-incisivo en la base de datos Web of Science hasta julio de 2020. También se identificaron los 100 artículos sobre hipomineralización molar-incisivo más citados. Dos investigadores realizaron la selección de artículos y la extracción de datos. Los mapas bibliométricos gráficos se crearon en VOSviewer. Se incluyeron un total de 292 estudios sobre hipomineralización molar-incisivo. Australia (51,0%) y Brasil (47,0%) fueron los países con más artículos. La Universidad de Melbourne tuvo el mayor número de publicaciones (18,5%). Los 100 artículos más citados sobre hipomineralización molar-incisivo recibieron una media de 32,01 citas. La mayoría de los artículos se publicaron entre 2013 y 2016 (52,0%). El tema más frecuente fue sobre la prevalencia de hipomineralización molar-incisivo (30,0%) el diseño de estudio más frecuente fue transversal (45%). No se encontraron correlaciones significativas entre la revista Impact Factor (2019) y el total de citas en WoS ($p=0,076$) y Google Scholar ($p=0,411$). Este estudio bibliométrico identificó las tendencias globales sobre la actividad investigadora del hipomineralización molar-incisivo.

Palabras clave: Análisis bibliométrico; Bibliometría; Hipomineralización molar-incisivo.

1. Introduction

Bibliometric analyses apply a set of methods quantitative and statistical to evaluate research published in journals. Bibliometrics allows the systematization and analysis of scientific publications (Pritchard, 1969; Khalil & Gotway, 2015). Quantitative data from bibliometric studies provide an estimate of the impact and global coverage of publications, allow the detection of collaborative networks, identify prolific authors, countries, journals, research trends, among other features of published studies (Khalil & Gotway, 2015). Citation analysis enables to identify the repercussion of a research publication, since the number of citations is an indirect indicator of scientific merit (Feijoo et al., 2014).

Although the first bibliometric studies were written in the last century, at present, bibliometric analysis are still scarce within the field of Dentistry (Pritchard, 1969; Perazzo et al., 2019). Recently, Perazzo et al. (2019) investigated the main articles most cited in pediatric dentistry journals. A great relevance in identifying the most cited articles is that they are usually written by experts or influential groups of recognized researchers who can present perceptions about the future directions on a given thematic (Mattos et al., 2020; Garcovich et al., 2020).

In 2001, a research group suggested the term “Molar-Incisor Hypomineralisation (MIH)” to define a specific qualitative enamel defect that compromises first permanent molars with or without affecting permanent incisors (Weerheijm et al., 2001). Nowadays, MIH is considered a dynamic enamel defect in which other teeth groups may be affected, such as canines and premolars. It has a global burden of 12.9% and worldwide prevalence of 14.2% varying from 0.5 to 40.2%, depending on the sample characteristics (Zhao et al., 2018; Dave & Taylor, 2018; Schwendicke et al., 2018). The etiology of MIH is yet to be elucidated, but the literature highlights possible environmental and systemic risk factors (Fatturi et al., 2019; Pang et al., 2020). Accordingly, it is believed that genetic factors have great potential over the higher risk of developing this condition (Vieira & Manton, 2019).

Clinically, MIH-affected teeth have asymmetrically located areas of demarcated opacity yellow, cream, white or

brown colored (da Costa-Silva et al., 2010). Enamel tends to be more porous and brittle, so post-eruptive rupture under masticatory forces are frequently reported (Rodd et al., 2007; Weerheijm, 2004). Patients with MIH often present chronic inflammation of the pulp, hypersensitivity and difficulties in obtaining adequate local analgesia and adequate behavior management as well (Fagrell et al., 2008; Lygidakis et al., 2010). Children with the condition tend to exhibit a higher experience of dental caries, with negative implications on their oral health-related quality of life, especially those classified as severe cases (Ebel et al., 2018; Ghanim et al., 2019). The clinical care of patients with MIH may reveal several treatment possibilities, including prevention (dental caries and post-eruptive rupture), minimal intervention, treatment of dentin hypersensitivity, restorative treatment, and tooth extraction (Vieira & Manton, 2018; Elhennawy & Schwendicke, 2016).

MIH is emerging topic with significant interest owing to the fact that it represents a current public health matter. Although several bibliometric studies about oral health aspects have been conducted in recent years (Perazzo et al., 2019; Mattos et al., 2020), such analysis on MIH was not published until now. An analysis about global research trends on molar-incisor hypomineralisation can help scientists to define the best research strategies focusing on gaps in knowledge in this field and also provide an overview about the network collaborations around the world. The aim of this study was to identify and analyze the global scientific research trends on molar-incisor hypomineralisation and to identify the 100 most-cited articles.

2. Methodology

The Clarivate Analytics Web of Science® Core Collection (WoS-CC) database was used to access the scientific output information of this quali-quantitative bibliometric study. The Science Citation Index Expanded (SCI-E), Social Sciences Citation Index (SSCI) and Emerging Sources Citation Index (ESCI) multidisciplinary indexes collection were used to access the databases. The search was carried out on July, 2020. The following keyword search strategy was used: TS=(“molar-incisor hypomineralisation” OR “molar-incisor-hypomineralisation” OR “molar incisor hypomineralization” OR “molar-incisor hypomineralization” OR “MIH”). The search was then refined by year (2001 to 2019) and document type (article and review), without language restriction.

Two independent researchers performed the selection of articles based on titles and abstracts of retrieved studies. Only articles focused on MIH were included. To identify global research trends related to MIH, the Result Analysis Tool of WoS-CC were used. The following bibliometric parameters were extracted: number of published documents per year, language, top prolific countries, institutions and journals, and most-cited articles. Furthermore, the Journal Citation Reports (JCR), Science Edition 2020 was used to obtain the journal Impact Factor (2019).

The 100 most-cited MIH articles were identified based on the number of citations received in WoS-CC. After reading the full text of included articles, the following data were manually extracted: title of the article, first author, year of publication, country of origin, journal title and journal Impact Factor (IF) (2019), total number of citations in WoS-CC; study design and aim. Any disagreement on data extraction was resolved through discussion and mutual consensus. Google Scholar was used to compare number of citations.

The Microsoft® Excel software was used for data analyses and to create graphics. The VOSviewer (v.1.6.15 Leiden University Center for Science and Technology Studies, Netherlands software) was used to build, visualize and analyze bibliometric networks. In the output map, the items or nodes represent the elements of analysis (authors, countries, journals or keywords). The larger the node size, the higher the density of this element in the network. A line linking two nodes represents the connection between them. A cluster is a set of nodes displayed within a map and each cluster is represented by a color (van Eck & Waltman, 2010). Strongly related terms are positioned closer to each other.

Data were analyzed using the software Stata (StataCorp LLC, Texas, EUA) version 13.0. To check normality, the Kolmogorov-Smirnov test was used. Correlations between the IF (2019) and total number of citations in WoS and Google

Scholar were estimated through Spearman's correlation analysis. The level of significance was set at 5%.

3. Results

3.1 Descriptive analysis

The search retrieved a total of 820 studies. After applying the eligibility criteria, 528 articles were excluded, resulting in a final selection of 292 MIH documents. English (96.5%) was the primary language of the published studies, while the remaining 3.5% of publications were written in German, Spanish, Italian, Polish and/or Turkish.

