The most cited articles in resinous infiltrates: a bibliometric analysis

ABSTRACT

Aims: To identify trends and growth in knowledge related to Resin Infiltrants, through a bibliometric review.

Study design: Bibliometric Review.

Methodology: A search was carried out in the Clarivate Analytics Web of Science database, using the terms (infiltrative resin OR resin infiltration) AND (white spot lesions OR white spots OR WSL OR Enamel demineralization OR orthodon* OR defect* OR hypoplas* OR discolor * OR dental fluorosis OR tooth demineralization OR calcification, tooth OR tooth discoloration OR dental enamel). Paired selection of manuscripts was carried out. The initial search identified 599 articles. After comparing titles and abstracts, the 50 most cited manuscripts involving Resinous Infiltrants were listed in order of classification.

Results: The most cited article in the top 50 was Frencken *et al.* in 2012. The earliest manuscript of this bibliometric analysis was published in 2001 by Robinson *et al.* in Caries Research and was cited 72 times, while two articles were the most recent, published in 2019 by Urquhart *et al.* in the Journal of Dental Research, it was cited 112 times and by Coelho Ased *et al.* in the Journal of Esthetic and Restorative Dentistry, cited 35 times. The citation distribution line shows high peaks in 2010 and 2012. The institutions that stood out the most were Charité UniversitatMedizin Berlin, followed by Universitatzu Kiel. The main country was Germany. Among the main journals are the Journal of Dentistry and the publisher Elsevier. In total, 274 keywords were used. The period of 2010 was the period with the greatest concentration of publications and the most productive.

Conclusion: The bibliometric review carried out in this study revealed the growing interest and research around the use of Resinous Infiltrants as an effective and minimally invasive alternative to address white spot lesions and tooth decay.

Keywords: Resinous Infiltrants, White Spots, Dental Caries, Minimally Invasive Dentistry, Dental Enamel.

1. INTRODUCTION

Dental caries is considered one of the most common oral pathologies affecting individuals of various ages worldwide [1]. Its incidence and prevalence vary according to socioeconomic, cultural, and regional factors, and it is also a public health problem [1]. It stems from irreversible demineralization of enamel caused by the action of lactic acid produced by cariogenic bacteria called Streptococcus mutans [2]. Resulting from the imbalance between health and disease, it may initially manifest as white spot lesions and, in more advanced stages, as dental cavitations. White spot lesions are the first signs of enamel demineralization, giving a white, opaque appearance, which may occur due to dental trauma, vitamin deficiencies, infections, or environmental or genetic factors [3,24-26].

Other factors influencing caries resistance include Salivary Buffering, a process that helps neutralize acids in the mouth, thus protecting teeth from decay [4]. When salivary flow is reduced due to medication use, habits like smoking, among others, the mouth's pH becomes more acidic, favoring enamel demineralization and potentially causing oral mucosa infections and periodontitis [4].

Minimally Invasive Dentistry (MID) is currently widely disseminated for carious lesion treatment as prevention and preservation are principles nowadays [5]. Consequently, various methods have been addressed for treating these lesions to avoid invasive procedures during cavity preparation [5]. For example, remineralization through topical

treatments has been advocated, but clinically, these lesions do not disappear. Therefore, microabrasion techniques for inactive lesions have been introduced, with the advantage of effectively eliminating stains but the drawback of minimal healthy tissue wear [6].
As a result, a new method has been proposed, namely the use of infiltrants, based on resin caries infiltration. This procedure was proposed because it inhibits demineralization, and the infiltrating resin is a product that enables the treatment of tooth decay in their early stages. ICON is an example, being a low viscosity (highly fluid) light-curing resin that penetrates the caries lesion, blocking acid diffusion channels and preventing caries in proximal and smooth areas [6].
The procedure involves applying a fluid material, typically a low-viscosity resin, to the affected white spot area [7]. This material penetrates the pores and fissures of the dental enamel structure, filling and stabilizing the caries lesion [7]. The aim is to halt caries progression and strengthen the tooth structure, preserving as much healthy dental tissue as possible [7]. According to Torres [8], when enamel presents white spot lesions, resin infiltration masks them, making them similar to the tooth. Besides inhibiting lesion progression, resin infiltrants have also been shown to have a positive effect on appearance due to their refractive index similarity to infiltrated and healthy enamel areas [7].
Thus, this bibliometric review aimed to search for the 50 most cited articles on resin infiltrants in dentistry to identify the interests of a journal/core/group of authors in this particular area. It is also important for evaluating the process and degree of scientific and technological development, as well as aiding in understanding the topic at hand [9].

2. METHODOLOGY

A bibliometric review on the topic of resin infiltrants was conducted following the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) using the Web of Science database from Clarivate Analytics. As a review, this study does not require approval from the research ethics committee.
The search was carried out on August 21, 2023, in the Clarivate Analytics Web of Science database. A search was carried out using the terms (infiltrative resin OR resin infiltration) AND (white spot lesions OR white spots OR WSL OR Enamel demineralization OR orthodon* OR defect* OR hypoplas* OR discolor* OR dental fluorosis OR tooth demineralization OR calcification, tooth OR tooth discoloration OR dental enamel) in the title and/or abstract. The results were extracted into a table in Microsoft Excel software and organized in descending order of citation count. Paired selection of manuscripts was carried out by two researchers, JOR and AFCG, independently and previously calibrated.
The study sample included publications that mentioned Resin Infiltrants in the title and/or abstract and publications that did not refer to the topic were excluded. There were no restrictions regarding the study design, year of publication, language or journal impact factor of the manuscripts.
The most cited articles were manually stratified according to information retrieved from the Clarivate Analytics Web of Science database, such as: year of publication, authors, number of citations, periodicals, keywords, contributing institution, country, among others. The address provided to the first author was used to define the country of origin and the contributing institution of the article.
The relationship among the authors is determined based on the number of times they cite each other, using a network visualization created with the VOSviewer software (University of Leiden, Netherlands).

3. RESULTS

The initial search identified 599 articles in the Web of Science Clarivate Analytics database. After comparing titles and abstracts, the 50 most cited manuscripts involving Resinous

Infiltrants were listed in rank order based on the number of citations in Table 1. The study selection process, including the search strategy used in the database, is summarized in a flowchart as shown in Figure 1.

Table 1. Top 50 articles on resinous infiltrates.

