JOURNAL of ENDODONTICS and RESTORATIVE DENTISTRY

Original Article

Bibliometric analysis of literature on Bulk-Fill Composite Resins in Dentistry

Kacper Nijakowski [a], Jakub Jankowski [b], Anna Lehmann [a]

[a] Department of Conservative Dentistry and Endodontics, Poznan University of Medical Sciences, 60-812 Poznan, Poland

[b] Student's Scientific Group in Department of Conservative Dentistry and Endodontics, Poznan University of Medical Sciences, 60-812 Poznan, Poland

ARTICLE INFO

Received: 23.07.2023
Completion of First Review: 09.08.2023
Accepted: 17.08.2023
Published: 01.09.2023

KEYWORDS

Bibliometric analysis
Bulk-fill composite
Resin composite

CORRESPONDENCE

Anna Lehmann
Department of Conservative Dentistry and Endodontics Poznan University of Medical Sciences ul. Bukowska 70, 60-812 Poznan
email: annalehmann@ump.edu.pl

CLINICAL SIGNIFICANCE

Over the past decade, there has been a rise in publications exploring bulk-fill composites. As these materials allow for deeper polymerization, research into their properties

ABSTRACT

Objectives: Bulk-fill composite resins, offer a simplified application process through the use of a single layer, saving valuable time and effort. This study aimed to Identify of all research areas, the most effective authors, countries, and journals about bulk-fill composite resins in the period of 2011-2022.

Materials and methods: Electronic research was conducted in the Web of Science database by selecting the words "bulk-fill composite" and "restoration". Bibliometrics were extracted and analysed using VOSviewer v1.6.14. To analyze the most frequently cited articles, a spreadsheet, where equal weight was given to each collaborator's contribution was used. VOSviewer helped to visualize the citation network and collaboration.

Results: The largest number of publications on bulk-fill appeared in 2021, and the most frequently cited work covers the subject of mechanical properties of the bulk-fill composite. Most articles on bulk-fill come from Brazil, and the researcher from Germany has achieved the greatest achievements in this field. David Craig Watts is identified as the author with the highest number of published works, whereas Nicoleta Ilie is recognized for receiving the most citations for her work. King Saud University produced the most publications with a total of 56, while the University of Munich was found to have received the highest number of citations, totalling 1672.

Conclusion: This bibliometric analysis illustrates the progress and trend of bulk-fill composite research. The results can be an excellent reference for identifying unexplored areas of knowledge and provide excellent tips on creating high-cited papers.

1. Introduction

Bibliometrics is a systematic method for evaluating research output to analyse literature using statistical and mathematical approaches. For several years, bibliometric analyses have been used in various fields of science to map publications and create a broader context of the analysed topic. Bibliometrics is a great tool to represent the historical development of research fields and evaluate the research productivity of journals, researchers, universities, countries, and many other organisations. Citation analysis, which examines the effect of research publication by examining citation data obtained by a scientific study, is the preferred method in bibliometry.[1,2] One limitation of this analysis is the publication time. Older articles are more likely to be cited. This is certainly a shortcoming of citation analysis, but today it maintains its popularity for measuring the attribution effect of an article. Equally helpful in analysing the topic can be a systematic review or meta-analysis. These are techniques for searching, evaluating, synthesising research evidence and combining quantitative research results on a given topic. Their limitation is certainly the narrow scope of the researched topic.

Due to their short history, bulk-fill composite materials are a perfect topic for knowledge mapping. In a short time, they have gained tremendous popularity among dentists worldwide.[3,4] Bulk-fill materials are characterised by a chemical composition that reduces polymerisation shrinkage. Consequently, they can be applied in a thicker layer than classic composite materials. This feature means they can be used in conservative dentistry in two ways - either to obtain a more durable filling with layer application or to shorten the procedure of filling a cavity with one layer application. The first solution is used for the conservative reconstruction of posterior teeth in adult patients, and the second option is worth using in the case of children and adults during procedures of prolonged duration.[5,6]

Due to the great interest in the subject of bulk-fill composite, it is necessary to discover new relationships that have not yet been established, continue the research undertaken to update them, and sometimes even change the existing theories.