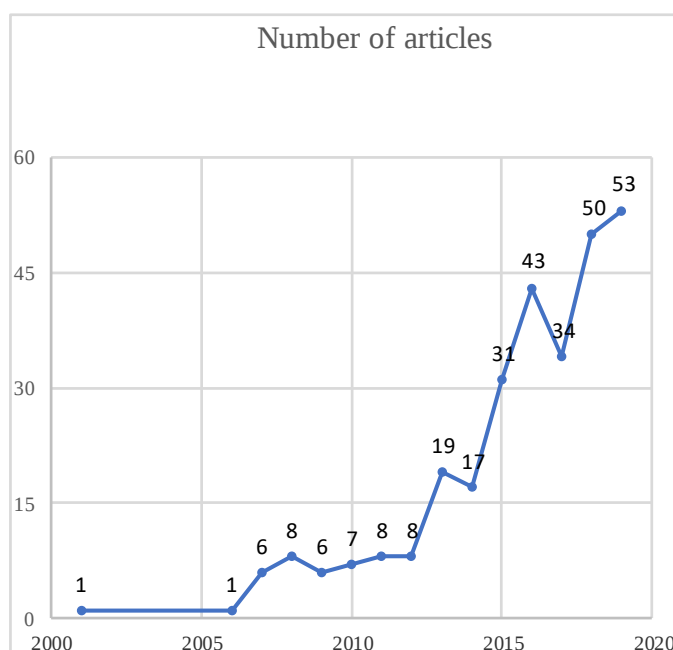
3.2 Analysis of publication trend and country activity

The Figure 1A shows the annual publications related to MIH from 2001 to 2019. The number of publications began to increase from 2013, and reached a peak in 2019 (n=53). Publications were conducted by 55 different countries among the all articles retrieved whereas thirty-six published 1–5 articles and nine published 6–11 articles. The Figure 1B is a world map with the top 10 countries with the highest number of MIH articles (235 articles; 80.2%). Among these countries, Australia published the largest number of articles (51 articles; 17.4%), followed by Brazil (47 articles; 16.0%) and Germany (31 articles; 10.9%).

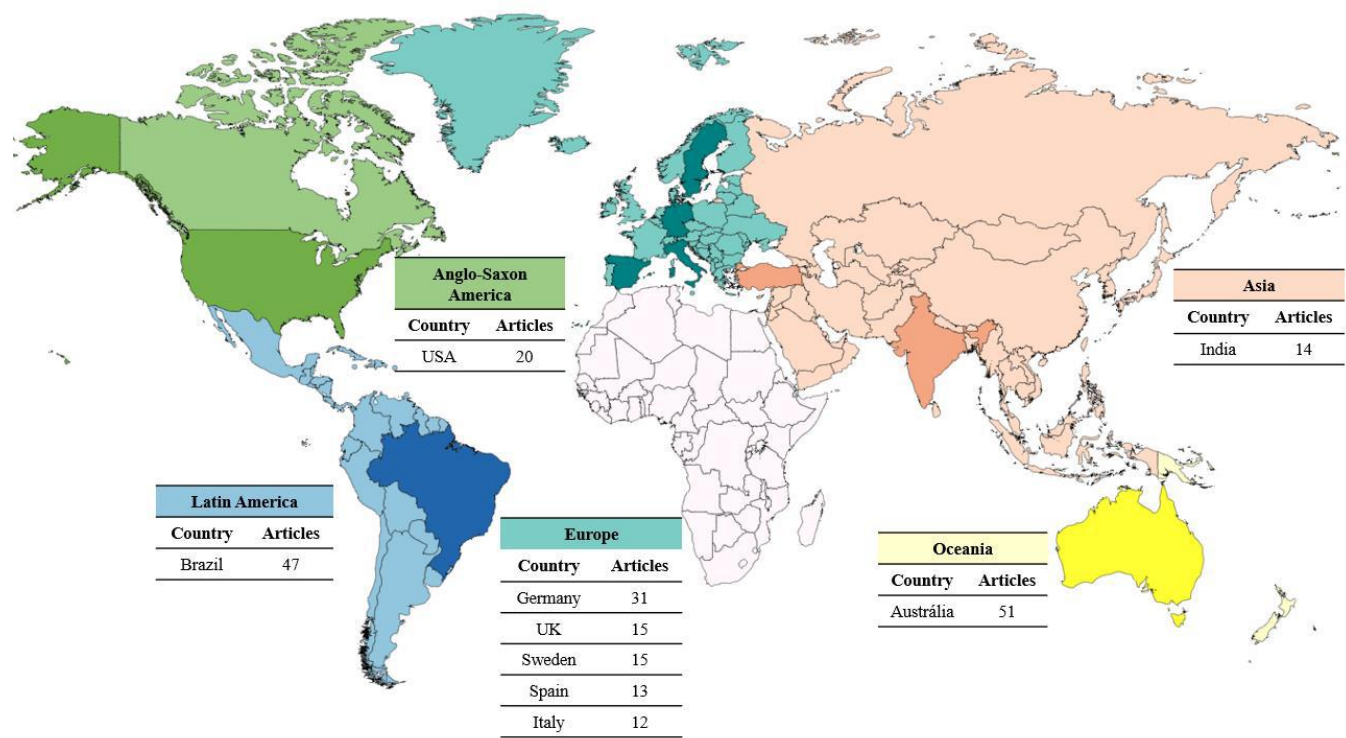
The VOSviewer software was used to analyze and visualization of collaboration network through co-authorship relationships between countries (Figure 1C). Only countries that had at least five articles were displayed. Of the 20 countries that met the threshold, substantial research collaborations were observed between Australia and almost all countries. Beyond Australia, the others top nodes are Germany, the USA, the Netherlands and Brazil.

Figure 1 - Overview of MIH- related articles. (A) The trend of annual publications from 2001 to 2019. (B) Global geographic distribution of the total number of articles by country. (C) Network visualization map of country co-authorships.

A



B



C

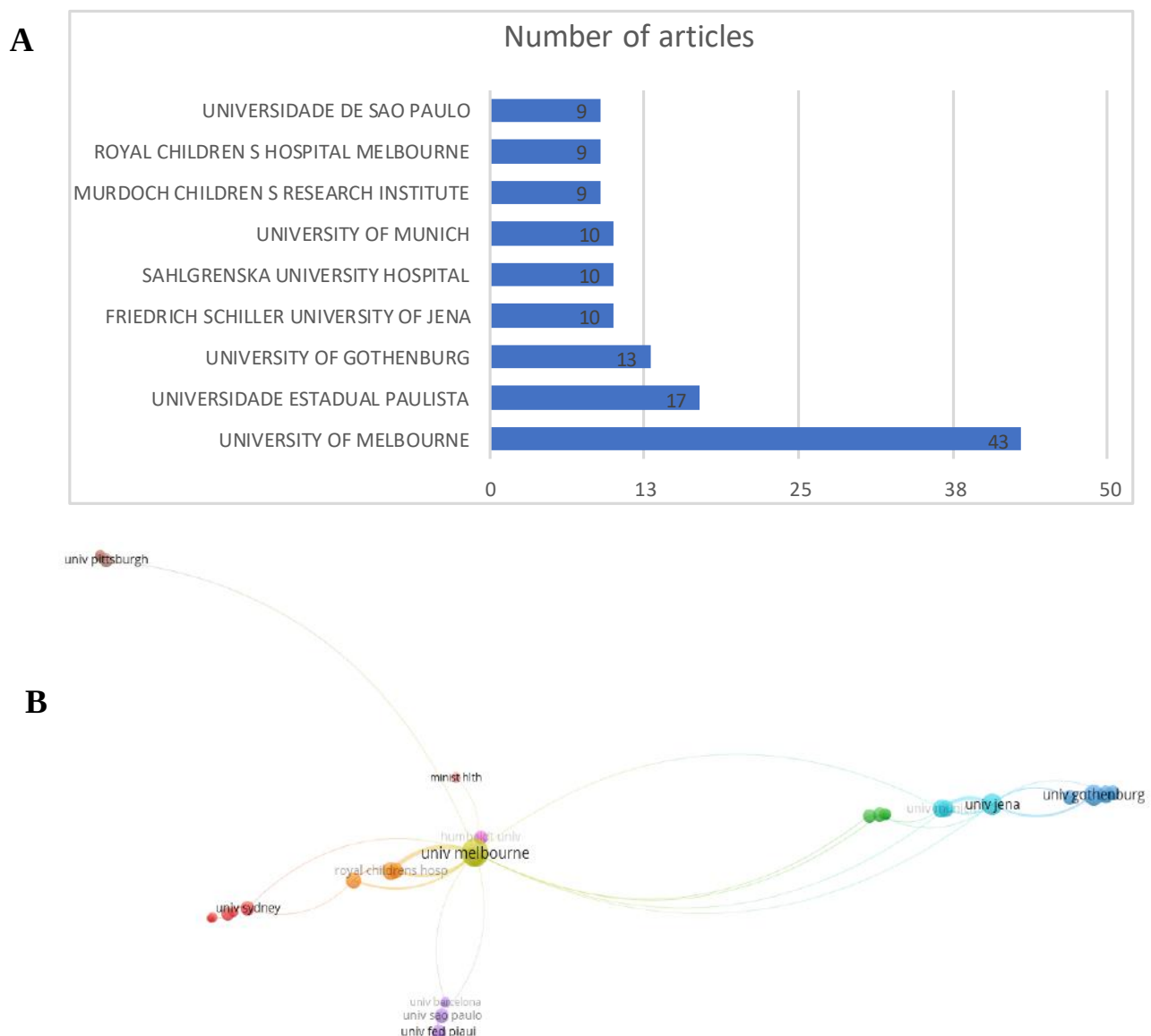


Source: Authors.