Rank	Author	Title	Publication year	Journal	Institution	Citations	Citations Density	Type of Study
1	Frencken JE *et al.*	Minimal intervention dentistry for managing dental caries - a review	2012	IDJ	Radboud University Nijmegen Medical Centre	237	19,75	Literature Review
2	Paris S *et al.*	Resin infiltration of natural caries lesions	2007	JDR	Charité-Universitätsmedizin Berlin	167	9,82	Laboratory Study
3	Paris S *et al.*	Resin Infiltration of Caries Lesions: an Efficacy Randomized Trial	2010	JDR	Christian-Albrechts-University Kiel	159	11,36	Clinical Study
4	Slayton RL *et al.*	Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions A report from the American Dental Association	2018	JADA	University of Washington	143	23,83	Systematic Review
5	Kielbassa AM *et al.*	Closing the gap between oral hygiene and minimally invasive dentistry: A review on the resin infiltration technique of incipient (proximal) enamel lesions	2009	QI	Charité-Universitätsmedizin Berlin	141	9,4	Literature Review
6	Meyer-Lueckel H; Paris S	Improved Resin Infiltration of Natural Caries Lesions	2008	JDR	Charité-Universitätsmedizin Berlin	136	8,5	Laboratory Study
7	Paris S; Meyer-Lueckel H	Inhibition of Caries Progression by Resin Infiltration in situ	2010	CR	Christian-Albrechts-University Kiel	115	8,21	Laboratory Study

8	Urquhart O *et al.*	Nonrestorative Treatments for Caries: Systematic Review and Network Meta-analysis	2019	JDR	American Dental Association	112	22,4	Systematic Review and Meta-analysis
9	Paris S *et al.*	Resin infiltration of artificial enamel caries lesions with experimental light curing resins	2007	DMJ	Charité-Universitätsmedizin Berlin	112	6,59	Laboratory Study
10	Paris S; Meyer-Lueckel H	Masking of labial enamel white spot lesions by resin infiltration-A clinical report	2009	QI	Christian-Albrechts-University Kiel	109	7,27	Clinical Study
11	Meyer-Lueckel H; Paris S	Progression of artificial enamel caries lesions after infiltration with experimental light curing resins	2008	CR	Charité-Universitätsmedizin Berlin	105	6,56	Laboratory Study
12	Erickson RL *et al.*	The role of etching in bonding to enamel: A comparison of self-etching and etch-and-rinse adhesive systems	2009	DM	Creighton University School of Dentistry	103	6,87	Laboratory Study
13	Torres CRG *et al.*	Effect of caries infiltration technique and fluoride therapy on the colour masking of white spot lesions	2011	JD	Sao Paulo State Univ Unesp	101	7,77	Laboratory Study
14	Kim S *et al.*	The evaluation of resin infiltration for masking labial enamel white spot lesions	2011	IJPD	Pusan National University	100	7,69	Clinical Study
15	Paris S *et al.*	Penetration coefficients of commercially available and experimental composites intended to infiltrate enamel carious lesions	2007	DM	Charité-Universitätsmedizin Berlin	95	5,59	Laboratory Study

16	Meyer-Lueckel H *et al.*	Randomized Controlled Clinical Trial on Proximal Caries Infiltration: Three-Year Follow-Up	2012	CR	Aachen University	94	7,83	Clinical Study
17	Martignon S *et al.*	Infiltrating/Sealing Proximal Caries Lesions: A 3-year Randomized Clinical Trial	2012	JDR	Universidad El Bosque	90	7,5	Clinical Study
18	Meyer-Lueckel H *et al.*	Influence of the application time on the penetration of different dental adhesives and a fissure sealant into artificial subsurface lesions in bovine enamel	2006	DM	Charité-Universitätsmedizin Berlin	76	4,22	Laboratory Study
19	Paris S *et al.*	Masking of white spot lesions by resin infiltration in vitro	2013	JD	Christian-Albrechts-University Kiel	73	6,64	Laboratory Study
20	Robinson C *et al.*	In vitro studies of the penetration of adhesive resins into artificial caries-like lesions	2001	CR	Leeds Dental Institute	72	3,13	Laboratory Study
21	Knosel M *et al.*	Durability of esthetic improvement following Icon resin infiltration of multibracket-induced white spot lesions compared with no therapy over 6 months: A single-center, split-mouth, randomized clinical trial	2013	AJOD	University of Göttingen	68	6,18	Clinical Study
22	Hochli D *et al.*	Interventions for orthodontically induced white spot lesions: a systematic review and meta-analysis	2017	EJO	University of Zurich	67	9,57	Systematic Review and Meta-analysis

23	Splieth CH *et al.*	Sealants in Dentistry: Outcomes of the ORCA Saturday Afternoon Symposium 2007	2010	CR	Ernst Moritz Arndt University	67	4,79	Literature Review
24	Dorri M *et al.*	Micro-invasive interventions for managing proximal dental decay in primary and permanent teeth	2015	CDSR	Bristol Oral and Dental School	63	7	Systematic Review and Meta-analysis
25	Paris S *et al.*	Progression of sealed initial bovine enamel lesions under demineralizing conditions in vitro	2006	CR	University School of Dental Medicine, Berlin	61	3,39	Laboratory Study
26	Borges AB *et al.*	Is resin infiltration an effective esthetic treatment for enamel development defects and white spot lesions? A systematic review	2017	JD	Sao Paulo State Univ Unesp	60	8,57	Systematic Review
27	Paris S *et al.*	Micro-hardness and mineral loss of enamel lesions after infiltration with various resins: Influence of infiltrant composition and application frequency in vitro	2013	JD	Christian-Albrechts-University Kiel	58	5,27	Laboratory Study
28	Paris S; Meyer-Lueckel H	Infiltrants Inhibit Progression of Natural Caries Lesions in vitro	2010	JDR	Christian-Albrechts-University Kiel	55	3,93	Laboratory Study
29	Paris S *et al.*	Resin infiltration of proximal caries lesions differing in ICDAS codes	2011	EJOS	Christian-Albrechts-University Kiel	52	4	Laboratory Study
30	Domejean S *et al.*	Resin Infiltration of Non-Cavitated Caries Lesions: A Systematic Review	2015	MPP	Centre de Recherche en Odontologie Clinique	50	5,56	Systematic Review