Until now, no complete bibliometric analysis of bulk-fill composites has been found in the literature. Our analysis of topics related to bulk-fill materials can help systematise knowledge, reveal missing research areas, and help scientists plan better research and publications. Nowadays, scientists are required to deliver high-cited papers. The bibliometric analysis seems to be a suitable tool for this purpose.

2. Materials and Methods

The search was performed through the Web of Science, a repository of top-notch literature resources owned by Clarivate. To enhance the precision of the search, the topic field was restricted to the keywords, abstract and title.

A search was conducted in June 2023 to locate articles on bulk-fill composites in dentistry. The search parameters were limited to articles published before December 31, 2022, specifically focusing on this topic. Only studies classified as "article", "proceeding paper", "review", or "early access" were selected, except for those published before 2011 (because bulk-fill composites were first introduced to the market in 2011). Additionally, all citation topics, except for 1.49 Dentistry & Oral Medicine from meso, were excluded.

Exporting the search results has been undertaken in a tab-delimited format and subsequently subjected to a meticulous analysis using VOSviewer v1.6.14, a bibliometric software program from the Leiden University's Center for Science and Technology Studies. This software program has facilitated comprehensive scrutiny of various parameters such as authors, affiliations, keywords, abstracts, titles, references, and countries. Furthermore,

pertinent data from the WoS functions of "analyse results" and "citation report" have been judiciously collated to supplement the analysis.

Data extraction, processing, and summarisation were conducted utilising Microsoft Office 2016 Excel and VOSviewer. The most frequently cited articles were analysed using a spreadsheet, with equal weight allotted to every collaborator's contribution. Visualising the citation network and collaboration was facilitated by VOSviewer. In the map, the size of the bubble indicated the number of publications, while the distance between bubbles demonstrated their relatedness. The colour of the bubble held varying meanings, depending on the visualisation employed. Network visualisation showed that the same-coloured bubbles formed clusters, indicating close collaboration in research output. Detailed information regarding these findings is available within the figure legends.

An analysis was conducted to assess the impact of keywords on publications. The methodology employed was akin to that of previous research.[7] A publication's relative citation score was determined by using a formula that divided the citation count of a publication by the average citation count of all publications during a specific time frame. Any publication with a score above 1 was deemed to have received more citations than the average. In order to calculate the normalised citation score for each term, the average of the normalised citation scores of all publications that contained the specific term was taken. This calculation was facilitated through the VOSviewer software program and its term map visualisations.

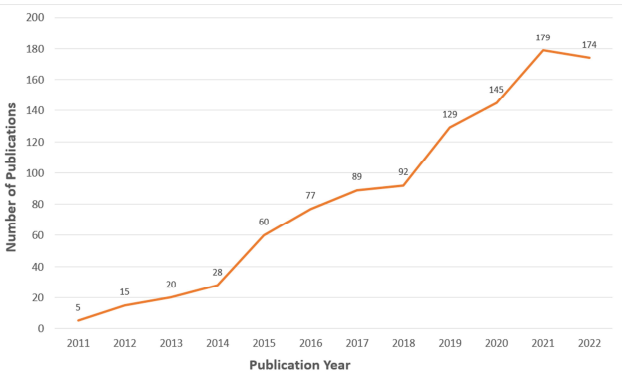

Fig 1. Number of research according to Publication year

3. Results

A comprehensive search was performed using the Web of Science database and found a total of 1013 studies that were

Table 1. Information about the top 20 most cited articles related to research on bulk-fill Composites.