3.3 Publication analysis based on institutions

A total of 340 institutions were represented in the published MIH articles. The top 9 prolific institutions are shown in Figure 2A. The University of Melbourne obtained the highest number of articles and citations (43 articles; 906 citations). Co-authorship collaboration map among the institutions also showed that the University of Melbourne has the greatest centrality and the largest with a largest link strength node with Children's Hospital Melbourne, indicating the importance of MIH theme for research activity (Figure 2B).

Figure 2 - Institution distribution. **(A)** The most productive organizations. **(B)** Network visualization map of the collaborations between organizations in the MIH field.



Source: Authors.

3.4 Publication analysis based on journals

The retrieved articles were published in 97 different journals. Among these journals, 25 journals between 2-4 articles. The most productive journals on MIH are presented in Table 1. These journals published more than half of MIH articles (162

articles; 55.2%) with highlight to the International Journal of Paediatric Dentistry (IJPd), (46 articles; 15.7%), European Archives of Paediatric Dentistry (24 articles; 8.2%), Journal of Dentistry (12 articles; 4.1%) and Clinical Oral Investigations (12 articles; 4.1%).

Table 1 - The top 12 most productive journals on MIH.

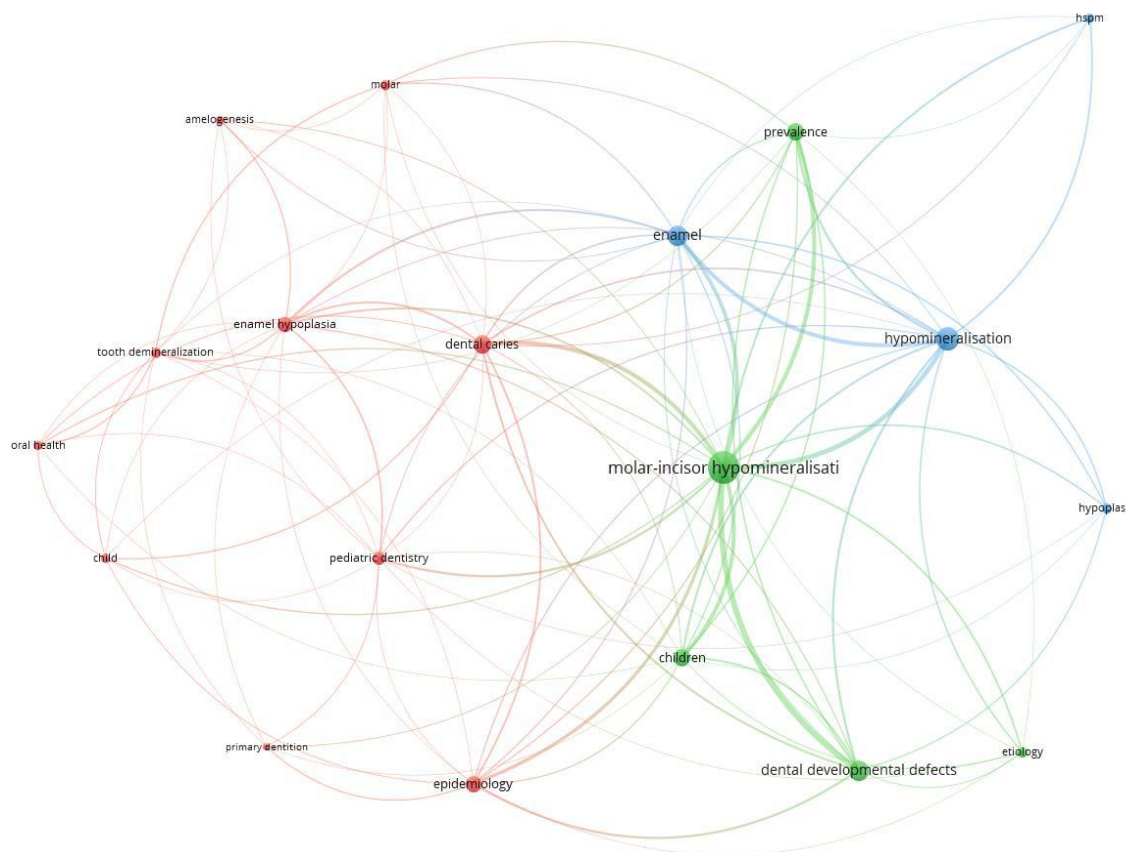
Rank	Journal name	IF (2019)	Number of articles	Number of citations
1	International Journal of Paediatric Dentistry	1.993	46	1,016
2	European Archives of Paediatric Dentistry	-	24	221
3	Journal of Dentistry	3.242	12	232
4	Clinical Oral Investigations	2.812	12	88
5	BMC Oral Health	1.911	11	58
6	Journal of Clinical Pediatric Dentistry	0.798	10	61
7	Pediatric Dentistry	1.594	9	179
8	Caries Research	2.186	9	151
9	European Journal of Paediatric Dentistry	1.500	9	83
10	Acta Odontologica Scandinavica	1.573	7	293
11	Journal of Dental Research	4.914	7	246
12	Archives of Oral Biology	1.931	6	201

IF: Impact factor. Source: Authors.

3.5 Keywords analysis

Authors keywords in MIH articles were analyzed through a co-occurrence network analysis in the VOSviewer software. The minimum occurrence of authors keyword was set at five. Of the 457 keywords, 19 met the threshold. The network revealed three clusters. The most frequent keywords used were “molar-incisor hypomineralisation”, “hypomineralisation” and “dental development defects” (Figure 3).

Figure 3 - Analysis of authors keywords co-occurrence on MIH. Network visualization map of the most frequently authors keywords.



Source: Authors.

3.6 Analysis of the top 100 most-cited MIH articles

The top 100 most-cited articles on MIH are listed in Table 2. Overall, these articles were cited 3,201 times in WoS-CC, ranging between 09 and 110 citations, and thirty-five of them were cited more than 35 times. In the Google Scholar, the total number of citations was 7,667, ranging between 14 to 362 citations. The articles were published between 2001 and 2018. The year of 2013 and 2015 had most publications (n=15), followed by 2014 (n=10). No significantly correlations were identified between the IF (2019) and total number of citations in WoS ($p=0.076$) and total number of citations in Google Scholar ($p=0.411$). The most-cited MIH article was a literature review entitled “Molar incisor hypomineralization: Review and recommendations for clinical management” authored by Willian et al. (2006) and published in Pediatric Dentistry.

The top 100 most-cited articles were published by 24 different countries. Australia was the most productive and most-cited country (20 articles; 566 citations), followed by Brazil (13 articles; 366 citations), and Germany (12 articles; 356 citations). The top 100 most-cited MIH articles were conducted by 147 institutions, and some studies have had more than one institution. Most articles were from the University of Melbourne, Australia (25 articles), followed by Friedrich Schiller University of Jena, Germany; Sahlgrenska University Hospital and University of Gothenburg, both from Sweden, with eight studies each institution. The most prolific author was Manton DJ (23 articles; 700 citations), followed by Ghanim A (10 articles; 251 citations) and Crombie FA (7 articles; 267 citations).