31	Senestraro SV *et al.*	Minimally invasive resin infiltration of arrested white-spot lesions A randomized clinical trial	2013	JADA	Oregon Health & Science University	50	4,55	Clinical Study
32	Meyer-Lueckel H; Paris S	Infiltration of Natural Caries Lesions with Experimental Resins Differing in Penetration Coefficients and Ethanol Addition	2010	CR	Christian-Albrechts-University Kiel	50	3,57	Laboratory Study
33	Sonesson M *et al.*	Management of post-orthodontic white spot lesions: an updated systematic review	2017	EJO	Malmö University	49	7	Systematic Review
34	Meyer-Lueckel, H *et al.*	Influence of application time on penetration of an infiltrant into natural enamel caries	2011	JD	Christian-Albrechts-University Kiel	47	3,62	Laboratory Study
35	Neto DMA *et al.*	Novel hydroxyapatite nanorods improve anti-caries efficacy of enamel infiltrants	2016	DM	Federal University of Ceará	44	5,5	Laboratory Study
36	Munoz MA *et al.*	Alternative Esthetic Management of Fluorosis and Hypoplasia Stains: Blending Effect Obtained with Resin Infiltration Techniques	2013	JERD	State University of Ponta Grossa	44	4	Clinical Study
37	Paula ABP *et al.*	THERAPIES FOR WHITE SPOT LESIONS-A SYSTEMATIC REVIEW	2017	JEBDP	University of Coimbra	43	6,14	Systematic Review
38	Crombie F *et al.*	Resin infiltration of developmentally hypomineralised enamel	2014	IJPD	University of Melbourne	41	4,1	Laboratory Study

39	Paris S *et al.*	Surface conditioning of natural enamel caries lesions in deciduous teeth in preparation for resin infiltration	2010	JD	Christian-Albrechts-University Kiel	41	2,93	Laboratory Study
40	Paris S *et al.*	Validation of Two Dual Fluorescence Techniques for Confocal Microscopic Visualization of Resin Penetration Into Enamel Caries Lesions	2009	MRT	Christian-Albrechts-University Kiel	41	2,73	Laboratory Study
41	Borges AB *et al.*	Color Stability of Resin Used for Caries Infiltration After Exposure to Different Staining Solutions	2014	OD	Sao Paulo State Univ Unesp	37	3,7	Laboratory Study
42	Torres CRG *et al.*	Effect of Caries Infiltration Technique and Fluoride Therapy on Microhardness of Enamel Carious Lesions	2012	OD	Sao Paulo State Univ Unesp	37	3,08	Laboratory Study
43	Paris S *et al.*	Comparison of sealant and infiltrant penetration into pit and fissure caries lesions in vitro	2014	JD	Charité-Universitätsmedizin Berlin	36	3,6	Laboratory Study
44	Wiegand A *et al.*	Adhesive performance of a caries infiltrant on sound and demineralised enamel	2011	JD	University of Zurich	36	2,77	Laboratory Study
45	Coelho ASED *et al.*	Dental hypomineralization treatment: A systematic review	2019	JERD	University of Coimbra	35	7	Systematic Review
46	Eckstein A *et al.*	Camouflage effects following resin infiltration of postorthodontic white-spot lesions in vivo: One-year follow-up	2015	AO	University of Göttingen	35	3,89	Clinical Study

47	Neuhaus KW *et al.*	Late Infiltration of Post-orthodontic White Spot Lesions	2010	JOO	University of Bern	34	2,43	Clinical Study
48	Ulrich I *et al.*	Tridimensional surface roughness analysis after resin infiltration of (deproteinized) natural subsurface carious lesions	2015	COI	Danube Private University	33	3,67	Laboratory Study
49	Schmidlin PR *et al.*	Protection of sound enamel and artificial enamel lesions against demineralisation: Caries infiltrant versus adhesive	2012	JD	University of Zurich	33	2,75	Laboratory Study
50	Neres EY *et al.*	Microhardness and Roughness of Infiltrated White Spot Lesions Submitted to Different Challenges	2017	OD	Sao Paulo State Univ Unesp	32	4,57	Laboratory Study

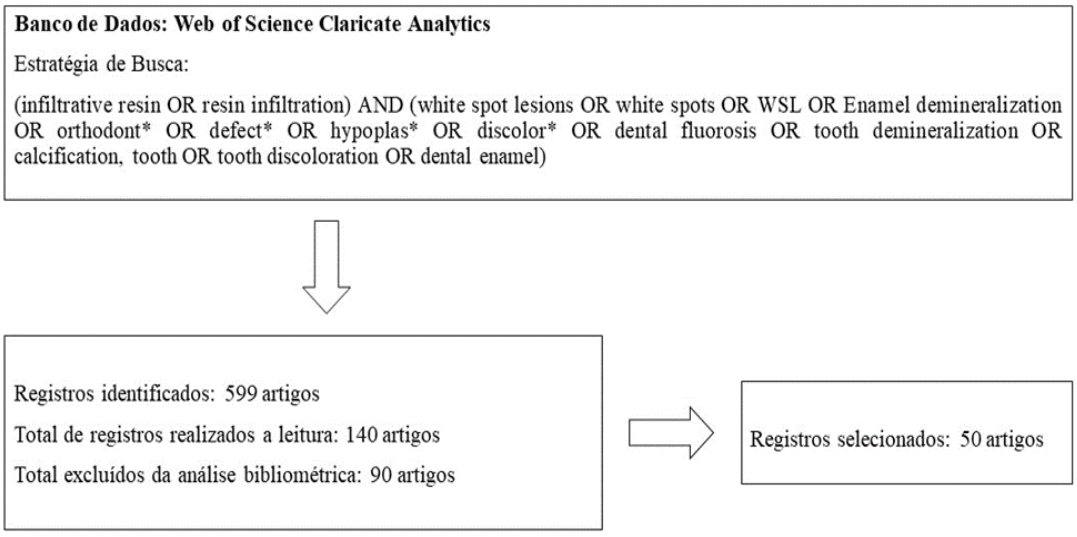

Fig. 1.Flowchart of the study selection process and search strategy.

3.1 Types of study, publications and author citations

Among the top 50 most cited articles in the field of Resin Infiltrants in dentistry, 56% of these scientific works are laboratory studies, 20% are clinical studies, and the remainder are reviews and meta-analyses, as shown in Figure 2.