	Title	Authors	Journal	Publication Year	Total Citations	Average per Year
1	Bulk-fill Resin-based Composites: An In Vitro Assessment of Their Mechanical Performance	Ilie, N.; Bucuta, S.; Draenert, M.	Operative Dentistry	2013	247	22.45
2	Physico-mechanical characteristics of commercially available bulk-fill composites	Leprince, J. G.; Palin, W. M.; Vanacker, J. et al.	Journal of Dentistry	2014	215	21.50
3	Light transmittance and micro-mechanical properties of bulk fill vs. conventional resin based composites	Bucuta, S.; Ilie, N.	Clinical Oral Investigations	2014	209	20.90
4	Depth of cure of resin composites: Is the ISO 4049 method suitable for bulk fill materials?	Flury, S.; Hayoz, S.; Peutzfeldt, A. et al.	Dental Materials	2012	179	14.92
5	In vitro comparison of mechanical properties and degree of cure of bulk fill composites	Czasch, P.; Ilie, N.	Clinical Oral Investigations	2013	178	16.18
6	Polymerization Shrinkage Stress Kinetics and Related Properties of Bulk-fill Resin Composites	El-Damanhoury, H. M.; Platt, J. A.	Operative Dentistry	2014	170	17.00
7	Bulk-fill resin composites: Polymerization properties and extended light curing	Zorzin, J.; Maier, E.; Harre, S. et al.	Dental Materials	2015	160	17.78
8	Cuspal deflection and microleakage in premolar teeth restored with bulk-fill flowable resin-based composite base materials	Moorthy, A.; Hogg, C. H.; Dowling, A. H.; Grufferty, B. F.; Benetti, A. R. et al.	Journal of Dentistry	2012	160	13.33
9	Physical properties and depth of cure of a new short fiber reinforced composite	Garoushi, S.; Sailynoja, E.; Vallittu, Pekka K.; Lassila, L.	Dental Materials	2013	154	14.00
10	Degree of conversion of bulk-fill compared to conventional resin-composites at two time intervals	Alshali, R. Z.; Silikas, N.; Satterthwaite, J. D.	Dental Materials	2013	148	13.45
11	Polymerization shrinkage, modulus, and shrinkage stress related to tooth-restoration interfacial debonding in bulk-fill composites	Kim, R.; Kim, Y.; Choi, N. et al.	Journal of Dentistry	2015	146	16.22
12	Bulk-Fill Resin Composites: Polymerization Contraction, Depth of Cure, and Gap Formation	Benetti, A. R.; Havndrup-Pedersen, C.; Honore, D. et al.	Operative Dentistry	2015	141	15.67
13	Bulk-Fill Composites: A Review of the Current Literature	Van Ende, A.; De Munck, J.; Lise, D. P. et al.	Journal of Adhesive Dentistry	2017	140	20.00
14	Translucency of esthetic dental restorative CAD/CAM materials and composite resins with respect to thickness and surface roughness	Awad, D.; Stawarczyk, B.; Liebermann, A. et al.	Journal of Prosthetic Dentistry	2015	140	15.56
15	Post-cure depth of cure of bulk fill dental resin-composites	Alrahlah, A.; Silikas, N.; Watts, D. C.	Dental Materials	2014	137	13.70
16	Monomer conversion, microhardness, internal marginal adaptation, and shrinkage stress of bulk-fill resin composites	Fronza, B.; Rueggeberg, F.; Braga, R. et al.	Dental Materials	2015	135	15.00
17	Mechanical properties, shrinkage stress, cuspal strain and fracture resistance of molars restored with bulk-fill composites and incremental filling technique	Rosatto, C. M. P.; Bicalho, A. A.; Verissimo, C.; Braganca, G. F. et al.	Journal of Dentistry	2015	128	14.22
18	Marginal quality of flowable 4-mm base vs. conventionally layered resin composite	Roggendorf, M. J.; Kraemer, N.; Appelt, A. et al.	Journal of Dentistry	2011	127	9.77
19	Effect of layering methods, composite type, and flowable liner on the polymerization shrinkage stress of light cured composites	Kwon, Y.; Ferracane, J.; Lee, I.	Dental Materials	2012	125	10.42
20	Bulk-filling of high C-factor posterior cavities: Effect on adhesion to cavity-bottom dentin	Van Ende, A.; De Munck, J.; Van Landuyt, K. L. et al.	Dental Materials	2013	123	11.18