The IJPD published the largest number of articles (26 articles; 965 citations), followed by European Archives of Paediatric Dentistry (8 articles; 138 citations) and Journal of Dentistry (7 articles; 205 citations). Interestingly, five non-dental

journals (Physiological Reviews, American Journal of Pathology, American Journal of Physical Anthropology, Journal of Materials Science-Materials in Medicine, Scientific Reports) published MIH articles. Ninety-nine articles were published in journals with an IF of <5, only one was published in a journal with an IF of >10 (Physiological Reviews).

Cross-sectional (45%) was the most frequent study design, followed by experimental in vitro studies (16%), literature review (11%) and cohort (10%). The research topic most surveyed was about prevalence of MIH (30.0%). Of these, 28 articles evaluated the prevalence of MIH and 2 were about hypomineralised second primary molars (HSPM).

Table 2 - Top 100 most-cited MIH articles.

Rank	Title	First Author	Year	Country	Journal	IF (2019)	Citation (WoS)	Citation (Google Scholar)	Design	Aim
1	Molar incisor hypomineralization: Review and recommendations for clinical management	Willian V	2006	Australia	Pediatric Dentistry	1.594	110	362	Literature review	Describe the diagnosis, prevalence, putative etiological factors, and features of hypomineralized enamel in MIH and to present a sequential approach to management.
2	The prevalence of demarcated opacities in permanent first molars in a group of Swedish children	Jälevik B	2001	Sweden	ACTA Odontologica Scandinavica	1.573	109	260	Cross-sectional	To determine the prevalence of enamel defects of permanent teeth and especially demarcated opacities in first molars and incisors and MIH in a group of 7-8 year-old Swedish children
3	Aetiology of molar-incisor hypomineralization: a critical review	Crombi FA	2009	Australia	International Journal of Paediatric Dentistry	1.993	103	261	Critical review	To assess the strength of evidence regarding the aetiology of MIH.
4	Multilevel complex interactions between genetic, epigenetic and environmental factors in the aetiology of anomalies of dental development	Brook AH	2009	United Kingdom	Archives of Oral Biology	1.931	93	215	Literature review	To review and evaluate current knowledge concerning the aetiology of anomalies of dental development.
5	Molar incisor hypomineralization: prevalence, severity and clinical consequences in Brazilian children	Costa-Silva CM	2010	Brazil	International Journal of Paediatric Dentistry	1.993	80	205	Cross-sectional	To assess the prevalence and severity of MIH as well as its clinical consequences in children aged 6 to 12 years-old.
6	Molar incisor hypomineralization in Hong Kong Chinese children	Cho SY	2008	China	International Journal of Paediatric Dentistry	1.993	79	209	Cross-sectional	To investigate retrospectively the prevalence of MIH in a group of Hong Kong Chinese children.
7	Molar incisor hypomineralization: a study of aetiological factors in a group of UK children	Whatlin R	2008	United Kingdom	International Journal of Paediatric Dentistry	1.993	76	186	Case-control	To investigate the aetiology of MIH in children.
8	Deciduous Molar Hypomineralization and Molar Incisor Hypomineralization	Elfrink ME	2012	The Netherlands	Journal of Dental Research	4.914	75	174	Cohort	To study the association between DMH in the second primary molars and MIH in the first permanent molars.
9	Amoxicillin May Cause Molar Incisor Hypomineralization	Laisi S	2009	Finland	Journal of Dental Research	4.914	74	181	Cross-sectional/ Experimental Study	To study whether the use of amoxicillin, penicillin V, the cephalosporins, the macrolides, and sulfonamide and

										trimethoprim was associated with MIH.
10	Etiology of molar incisor hypomineralization - A systematic review	Silva MJ	2016	Brazil	Community Dentistry and Oral Epidemiology	2.135	71	136	Systematic review	To assess the strength of evidence linking etiological factors for MIH and HSPM.
11	Prevalence and severity of molar incisor hypomineralization in a region of Germany - A brief communication	Preusser SE	2007	Germany	Journal of Public Health Dentistry	1.743	67	167	Cross-sectional	Ascertain the frequency of MIH in the region of central Hesse, Germany
12	Genes expressed in dental enamel development are associated with molar-incisor hypomineralization	Jeremia F	2013	Brazil	Archives of Oral Biology	1.931	65	123	Case-control	To test if genetic variation in enamel formation genes is associated with MIH, also taking into consideration caries experience.
13	Prevalence and distribution of demarcated opacities and their sequelae in permanent 1st molars and incisors in 7 to 13-year-old Brazilian children	Soviero V	2009	Brazil	ACTA Odontologica Scandinavica	1.573	61	173	Cross-sectional	To describe the prevalence and distribution of permanent 1st molars and incisors with demarcated opacities in a group of Brazilian children.
14	Hypomineralized second primary molars: Prevalence data in Dutch 5-year-olds	Elfrink ME	2008	The Netherlands	Caries Research	2.186	60	126	Cross-sectional	To report on the prevalence of hypomineralizations in second primary molars in 5-year-old Dutch children.
15	Molar-incisor hypomineralisation: prevalence and defect characteristics in Iraqi children	Ghanim A	2011	Australia	International Journal of Paediatric Dentistry	1.993	55	123	Cross-sectional	To evaluate the prevalence and the clinical features of MIH in school-aged children residing in Mosul City, Iraq.
16	Bacterial invasion of dentinal tubules beneath apparently intact but hypomineralized enamel in molar teeth with molar incisor hypomineralization	Fagrell TG	2008	Sweden	International Journal of Paediatric Dentistry	1.993	51	108	Experimental <i>in vitro</i>	To histologically study possible bacterial invasion of dentinal tubules beneath apparently intact, but hypomineralized enamel in permanent molars with MIH.
17	Standardised studies on Molar Incisor Hypomineralisation (MIH) and Hypomineralised Second Primary Molars (HSPM): a need	Elfrink ME	2015	The Netherlands	European Archives of Paediatric Dentistry	NI	49	101	Literature review	To describe the guidelines to perform a prevalence and/or aetiology study on MIH and HSPM.
18	Developmental defects of enamel and dentine: challenges for basic science research and clinical management	Seow WK	2014	Australia	Australian Dental Journal	1.401	49	106	Literature review	To review of genetic and environmental influences on the development of enamel and dentine.
19	Dental enamel formation and implications for oral health and disease	Lacruz RS	2017	USA	Physiological Reviews	25.588	47	62	Literature review	To discuss enamel from its developmental beginnings to its final structure.
20	Enamel Defects Reflect Perinatal Exposure to Bisphenol A	Jedon K	2013	France	American Journal of Pathology	3.491	47	107	Experimental <i>in vivo</i>	To assess the possible effect of BPA on enamel development and elucidate any underlying mechanism of action.