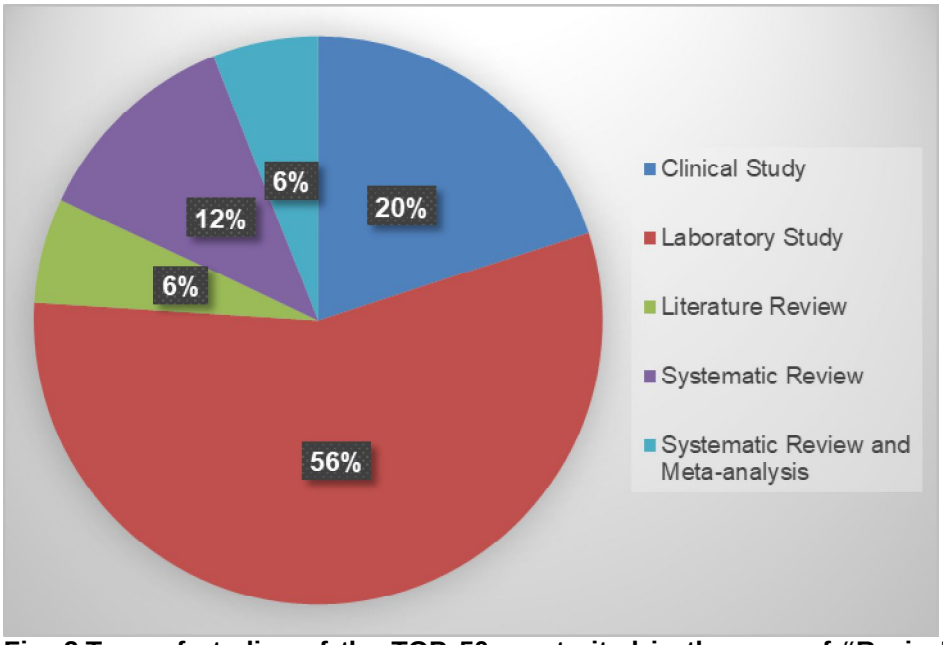

Fig. 2.Type of studies of the TOP 50 most cited in the area of "Resin Infiltrants in dentistry".

The number of authors in the articles varied between 2 and 19 (average 5.04±3.16), totaling 161 authors in the 50 most cited articles on "Resinous Infiltrants". The authors and co-authors with the highest number of publications, followed by their respective score, Meyer-Lueckel H and Paris S appeared in 21 articles, followed by Kielbassa AM who appeared in 7 articles. Figure 3 shows a graphical representation of the network between authors.

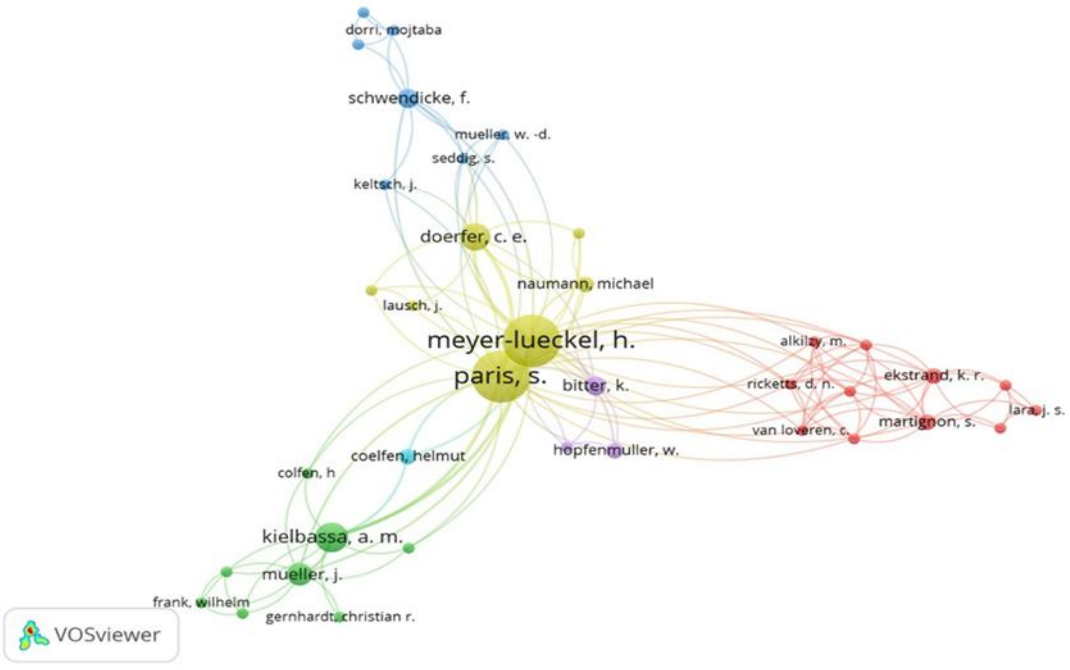

Fig 3. Network of authors and citations of the bibliometric research "Resin Infiltrants". The sizes of the circles are related to the number of publications by each author/coauthor.

The most cited articles in the top 50 were in first position Frencken *et al.* in 2012 with a total of 237 citations, followed by Paris *et al*. in 2007 with 167 citations and again Paris *et al.* in 2010 with 159 citations to his article. The number of citations varied between 32 and 237 (average 74.78±43.29). Around 14 articles achieved 100 or more citations (Table 1). The oldest manuscript of this bibliometric analysis was published in 2001 by Robinson *et al.* in Caries Research (CR) and was cited 72 times, while two articles were the most recent, published in 2019 by Urquhart *et al.* in the Journal of Dental Research (JDR), it was cited 112 times and by Coelho *et al.* in the Journal of Esthetic and Restorative Dentistry (JERD), cited 35 times.

Figure 4 shows the correlation between the number of citations and the year of publication of the studies of the 50 most cited articles in the area of "Resinous Infiltrants". The citation distribution line shows high peaks in 2010 and 2012, with the highest citations added to the top 50 studies, with 521 and 491 respectively.

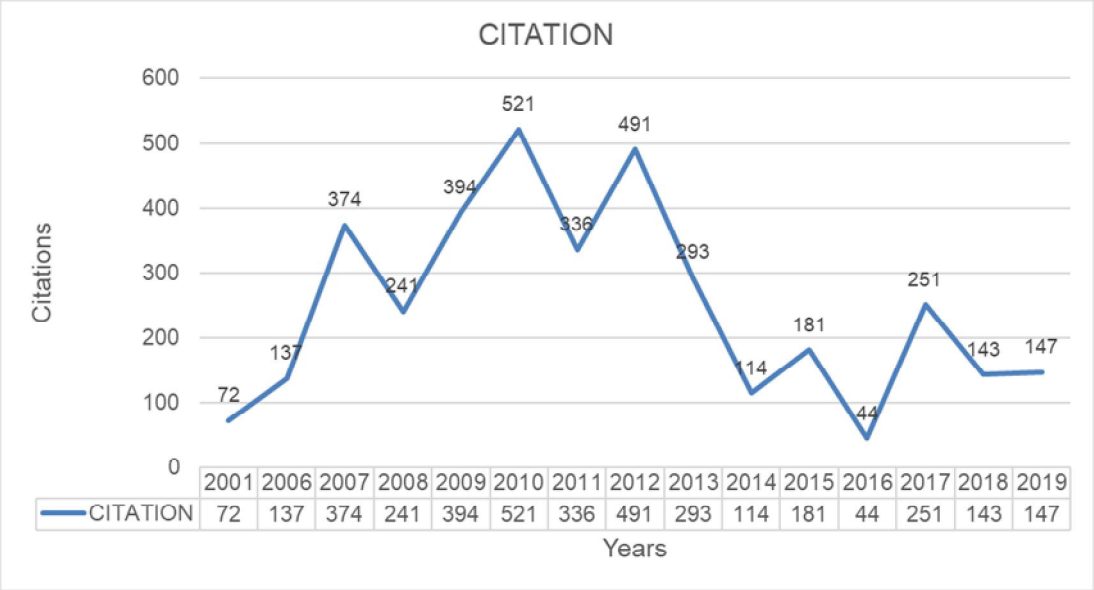

Fig 4. Correlation between the number of citations and the year of publication of the studies.