21	Surface Integrity Governs the Proteome of Hypomineralized Enamel	Mangum JE	2010	Australia	Journal of Dental Research	4,914	47	100	Experimental <i>in vitro</i>	To characterize the protein composition of MIH enamel on first permanent molars.
22	Chemical, mechanical and morphological properties of hypomineralized enamel of permanent first molars	Fagrell TG	2010	Sweden	ACTA Odontologica Scandinavica	1,573	46	103	Experimental <i>in vitro</i>	To examine normal and hypomineralized enamel utilizing scanning electron microscopy, hardness measurements and X-ray microanalysis.
23	Mineral density of hypomineralised enamel	Farah RA	2010	New Zealand	Journal of Dentistry	3,242	45	112	Experimental <i>in vitro</i>	To quantitatively describe the range of mineral densities of MIH enamel, to compare this with the range of mineral density in normal enamel.
24	Molar-incisor hypomineralization and oral hygiene in 10-to-12-yr-old Swedish children born preterm	Brogårdh Roth S	2011	Sweden	European Journal of Oral Sciences	2,220	43	94	Case-control	To study the prevalence and severity of MIH and the status of oral hygiene and gingival health in a group of 10- to-12-year-old Swedish.
25	<u>Dental caries experience and Molar-Incisor Hypomineralization</u>	Jeremias F	2013	Brazil	ACTA Odontologica Scandinavica	1,573	41	98	Cross-sectional	To identify the presence of enamel defects known as MIH among children of 6–12 years of age and establish its prevalence, severity and association with dental caries.
26	Global burden of molar incisor hypomineralization	Schwendicke F	2018	Germany	Journal of Dentistry	3,242	40	66	Systematic review	To systematically review and meta-analyze the global, super-regional, regional and national level prevalence of MIH data.
27	Evaluation of spontaneous space closure and development of permanent dentition after extraction of hypomineralized permanent first molars	Jälevik B	2007	Sweden	International Journal of Paediatric Dentistry	1,993	40	122	Descriptive	To evaluate the development of the permanent dentition and need for orthodontic treatment after extraction of permanent first molars due to severe MIH.
28	A systematic review on the association between molar incisor hypomineralization and dental caries	Americano GC	2017	Brazil	International Journal of Paediatric Dentistry	1,993	38	91	Systematic review	To perform a systematic review to assess the association between MIH and dental caries in the permanent dentition.
29	The prevalence of molar incisor hypomineralization (MIH) in a group of children in a highly polluted Urban Region and a Windfarm-Green Energy Island	Kusku OO	2009	Turkey	International Journal of Paediatric Dentistry	1,993	37	82	Cross-sectional	To determine the prevalence of MIH in children from the most industrialized and polluted region and the most Green-Energy Island of Turkey.
30	Gross enamel hypoplasia in molars from subadults in a 16th-18th century London graveyard	Ogden AR	2007	United Kingdom	American Journal of Physical Anthropology	2,414	37	89	Cross-sectional	To report a prevalence and early age of onset of extensive enamel defects in deciduous and permanent molars in the subadults from the post-medieval cemetery of Broadgate, east central London.
31	The prevalence of molar incisor hypomineralisation in Northern England and its	Balmer R	2010	United Kingdom	International Journal of Paediatric Dentistry	1,993	36	99	Cross-sectional	To determine the prevalence of MIH in 12-year old in Northern England and to consider the relationship with

	relationship to socioeconomic status and water fluoridation									socioeconomic status and background water fluoridation.
32	Epidemiologic study of molar-incisor hypomineralization in 8-year-old Spanish children	Garcia-Margarit M	2014	Spain	International Journal of Paediatric Dentistry	1.993	35	96	Cross-sectional	To determine MIH prevalence in a representative sample of the 8-year-old population of the Valencia.
33	Protein content of molar-incisor hypomineralisation enamel	Farah RA	2010	New Zealand	Journal of Dentistry	3.242	35	93	Experimental <i>in vitro</i>	To compare the relative amounts and nature of the protein content of sound and hypomineralized human enamel and identifies serum proteins in MIH enamel.
34	Transmission electron microscope characterisation of molar-incisor-hypomineralisation	Xie Z	2008	Australia	Journal of Materials Science-Materials in Medicine	2.489	35	77	Experimental <i>in vitro</i>	To identify microstructural change associated with hypomineralisation using dual-beam field emission scanning electron microscope (FESEM/FIB).
35	Molar incisor hypomineralization: A survey of members of the Australian and New Zealand Society of Paediatric Dentistry	Crombi FA	2008	Australia	Australian Dental Journal	1.401	35	102	Cross-sectional	To ascertain the knowledge and opinions regarding MIH in a population of Australian dental care providers and to describe their clinical experience associated with MIH.
36	A practical method for use in epidemiological studies on enamel hypomineralisation	Ghanim A	2015	Australia	European Archives of Paediatric Dentistry	NI	34	71	Descriptive	To describe the rationale, development, and content of a scoring method for MIH diagnosis in epidemiological studies as well as clinic- and hospital-based studies.
37	Increase in severity of molar-incisor hypomineralization and its relationship with the colour of enamel opacity: a prospective cohort study	Costa-Silva CM	2011	Brazil	International Journal of Paediatric Dentistry	1.993	34	83	Cohort	To analyse the relationship between colours of MIH opacity of children aged 6–12 (baseline) and other clinical and demographic variables involved in the increase in severity of MIH.
38	On the Etiology of Molar-Incisor Hypomineralization	Vieira AR	2016	USA	Caries Research	2.186	32	53	Literature review	To provide a rationale to explain the preferential affection of molars and incisors in HMI.
39	Treatment outcomes and dental anxiety in 18-year-olds with MIH, comparisons with healthy controls - a longitudinal study	Jälevik B	2012	Sweden	International Journal of Paediatric Dentistry	1.993	32	93	Cohort	To assess the long-term outcomes of dental treatments, dental anxiety, and patients' satisfaction in adolescents with MIH.
40	Aetiology of severe demarcated enamel opacities - an evaluation based on prospective medical and social data from 17,000 children	Fagrell TG	2011	Sweden	Swedish Dental Journal	2.489	32	66	Cohort	To evaluate possible aetiological factors to severe demarcated opacities (SDO) in first permanent molars in a large cohort of children by using social and medical data collected prospectively during their first years of life by the ABIS study.
41	Characterisation of developmentally hypomineralised human enamel	Crombi FA	2013	Australia	Journal of Dentistry	3.242	30	78	Experimental <i>in vitro</i>	To investigate and clarify physical and chemical properties of enamel affected by molar incisor hypomineralisation

										(MIH).
42	Is there a positive relationship between molar incisor hypomineralisations and the presence of dental caries?	Heitmüeller D	2013	Germany	International Journal of Paediatric Dentistry	1.993	30	68	Cross-sectional	To compare the caries experience in 10-year-olds with and without molar incisor hypomineralisation (MIH).
43	The prevalence of molar incisor hypomineralization: evidence from 70 studies	Zhao D	2018	China	International Journal of Paediatric Dentistry	1.993	29	56	Systematic review	To estimate the global prevalence of MIH.
44	Elevated Serum 25(OH)-Vitamin D Levels Are Negatively Correlated with Molar-Incisor Hypomineralization	Kühnisch J	2015	Germany	Journal of Dental Research	4.914	28	59	Cross-sectional	To analyze the Cross-sectional/ Experimental Study between serum 25-hydroxy-vitamin D (25(OH)D) status and dental health.
45	Pre- and Postnatal Determinants of Deciduous Molar Hypomineralisation in 6-Year-Old Children. The Generation R Study	Elfrink ME	2014	The Netherlands	Plos One	2.740	28	43	Cohort	To identify prenatal, perinatal and early postnatal determinants of DMI.
46	Prevalence of Molar-Incisor-Hypomineralisation among school children in four German cities	Petrou MA	2014	Germany	International Journal of Paediatric Dentistry	1.993	27	58	Cross-sectional	To determine the prevalence of MIH in Germany and to compare the findings with other studies
47	The prevalence and aetiology of Molar-Incisor Hypomineralisation in a group of children in Istanbul	Kusku OO	2008	Turkey	European Journal of Paediatric Dentistry	1.500	26	74	Cross-sectional	To investigate the prevalence and aetiology of MIH in a group of children in Istanbul.
48	Proportion and extent of manifestation of molar-incisor-hypomineralizations according to different phenotypes	Kühnisch J	2014	Germany	Journal of Public Health Dentistry	1.743	25	46	Cohort	To assess the proportion and extent of manifestation of enamel hypomineralization, including MIH in the permanent and primary dentition.
49	Molar Incisor Hypomineralization : A Study of Prevalence and Etiology in a Group of Iranian Children	Ahmadi R	2012	Iran	Iranian Journal of Pediatrics	0.370	25	99	Cross-sectional	To investigate the prevalence of MIH and its relationship with systemic conditions in a group of Iranian children.
50	Clinical solutions for developmental defects of enamel and dentin in children	Sapir S	2007	Israel	Pediatric Dentistry	1.594	25	66	Literature review	To present the clinical management of some common dental defects as hypoplasia, diffuse and demarcated opacities; fluorosis, amelogenesis imperfecta, and dentinogenesis imperfecta.
51	Prevalence of molar-incisor hypomineralisation observed using transillumination in a group of children from Barcelona (Spain)	Gomez PTM	2012	Spain	International Journal of Paediatric Dentistry	1.993	24	57	Cross-sectional	To investigate the prevalence of the condition, by using transillumination, in a group of children.
52	Risk factors in the occurrence of molar-incisor hypomineralization amongst a group of Iraqi children	Ghanim A	2012	Australia	International Journal of Paediatric Dentistry	1.993	23	67	Cross-sectional	To investigate risk factors involved in the development of MIH in a group of school-aged Iraqi children