3.2 Institutions and countries

A total of 64 different institutions are related to these studies, involving authors and co-authors. The institutions that stood out the most were Charité-Universitätsmedizin Berlin, which topped the list with 17 published manuscripts, followed by Christian-Albrechts-University Kiel with 15 published manuscripts, among the 50 most cited. When observing only the first author's institutions, 25 institutions were found. In first place was Christian-Albrechts-University Kiel which published 11 articles (800 citations), followed by Charité-Universitätsmedizin Berlin with 8 articles (868 citations), Sao Paulo State Univ Unesp with 5 articles (267 citations) as can be seen in Table 2.

Table 2. Correlation between the first author's institutions, number of publications and citations of the top 50 most cited articles on resinous infiltrants.

First Author's Institutions	Number of articles	Total Citations
Christian-Albrechts-University Kiel	11	800
Charité-Universitätsmedizin Berlin	8	868
Sao Paulo State Univ Unesp	5	267
University of Zurich	3	136
University of Göttingen	2	103
University of Coimbra	2	78
Danube Private University	1	33
University School of Dental Medicine, Berlin	1	61
Ernst Moritz Arndt University	1	67
Leeds Dental Institute	1	72
Oregon Health & Science University	1	50
University of Washington	1	143
University of Bern	1	34
Creighton University School of Dentistry	1	103
Bristol Oral and Dental School	1	63
Federal University of Ceará	1	44
Centre de Recherche en Odontologie Clinique	1	50
State University of Ponta Grossa	1	44
Malmö University	1	49
Pusan National University	1	100
Radboud University Nijmegen Medical Centre	1	237
American Dental Association	1	112
University of Melbourne	1	41
Aachen University	1	94
Universidad El Bosque	1	90
Total Geral	**50**	**3739**

The studies originated in 13 different countries when looking only at the location of the first author. The main countries were Germany with 24 published manuscripts (1,993 citations), followed by Brazil with 7 manuscripts (355 citations), USA with 4 articles (408 citations) and Switzerland, also with 4 articles (170 citations), among the top 50 articles, as shown in Table 3. Figure 5 shows the World Map and the countries in the top 50 most cited, taking into account the first author.

Table 3.Number of articles published and number of citations from each country of origin of the top 50 most cited articles on resinous infiltrants.

Country Of the First Author	Number of	Number of Citations

	Articles	
Alemanha	24	1993
Brasil	7	355
Suíça	4	170
EUA	4	408
Portugal	2	78
Reino Unido	2	135
Coréia do Sul	1	100
Colômbia	1	90
Suécia	1	49
Aústria	1	33
Austrália	1	41
França	1	50
Holanda	1	237
Total	**50**	**3739**

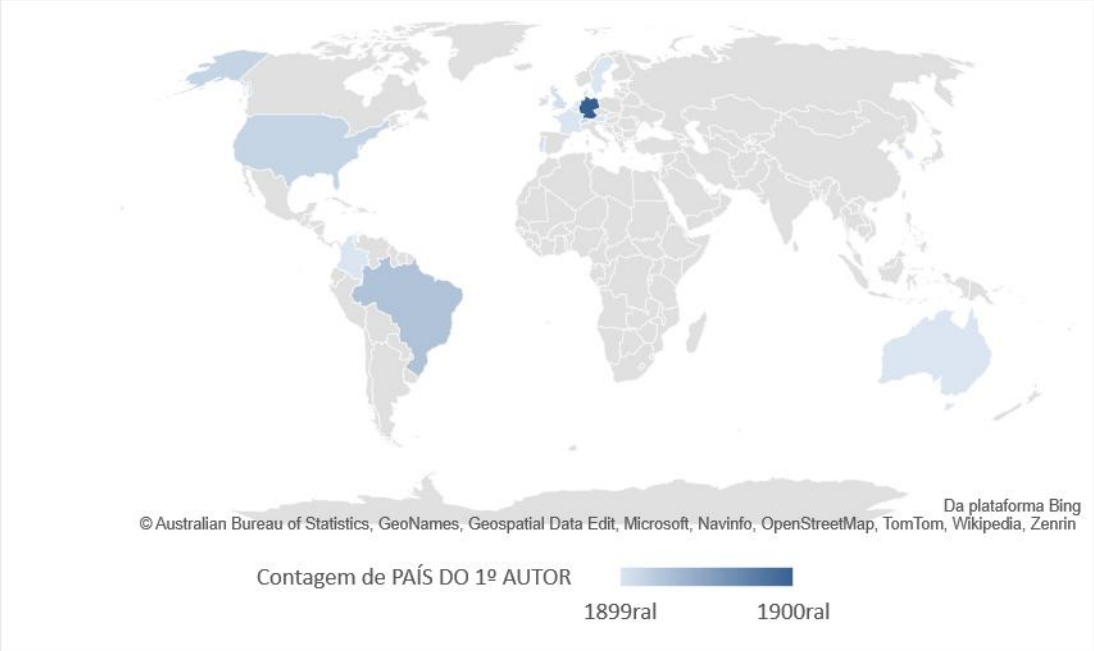

Fig. 5. World Map with the countries of origin of the top 50 most cited articles. The bluer it is, the greater the number of articles published.

When looking at the country of all authors and co-authors, the number of countries of origin increases to 21, so Germany continues to appear in first place, with 27 articles, Brazil with 7 articles and the USA with 5 articles published, as shown in figure 6.

Fig 6.Analysis of the network of the main countries based on the bibliographical research "Resinous Infiltrants".
The sizes of the circles are related to the countries and their number of publications.

3.3Periodicals

The 50 most cited articles involving Resin Infiltrants in Dentistry were published in 21 different journals. Among the main ones are the Journal of Dentistry (JD), leading the ranking with 9 articles, followed by Caries Research (CR) with 7 articles and the Journal of Dental Research (JDR) with 6 articles, as shown in Figure 7.