53	Managing molar-incisor hypomineralization: A systematic review	Elhennawy K	2016	Germany	Journal of Dentistry	3.242	22	69	Systematic review	To systematically reviewed treatment modalities for MIH-affected molars and incisors.
54	Onset of Molar Incisor Hypomineralization (MIH)	Fagrell TG	2013	Sweden	Swedish Dental Journal	2.489	22	46	Experimental in vitro	To examine ground radial and sagittal sections from teeth diagnosed with MIH using light microscopy, polarized light microscopy and X-ray micro-computed tomography (XMCT).
55	Perception of Molar-Incisor Hypomineralisation (MIH) by Iraqi Dental Academics	Ghanim A	2011	Australia	International Journal of Paediatric Dentistry	1.993	22	38	Cross-sectional	To determine the perception of Iraqi academic clinicians about MIH prevalence, severity and aetiological factors.
56	Relationship between laser fluorescence and enamel hypomineralisation	Farah RA	2008	New Zealand	Journal of Dentistry	3.242	21	43	Experimental in vitro	To assess the relation between the mechanical properties of hypomineralized enamel, and its laser fluorescence.
57	Molar incisor hypomineralisation (MIH) training manual for clinical field surveys and practice	Ghanim A	2017	Australia	European Archives of Paediatric Dentistry	NI	20	38	Literature review	To provide a comprehensive manual as a companion to assist researchers in planning epidemiological studies of MIH and hypomineralised second primary molars (HSPM).
58	An in vivo investigation of salivary properties, enamel hypomineralisation, and carious lesion severity in a group of Iraqi schoolchildren	Ghanim A	2013	Australia	International Journal of Paediatric Dentistry	1.993	20	39	Cross-sectional	To determine and compare the dental caries status and salivary characteristics of hypomineralisation affected and non-affected children.
59	Resin infiltration of developmentally hypomineralised enamel	Crombi FA	2013	Australia	International Journal of Paediatric Dentistry	1.993	19	59	Experimental in vitro	To investigate whether caries infiltrant resin can penetrate MIH-affected enamel.
60	MIH Supplementation Strategies: Prospective Clinical and Laboratory Trial	Baroni C	2011	Italy	Journal of Dental Research	4.914	19	65	Experimental in vitro and in vivo	To improving mineralization quality in calcium-deficient teeth by means of preventive, non-invasive topical supplements.
61	Linking the clinical presentation of molar-incisor hypomineralisation to its mineral density	Farah RA	2010	New Zealand	International Journal of Paediatric Dentistry	1.993	19	66	Experimental in vitro	To assess whether there is a relation between the severity of the defects in MIH enamel and the clinical presentation.
62	Drugs related to the etiology of molar incisor hypomineralization A systematic review	Serna C	2016	Spain	Journal of the American Dental Association	2.803	18	35	Systematic review	To systematically review studies in which the investigators had studied how the etiology of MIH was related to medication intake.
63	Hypomineralised second primary molars: prevalence, defect characteristics and possible association with Molar Incisor Hypomineralisation in Indian children	Mittal N	2015	India	European Archives of Paediatric Dentistry	NI	18	39	Cross-sectional	To report on the prevalence, defect characteristics, and distribution of hypomineralised second primary molars (HSPM) in Gautam Budh Nagar, Uttar Pradesh, India.
64	Distribution and severity of molar hypomineralisation: trial of a new	Oliver K	2014	Australia	International Journal of Paediatric	1.993	18	45	Cross-sectional	To describe characteristics of molar hypomineralisation and MIH and trial the new

severity index			Dentistry							Molar Hypomineralisation Severity Index.
65	Mineralisation of Developmentally Hypomineralised Human Enamel <i>in vitro</i>	Crombi FA	2013	Australia	Caries Research	2.186	18	46	Experimental <i>in vitro</i>	To determine if developmentally hypomineralised enamel of MIH is capable of improvement.
66	Hypomineralized Second Primary Molars as Predictor of Molar Incisor Hypomineralization	Negre-Barber A	2016	Spain	Scientific Reports	3.998	17	19	Cross-sectional	To assess the predictive value of hypomineralized second primary molars for the appearance of MIH, as well as their distribution in the child population of Valencia (Spain).
67	Family-Based Genetic Association for Molar-Incisor Hypomineralization	Jeremias F	2016	Brazil	Caries Research	2.186	17	37	Cross-sectional	To investigate the genetic carriage potentially involved in MIH development.
67	Prevalence, pattern and severity of molar incisor hypomineralisation in 8- to 10-year-old school children in Ile-Ife, Nigeria	Oyedele TA	2015	Nigeria	European Archives of Paediatric Dentistry	NI	17	31	Cross-sectional	To determine the prevalence, pattern and severity of MIH in school children resident in a suburban population in Nigeria.
69	Oral health-related quality-of-life in Swedish children before and after dental treatment under general anesthesia	Ridell K	2015	Sweden	ACTA Odontologica Scandinavica	1.573	17	33	Cross-sectional	To evaluate oral health-related quality-of-life in Swedish children and families before and after dental treatment of the children under general anesthesia because of severe caries or MIH
70	Molar incisor hypomineralisation and dental caries among children in Slovenia	Grošelj J	2013	sLOVENIA	European Journal of Paediatric Dentistry	1.500	17	45	Cross-sectional	To investigate the prevalence of MIH in children in Slovenia.
71	Factors associated with molar incisor hypomineralization in Thai children	Pitiphat W	2014	Thailand	European Journal of Oral Sciences	2.220	16	41	Cross-sectional	To examine the effects of pre-, peri-, and postnatal risk factors on the development of MIH among a group of schoolchildren in urban areas of Khon Kaen, Thailand
72	Genome-wide association study (GWAS) for molar-incisor hypomineralization (MIH)	Kühnisch J	2014	Germany	Clinical Oral Investigations	2.812	16	51	Cohort	To investigate the relationship MIH and possible genetic loci.
73	Is there a relationship between hyperactivity/inattention symptoms and poor oral health? Results from the GINIplus and LISAPlus study	Kohlboeck G	2013	Germany	Clinical Oral Investigations	2.812	16	35	Cohort	To associate hyperactivity/inattention symptoms with relevant dental health markers, e.g., oral hygiene, caries, MIH, and dental trauma in two large population-based birth cohorts at 10 years of age
74	Exploring the association between genetic and environmental factors and molar incisor hypomineralization: evidence from a twin study	Teixeira RJPB	2018	Brazil	International Journal of Paediatric Dentistry	1.993	15	33	Cross-sectional	To evaluate the agreement of MIH between monozygotic and dizygotic twin pairs and the association with environmental factors.
75	Structural, mechanical and	Elhennawy K	2017	Germany	Archives of Oral	1.931	15	29	Systematic review	To systematically collect, evaluate and contrast