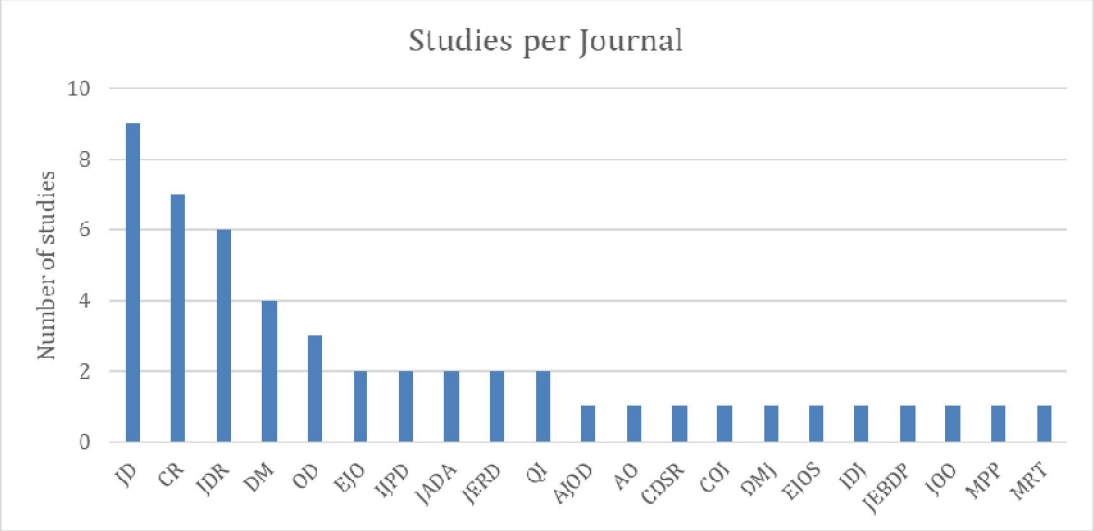

Fig 7. Number of studies published by Periodicals.

Fourteen publishers were found in this research. The most prevalent among the 50 articles were Elsevier SCI LTD (ESL) with 13 studies, followed by Karger (K) and Wiley (W) with 8 studies each, as shown in Figure 8.

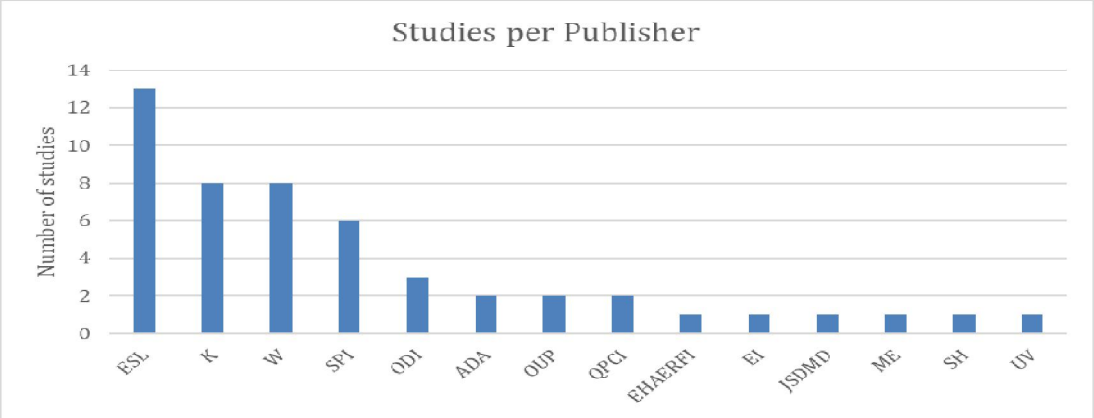

Fig 8.Number of studies published by Publishers of the top 50 most cited articles.

3.4Keywords

In total, 274 keywords were used. The most used keywords in this list of the top 50 articles were: Resin infiltration (22 articles), progression (19 articles), penetration (18 articles), enamel (17 articles), in vitro (17 articles), caries (14 articles), infiltration (13 articles). The most used keyword was repeated in 22 studies, and the frequency of keyword use varied between 1 and 22 repetitions. Figure 9 shows a graphical representation in the form of a map of keywords that are repeated more than twice.

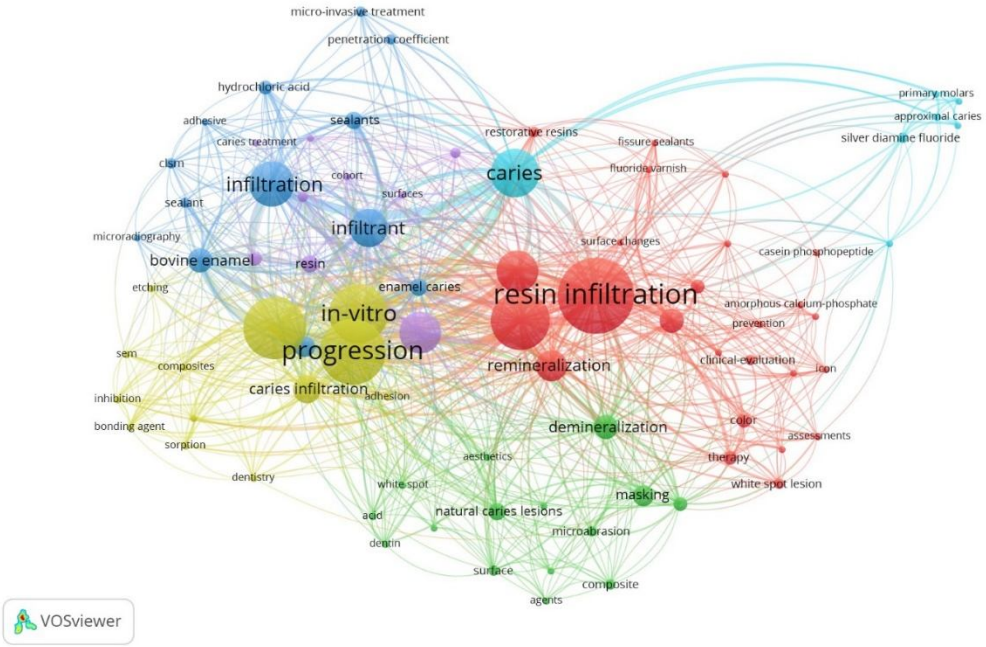

Fig. 9.Keyword network analysis of the bibliographic search “Resinous Infiltrants”. The sizes of the circles are related to the number of citations for each keyword used.

3.5 Temporal pattern of publications

Based on the distribution of 50 articles over the years, 2010 was the period with the highest concentration of publications and the most productive, with 7 studies as shown in Figure 10.

Among the most cited studies, no more current studies appeared, with the most recent articles among the 50 most cited articles of 2019, presenting two articles.

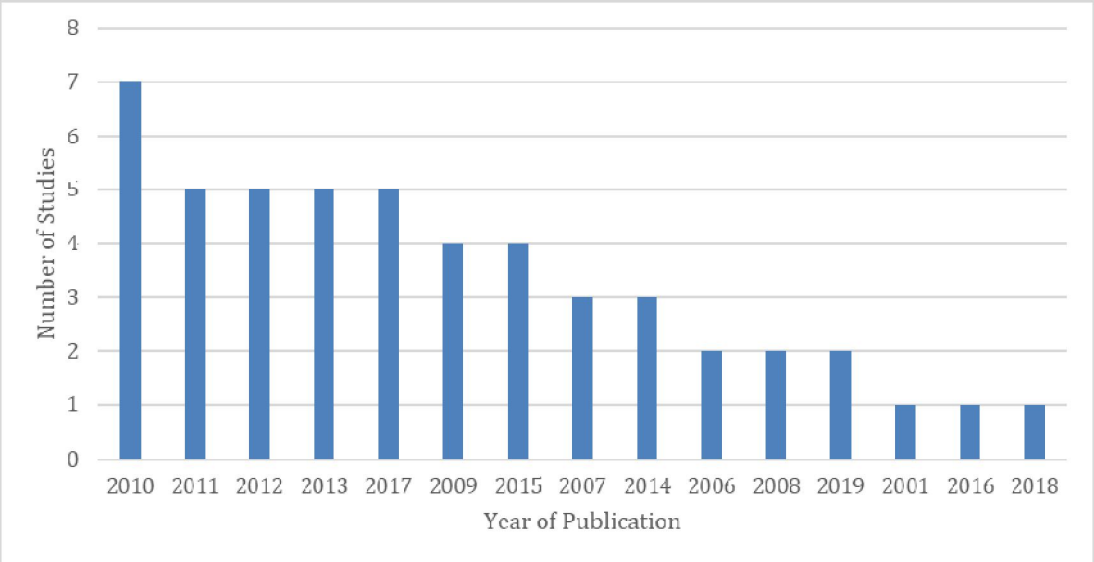

Fig. 10. Temporal distribution of the 50 most cited studies on "Resinous Infiltrants" over the years.

4. DISCUSSION

The bibliometric analysis of Resin Infiltrants aimed to identify the evolution of research in a temporal portrait and in a given area in order to obtain a greater understanding of the sector in question being researched. As it is a relatively new material on the dental market, the applicability of Resinous Infiltrants is not well understood. Despite several recommendations on the non-invasive treatment of early carious lesions – white spot lesions, clear treatment routines based on higher level clinical evidence are scarce, especially in the last 5 years.

According to the initial search in the Web of Science Clarinete Analytics database, it was possible to identify 599 articles related to Resinous Infiltrants. The bibliometric analysis of the top 50 in relation to publication and the number of cited authors reveals the importance of these works for the scientific community. Of these selected articles, the majority were laboratory tests (28 articles), this type of study design is the base of the evidence pyramid [10]. Appearing in second place are clinical studies (10 articles), followed by systematic review (6 articles), systematic review and meta-analysis (3 articles) and literature review (3 articles). Systematic review and meta-analysis articles represent the top of the pyramid of scientific evidence, they present important information for decision-making [10].

Of the top 50, 28% of the articles reached 100 or more citations and can be considered as classic articles related to the "Resinous Infiltration" material, as according to Feijoo and collaborators [11], articles that present more than 100 citations are classified as classic studies. Average citations per year is also an important metric as newer articles may have the same ranking parameter as older articles. In this review, four articles had more than 10 citations per year. The first was the fourth most cited article, with 23.83 citations per year this article formulated evidence-based clinical recommendations for the interruption or reversal of non-cavitated and cavitated dental caries using non-restorative treatments in children and adults [12], and the second was an article published in 2019 and is a systematic review and network meta-analysis that aimed to summarize the available evidence on non-restorative treatments for the results of interruption or reversal of non-cavitated and cavitated caries lesions in deciduous and permanent teeth and in adverse events [13]. This article had an average of 22.40 citations per year. The third article evaluated by the number of citations per

year, was the 1st (st) in the ranking of most cited articles, is also a review article on the management of dental caries, reducing the need for restorative therapy, through minimal intervention, and had an average 19.75 citations per year [14]. The fourth article about a randomized study with Resinous Infiltrants had 11.36 citations per year [15]. leading us to infer that one of the most important topics for researchers in the field involved the use of a non-invasive restorative treatment.

Leading the ranking of the most cited was the review article by Frencken *et al.* in 2012 [14], entitled “Minimal intervention dentistry for managing dental caries - a review” published in the International Dental Journal with a total of 237 citations. The work of a group from FDI - World Dental Federation, addresses some less invasive caries control measures and their effectiveness and reports on the technique of resin infiltration in non-cavitated lesions as a promising therapy to prevent the progression of carious lesions in enamel. As a result of a better understanding of the structural and functional biology of hard dental tissues highlighted in scientific works over the last three decades [16], minimally invasive dentistry is a topic in evidence in the literature. In this sense, the approach of the most cited article corroborates what was expected, given that Resinous Infiltrant is considered a minimally invasive product capable of paralyzing the carious lesion and inhibiting future demineralization [15].

There was a variation in the number of citations, ranging between 32 and 237, which points to the diversity of themes and approaches present in the most cited articles. Representing 34% of the 50 most cited articles, the most studied topic was infiltration aimed at masking white spots. The ability of Resin Infiltrants to penetrate through capillarity into the porosities of the enamel and fill the pores that have been demineralized [17] has indicated a masking of the infiltrated white spot lesions allowing to aesthetically improve the appearance of the teeth, this effect occurs due to the similar refractive index of the infiltrating and healthy enamel areas [18, 19]. This additional feature has become extremely attractive to professionals and researchers in order to carry out an approach aimed at aesthetics with minimal intervention, which justifies the result found. However, there was a diversity of themes, also observing the application of the infiltrant in post-orthodontic injuries; comparing the progression of infiltrated and sealed caries lesions; tests with experimental infiltrants; observing the influence of the infiltrant composition; modifications to formulations through the incorporation of hydroxyapatite; evaluating different acids with the use of infiltrants; comparing the validity and reproducibility of the methods used to verify their infiltration effectiveness; checking the surface roughness, microhardness and shear of the area of infiltrated lesions and resin infiltration compared to adhesive systems [3]. It can then be seen that a large part of the studies are focused on improving the material, which leads us to infer that the widespread use of Resinous Infiltrant is conditioned by numerous details, making it necessary to elucidate further studies with the purpose of deepening the knowledge and basis of the use of this material.