	chemical evaluation of molar-incisor hypomineralization-affected enamel: A systematic review				Biology					available studies on the structural, physical and chemical alterations of MIH-affected compared with unaffected enamel.
76	Association between Molar Incisor Hypomineralization in Schoolchildren and Both Prenatal and Postnatal Factors: A Population-Based Study	Tourino LFPG	2016	Brazil	Plos One	2.740	15	42	Cross-sectional	To evaluate the prevalence of MIH and identify associated prenatal, perinatal and postnatal factors among Brazilian schoolchildren aged 8 and 9 years
77	Impact of molar-incisor hypomineralization on oral health-related quality of life in schoolchildren	Dantas-Neta NB	2016	Brazil	Brazilian Oral Research	1.633	14	47	Cross-sectional	To evaluate the impact of MIH on oral health-related quality of life according to schoolchildren's and their parents'/caregivers' perceptions.
78	Combined effect of amoxicillin and sodium fluoride on the structure of developing mouse enamel in vitro	Sahlberg C	2013	Finland	Archives of Oral Biology	1.931	14	29	Experimental <i>in vitro</i>	To investigate experimentally if simultaneous exposure to amoxicillin and NaF has potentiative effects on developing enamel in vitro
79	The process of mineralisation in the development of human tooth	Caruso S	2016	Italy	European Journal of Paediatric Dentistry	1.500	13	18	Literature review	To explain mineralisation, its stages and when damage occurs and alters the hard tissues structure.
80	Epidemiologic Study of Molar-incisor Hypomineralization in Schoolchildren in Northeastern Brazil	Lima MDM	2015	Brazil	Pediatric Dentistry	1.594	13	30	Cross-sectional	To determine the prevalence of molar-incisor hypomineralization in children and possible factors associated with this disorder
81	Molar incisor hypomineralization (MIH): conservative treatment management to restore affected teeth	Fragelli CMB	2015	Brazil	Brazilian Oral Research	1.633	13	60	Cohort	To evaluate the clinical performance of glass ionomer restorations in teeth with MIH for a period of 12 months
82	Association of amoxicillin use and molar incisor hypomineralization in piglets: Visual and mineral density evaluation	Kusco OO	2013	Turkey	Archives of Oral Biology	1.931	13	29	Experimental <i>in animal</i>	To determine the prevalence of MIH both visually and quantitatively and describes the range of mineral densities of enamel specimens from three groups of piglets where two groups were given different doses of amoxicillin in infancy.
83	The effect of resin infiltration and oxidative pre-treatment on microshear bond strength of resin composite to hypomineralised enamel	Chay PL	2014	Australia	International Journal of Paediatric Dentistry	1.993	12	29	Experimental <i>in vitro</i>	To investigate whether the adhesion of resin composite to hypomineralised enamel can be improved by the use of a resin infiltrant, the use of oxidative pre-treatment, or the use of oxidative pre-treatment followed by a resin infiltrant.
84	Clinical Evaluation of Desensitizing Treatment for Incisor Teeth Affected by Molar-Incisor	Ozgül BM	2013	Turkey	Journal of Clinical Pediatric Dentistry	0.798	12	29	Nonrandomized non-controlled clinical trial	To evaluate the hypersensitivity observed in MIH-affected teeth and the effect of desensitizing agents applied with and without

Hypomineralization										ozone to incisors affected by MIH.
85	Understanding MIH: definition, epidemiology, differential diagnosis and new treatment guidelines	Mast P	2013	Switzerland	European Journal of Paediatric Dentistry	1.500	12	43	Literature review	To describe the definition, epidemiology, differential diagnosis, and new treatment guidelines on Molar-Incisor Hypomineralization.
86	Degraded prism sheaths in the transition region of hypomineralized teeth	Chan YL	2010	China	Journal of Dentistry	3.242	12	27	Experimental <i>in vitro</i>	To evaluate the fracture properties and microstructure of enamel from specific regions of two MIH teeth using a state-of-the-art combination of the focused ion beam and nanoindentation techniques.
87	Morphology and chemical composition of dentin in permanent first molars with the diagnose MIH	Heijs SCB	2007	The Netherlands	Swedish Dental Journal	2.489	12	34	Experimental <i>in vitro</i>	To study the morphology and distribution of some inorganic elements in dentin in first permanent molars from children with MIH.
88	Relationship between caries experience and demarcated hypomineralised lesions (including MIH) in the permanent dentition of 15-year-olds	Kühnisch J	2018	Germany	Clinical Oral Investigations	2.812	11	15	Cross-sectional	To determine DHL prevalence, extent and tooth- and surface-related distribution in 15-year-old adolescents.
89	Treatment decisions on Molar-Incisor Hypomineralization (MIH) by Norwegian dentists - a questionnaire study	Kopperud SE	2016	Norway	BMC Oral Health	1.911	11	27	Cross-sectional	To explore the variability between the treatment decisions dentists make for MIH-affected teeth.
90	Do We Really Know the Prevalence of MIH?	Hernandez M	2016	Spain	Journal of Clinical Pediatric Dentistry	0.798	11	27	Literature review	To analyze the existing variability on MIH prevalence in the literature.
91	The prevalence and pattern of deciduous molar hypomineralization and molar-incisor hypomineralization in children from a suburban population in Nigeria	Temilola OD	2015	Nigeria	BMC Oral Health	1.594	11	34	Cross-sectional	To determine the prevalence, and pattern of presentation of MIH and MID in the primary dentition and mix dentition of children resident in Ile-Ife, a suburban region of Nigeria.
92	Prevalence of molar incisor hypomineralization (MIH) in Singaporean children	Ng JJ	2015	Singapore	International Journal of Paediatric Dentistry	1.993	11	50	Cross-sectional	To assess the prevalence of MIH in Singaporean children.
93	Amoxicillin use during early childhood and fluorosis of later developing tooth zones	Hong L	2011	USA	Journal of Public Health Dentistry	1.743	11	20	Cohort	To assess the association between amoxicillin use and fluorosis on late-erupting permanent teeth
94	Hypomineralized second primary molars: prevalence, defect characteristics and relationship with dental caries in Melbourne preschool children	Owen ML	2018	Australia	Australian Dental Journal	1.401	10	18	Cross-sectional	To determine in Melbourne preschool children the prevalence of hypomineralized second primary molars (HSPM), the relationship between demarcated hypomineralized enamel lesions severity, extent

											and number of affected HSPM, the prevalence of Early childhood caries (ECC), and the relationship between ECC and HSPM.
95	Molar Incisor Hypomineralization of Eight- and 14-year-old Children: Prevalence, Severity, and Defect Characteristics	Kevrekidou A	2015	Greece	Pediatric Dentistry	1.594	10	26	Cross-sectional	To report on the prevalence, severity, defect location, and other characteristics of MIH.	
96	Severity of MIH findings at tooth surface level among German school children	Petrou MA	2015	Germany	European Archives of Paediatric Dentistry	NI	10	22	Cross-sectional	To investigate the distribution and clinical characteristics of teeth diagnosed with MIH at surface and defect type level in a cohort of German children.	
97	Knowledge, experience and perceptions regarding Molar-Incisor Hypomineralisation (MIH) amongst Australian and Chilean public oral health care practitioners	Gambetta-Tessini K	2016	Australia	BMC Oral Health	1.594	9	18	Cross-sectional	To compare the knowledge, clinical experience and perceptions regarding MIH of Australian and Chilean OHCPs from the public dental sector.	
98	Knowledge and attitudes regarding molar incisor hypomineralisation amongst Saudi Arabian dental practitioners and dental students	Silva MJ	2016	Australia	European Archives of Paediatric Dentistry	NI	9	14	Cross-sectional	To investigate the perception of general dental practitioners (GDPs), specialist dentists and dental students regarding the prevalence, severity and aetiological factors of MIH.	
99	Canines are affected in 16-year-olds with molar-incisor hypomineralisation (MIH): an epidemiological study based on the Tromsø study: "Fit Futures"	Schmalfluss A	2016	Norway	European Archives of Paediatric Dentistry	NI	9	26	Cross-sectional	To determine the prevalence, distribution of affected teeth and severity of MIH in adolescents from Northern Norway.	
100	Assessment of association between molar incisor hypomineralization and hypomineralized second primary molar	Mittal R	2016	India	Journal of International Society of Preventive & Community	NI	9	25	Cross-sectional	To scrutinize the association between hypomineralized second primary molars and MIH and their prevalence in school going pupils in Nagpur, Maharashtra, India and the associated severity of dental caries.	

IF- Impact factor; NI – Not informed. Source: Authors.