The identification of the oldest manuscript among the articles selected in the bibliometric review was the study developed by the authors Robinson C; Brookes SJ; Kirkham J; Wood SR; Shore RC EM, Leeds Dental Institute, Leeds UK, published in Caries Research in 2004 [20]. The study took into account previous work that showed successful infiltration of materials into white spot lesions, using resorcinol-formaldehyde as an infiltrant, however its use was clinically unacceptable, so in his research he used dental adhesives with infiltrants in artificial white spot lesions and arrived at the result that up to 60% of the pore volume of the lesion was occluded after infiltration with some of the materials tested and that this treatment was able to further reduce acid demineralization. The article had a total of 72 citations, ranking 40th of the 50 most cited articles. Although the work evaluated other materials to perform the infiltration of white spot lesions, studies seeking to treat incipient carious lesions began in the 1970s when the concept of caries infiltration was first mentioned by Davila and collaborators (1975) [21].

Two articles were the most recent, published in 2018, one by Urquhart and collaborators [13], which is a systematic review and network meta-analysis with a total of 112 citations, occupying 8th position in the ranking and the other most recent article was by Coelho and collaborators [22] also refers to a systematic review, with a total of 112 citations, occupying 45th position in the ranking. More recent citations from systematic reviews detected in this bibliometric review show how emerging Resin Infiltrants are, justifying their constant evolution and continuity of research over time. Furthermore, another aspect that must be taken into consideration is that the first Resinous Infiltrator was launched in 2009, in Germany (Charité-Berlin University Hospital). After in vitro and in vivo studies carried out on the penetration of resinous material into incipient cavities, Icon® Resin Infiltrant (DMG America Company, Englewood) was introduced to the dental market [18]. Furthermore, ICON is the only commercially available material, thus justifying current investigations on the topic. To improve Icon and/or develop a material with the desired characteristics, in addition to making it more economically viable, since by being unique, the material has a high value.

From the analysis in relation to the institution and countries, it was possible to observe that studies on the topic had significant distributions in different countries and institutions. The standout institution when observing authors and co-authors was the Charité-Universitätsmedizin Berlin, with the largest number of published manuscripts, followed by the Christian-Albrechts-University Kiel. These data suggest that these institutions have a greater interest in the topic in question. It was through studies from these two universities that it was possible to launch a commercially viable material onto the dental market. Resinous Infiltrant from the patented Icon® brand, consisting of three syringes: Icon-Etch® (hydrochloric acid), Icon-Dry® (ethanol) and Icon-Infiltrant® (infiltrating resin) [23]. These Resinous Infiltrants are transported through the capillary forces present in the porosities of the enamel that were induced by demineralization, after polymerization they block the diffusion pathways of cariogenic acids [17]. They cause changes in the appearance of the enamel, promoting the dispersion of light due to the refractive index (IR) of the resin, camouflaging the white spot lesion [21].

Furthermore, the distribution of studies by country also reveals a wide variety of contributions, with Germany in first place with the largest number of manuscripts, Brazil and the United States. These data indicate a great diversity of academic and cultural contexts involved in the studies. Therefore, the topic in question has a global reach, which reinforces the importance of considering different perspectives and contexts when approaching this study.

The analysis of the most frequent journals and publishers in the 50 most cited articles on the topic of Resinous Infiltrants in Dentistry reveals a diversity in terms of publications and publishers involved. The Journal of Dentistry leads the ranking, followed by Caries Research and Journal of Dental Research, this indicates a concentration of studies on the topic in specific journals. With regard to publishers, we have 14 different ones in the 50 most cited articles, but as the most present, Elsevier SCI LTD (ESL) stands out with the largest number of published studies, followed by Karger and Wiley, which demonstrates a broad involvement of different agents in the dissemination of knowledge in this field. Therefore, the presence of multiple publishers indicates the existence of a wide variety of approaches and perspectives on the topic, thus the plurality of publication sources and periodicals also points to the need to promote interdisciplinary dialogue and collaboration between different publishers and periodicals.

The study of the most frequent keywords on Resin Infiltrants in Dentistry reveals the main themes and focuses of interest in this area. The keyword “resin infiltration” stands out as the most used, suggesting that the topic “resin infiltration” is central and widely explored in the literature. The significant presence of keywords such as “progression”, “penetration”, “enamel”, “in vitro" and “caries” also reveals the main aspects of interest in this field. The graphical representation in the form of a map, as shown in Figure 8, offers a clear visualization of the interconnection between the themes and subtopics covered. This

representation can be useful to identify patterns, trends and relationships between the most used keywords, helping to understand the structure of the existing literature on Resin Infiltrants in Dentistry.
Finally, investigating the distribution of the 50 main articles over the years, it was noted that the year 2010 was the most productive, with seven studies published. This concentration of publication in this period shows greater interest and research activities at that specific moment. More current studies were not found, with the most recent being dated 2019. These results expose important questions about the evolution of the field of Resinous Infiltrants in Dentistry, the absence of more recent studies among the 50 most cited articles may indicate a decline in interest or research activities in this topic, or that more recent studies have not had sufficient time to achieve the same level of impact and citation as older studies. In view of this, this analysis can offer greater insights for researchers who wish to direct their current investigations or unmet needs in the field of Resinous Infiltrants within Minimally Invasive Dentistry.
Therefore, the analysis of the most cited articles provides important insights into the trends and impacts of research in this field, with these data being valuable for researchers, professionals and educational and research institutions as they help to identify the most promising areas for future investigations and to understand the relevance and impact of research already carried out.

5. CONCLUSION

In short, tooth decay is a disease with a significant impact on oral health, affecting individuals around the world. White spot lesions and caries progression present clinical challenges, but different treatment approaches have been developed to minimize the need for invasive procedures. The bibliometric review carried out in this study revealed the growing interest and research around the use of Resinous Infiltrants as an effective and minimally invasive alternative to address white spot lesions and tooth decay. The technique has shown promise in stopping the progression of cavities, strengthening tooth structure and improving dental aesthetics. Thus, the use of Resinous Infiltrants has the potential to provide significant benefits to patients, contributing to improving dental care and quality of life, meeting the requirements of preserving healthy dental tissue, preventing caries progression and improving dental aesthetics. With continuous evolution in this field, the Resin Infiltration technique promises to be an important and effective treatment for tooth decay. However, it has already been established that new research is needed to help the infiltrator over the years.

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Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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Details of the AI usage are given below:

1.

2.

3.

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