4. Discussion

4.1 The international scientific production

This study performed a global bibliometric analysis about scientific production of MIH and analyzed the 100 most-cited MIH articles afterwards. In comparison to other bibliometric studies, this analysis type is a novelty providing to the readers more than data related to the top ranked articles but also tendencies and a global scene of this theme, independent of citation rankings.

To date, the screening was carried out comprising a period of 18 years (2001-2019), considering the inception of the term MIH in the beginning of 2000s (Weerheijm et al., 2001). The findings of this study are relevant for organizations and researchers that are active in this field, allowing the management of relevant topics and in finding convenient teams to collaborate, and enabling access to global trends. For clinicians, knowing the relevance of the titles of the most-cited MIH articles on MIH directs their attention to the main subjects studied, and the possible most relevant articles to help guide clinical decision-making.

In the context of MIH, global scientific research trends showed that the number of published articles has been increasing in recent years. The publications on MIH began to increase from 2013. A systematic review carried out in 2017 identified that MIH is highly prevalent globally affecting 878 million people with an average of 17.5 million new cases are reported each year (Schwendicke et al., 2018). The high prevalence, the close relationship between the presence of MIH and dental caries, the negative impact on the oral health-related quality of life, diagnosis and treatment challenges have made the MIH subject an important research field (Ghanim et al., 2019). Furthermore, a recent paediatric dentistry bibliometric investigation, stated, among frequent field of study in this area, a crescent highlight on MIH subject displaying a high number of citations per year (Garcovich et al., 2020).

Australia, Brazil and Germany were the most prolific countries on MIH research. Their influence in this field possibly comes from investments, especially for emergent countries as Brazil in the area of dental research, with greater involvement of researchers. Interestingly, the first two countries ranked present organization research groups known as The D3 Group (D3G – Australia, since 2007) and HMI group (Brazil, since 2002), both focused on translation research and education network due to increasing awareness of developmental dental defects, especially MIH and uncertainties about their cause and treatment. Also, to find out the global collaboration networks between countries, country co-authorships network visualization was evaluated (van Eck & Waltman, 2010). Thus, it is highlighted the existence of an interrelationship between MIH researchers and institutions. As verified, Australia, Germany, the USA, the Netherlands and Brazil had the closest collaboration with other countries. To date, it is valid to highlight the two larger node size between Australia - Germany and Brazil - the USA.

University of Melbourne (Australia) and Universidade Estadual Paulista (Brazil) published the largest number of studies among the institutions. It is noteworthy the leading role of Oceania represented by University of Melbourne due to the highest number of citations and articles with a largest total link strength at VOSviewer with Children's Hospital Melbourne, reflecting its high contribution to the theme (van Eck & Waltman, 2010). In addition, the high prevalence at the superregional level that Oceania and Brazil have in cases of MIH appears as a hypothesis for these findings beyond the fact to be continental countries as well (Schwendicke et al., 2018; Balmer et al., 2005). The data presented on the main institutions may be relevant for establishing to collaborative networks of scientific on MIH and also to highlight possible other that may contribute to each other.

Journals have great relevance as disseminators of information from scientific research (Sutherland et al., 2011). The most prolific journals on MIH was the International Journal of Paediatric Dentistry. Although a great number of MIH studies were published in journals with scope focused on pediatric dentistry, there is dispersion in publications due to interdisciplinarity of this theme evolving non-dental focus, such as genetic, environmental and systemic risk factors.

The co-occurrence analysis of authors keywords was performed with purpose to identify research focus and the main contents MIH studies (Khalil & Gotway, 2015). The VOSviewer identified three clusters with close relationship with each other, with many cross-links between nodes from different clusters (van Eck & Waltman, 2010). The most common authors keywords deal with the use of the term that was defined in 2001, possibly to actually differentiate MIH from other enamel changes.

The optimization of the data provided by the database is of great relevance because there are variations between the articles contained in the different databases and fluctuations in the number of citations. Even if there are fluctuations in the number of citations there may be correlations between the databases (Mattos et al., 2020). The database used in this study was the WoS-CC, because it is one of the largest and most comprehensive bibliographic databases and encompasses peer-reviewed with high-quality scholarly journals (Mattos et al., 2020; Jin et al., 2020).

4.2 The top 100 most-cited MIH articles

Another aim of this study was to identify the top 100 most-cited MIH articles, allowing to identify those articles that had an important contribution on the scientific and clinical practice on the MIH field. The number of citations of an article can be applied to evaluate, in part, its academic impact, (Mattos et al., 2020; Jin et al., 2020). In this study, self-citations were included in the total count of most-cited articles. Studies showed that self-citation did not significantly change the order of most-cited articles (Swanson et al., 2016; Perazzo et al., 2019). On the other hand, the publishing date frequently has an effect on citation numbers since articles tend to accumulate citations over time (Feijoo et al., 2014). Nevertheless, this was not observed when analyzing the top 100 most-cited MIH articles maybe because of the relatively short interval of time between publications (2001-2018). In addition, when analyzed the top ranked investigations receiving 100 or greater citations, considered as highly-cited articles, it was verified only three studies that have exceeded that threshold. As previously discussed, only articles from 2001 to 2019 have been selected for this analysis, being the chance of higher citations reduced since this ratio is time dependent.

A variation in citation counts between WoS-CC and other databases is expected. For this reason, Google Scholar was chosen for comparison because it provides more citations from books, dissertations, thesis, monographs and non-scholarly sources (Haddaway et al., 2015). In the present study, no positive correlation was observed between the number of citations on WoS-CC or Google Scholar and journal IF, similar to another study on dentistry. Of the 100 top-cited MIH articles, only one was published in a journal with IF > 10. Gondivkar et al. (2018), suggests that authors from different subareas of dentistry prefer to choose specialty journals over general dentistry or medical journals to publish their high-quality articles independent of IF values. This could have occurred because the impact factor of a journal is not determined solely by the number of citations of the most relevant articles, but rather on the total number of citations received over a given year by all the articles published in that journal in the previous two years, or, for some instance, the cost of some journals or increase relevance of others.

When analyzing the countries of origin, institutions and authors that contributed to the most-cited MIH articles, it was observed that the most-cited studies were published by twenty-four different countries and Australia was the most productive and most-cited country. The University of Melbourne (Australia) stood out as the most productive institution and most prolific authors Manton DJ, Ghanim A and Crombie FA) were affiliated in that same intuition.

When evaluating the evidence-based dental practice, a greater weightage is given to high-grade studies, preferably systematic reviews or randomized clinical studies. In the present investigation, the most common study of the top 100 most-cited MIH articles was cross-sectional which are in agreement of other dental bibliometric investigations (Perazzo et al., 2019; Patil et al., 2020). Cross-sectional studies on MIH have received a considerable attention and citations since they describe the prevalence of this dental condition and associate factors. For instance, this result is not a surprise, since current data about MIH prevalence in the most productive countries deserves attention. Contrary, the top most-cited article classified as a narrative review (represented by only 11% of study types) render to the readers easy access to the available information. Though they are not projected on top of the ladder of evidence, their role cannot be denied. Yet, *in vitro* studies (second study type most common). Still, a lower number of intervention studies may be due to this subject is considered a novelty and drawing and

conducting a high-quality study in this field is a hard task considering the difficulties of managing the individuals with this dental condition.

This study furnished a brand new analysis about global trends on MIH, besides of identifying the top 100 most-cited MIH articles, however it has limitations. The WoS-CC was the only database used for extraction the scientific literature on MIH, thus, some articles published in journals indexed only in other databases were not considered in this analysis. Recently published high-quality articles may not have been included on the top 100 most-cited articles because of their low citation count. Furthermore, this study presents a cross-sectional design. If the search is made at different time points or databases, the article list as well as the number of citations probably will be been different. Thus, this study can be updated in the future.

5. Conclusion

This bibliometric analysis allowed a better understanding of international scientific production trends on MIH. The literature on MIH has accrete over the years. There is a great need for further clinical randomized clinical trials addressing the MIH topic. The articles were more published in journals focused on pediatric dentistry.

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