Table 2. Top 10 Productive and cited Authors

Top 10 Productive Authors				Top 10 Cited Authors			
Authors	**Institution**	**Country**	**No of articles**	**Authors**	**Instutuion**	**Country**	**No of citations**
Watts, David Craig	University of Manchester	England	32	Ilie, Nicoleta	University of Munich	Germany	1400
Giannini, Marcelo	Universidade E. de Campinas	Brazil	30	Silikas, Nick	University of Manchester	England	1107
Ilie, Nicoleta	University of Munich	Germany	29	Watts, David Craig	University of Manchester	England	1046
Price, Richard B.	Dalhousie University	Canada	26	Giannini, Marcelo	Uni. Estadual de Campinas	Brazil	617
Silikas, Nick	University of Manchester	England	24	Van Meerbeek, Bart	University Hospital Leuven	Belgium	540
Soares, Carlos José	Universidade Federal de Uberlândia	Brazil	22	de Munck, Jan C.	University Hospital Leuven	Belgium	528
Tarle, Zrinka	University of Zagreb	Croatia	19	Garoushi, Sufyan	University of Turku	Finland	442
Attin, Thomas	University of Zurich	Switzerland	17	Vallittu, Pekka K.	University of Turku	Finland	386
Taubock, Tobias T.	University of Zurich	Switzerland	17	Alshali, Ruwaida Z.	King Abdulaziz University	Saudi Arabia	383
Marovic, Danijela	University of Zagreb	Croatia	16	Palin, William M.	University of Birmingham	England	342

published between 2011 and 2023. The data indicates a consistent upward trend in the number of articles published annually, with a marked increase after 2014 (Fig. 1). However, a decline in publication activity is observed in 2021. Out of the 1013 publications, the majority of articles fell under the categories of Dentistry, Oral Surgery Medicine (n=683, 67.42%), Materials Science (n=293, 28.92%), Engineering (n=90, 8.88%), and Chemistry (n=53, 5.23%).

The combined citations for publications on bulk-fill composites amounted to 14,934. With an h-index of 56, each article received an average of 14.74 citations. Twenty-five of the publications were cited more than 100 times. Table 1 displays the 20 most cited papers.

According to data presented in Table 2, a total of 3153 authors contributed to the articles analysed, with an average of 3.11 authors per article. Analysis of the network of collaborations, as illustrated in Fig. 2A, reveals that highly productive authors were at the centre of the network. Among them, David Craig Watts emerged as the most prolific author, while Nicoleta Ilie's work garnered the highest number of citations. Notably, four scholars: David Craig Watts, Giannini Marcelo, Nicoleta Ilie, and Nick Silikas, were included in both lists, indicating their exceptional productivity and influence in this field.

The literature on bulk-fill composites received contributions from 902 organisations across 71 countries or regions. As per Table 3, it was noted that King Saud University produced the most publications, with a total of 56, while the University of Munich received the highest number of citations, totalling 1672. Most of the studies were conducted in universities, with the University of Manchester showing a high citation rate per article. Figure 2B revealed several clusters of institutions centred on King Saud University, the University of Zurich, Universidade Estadual de Campinas, and King Abdulaziz University.productivity and influence in this field.

As illustrated in Table 4, Brazil has acquired the largest share of articles, amounting to 21.62%, corresponding to 219 articles. Turkey and the USA are closely behind, commanding 16.19% with 164 papers each. It is noteworthy that the USA has received the highest number of citations, amounting to 3030, whereas Brazil and Germany trail behind with 2688 and 2472 citations, respectively. When scrutinising international collaborations, it has been observed that Brazil, Turkey, the USA, and Saudi Arabia have received the most extensive attention, as indicated in Figure 2C.

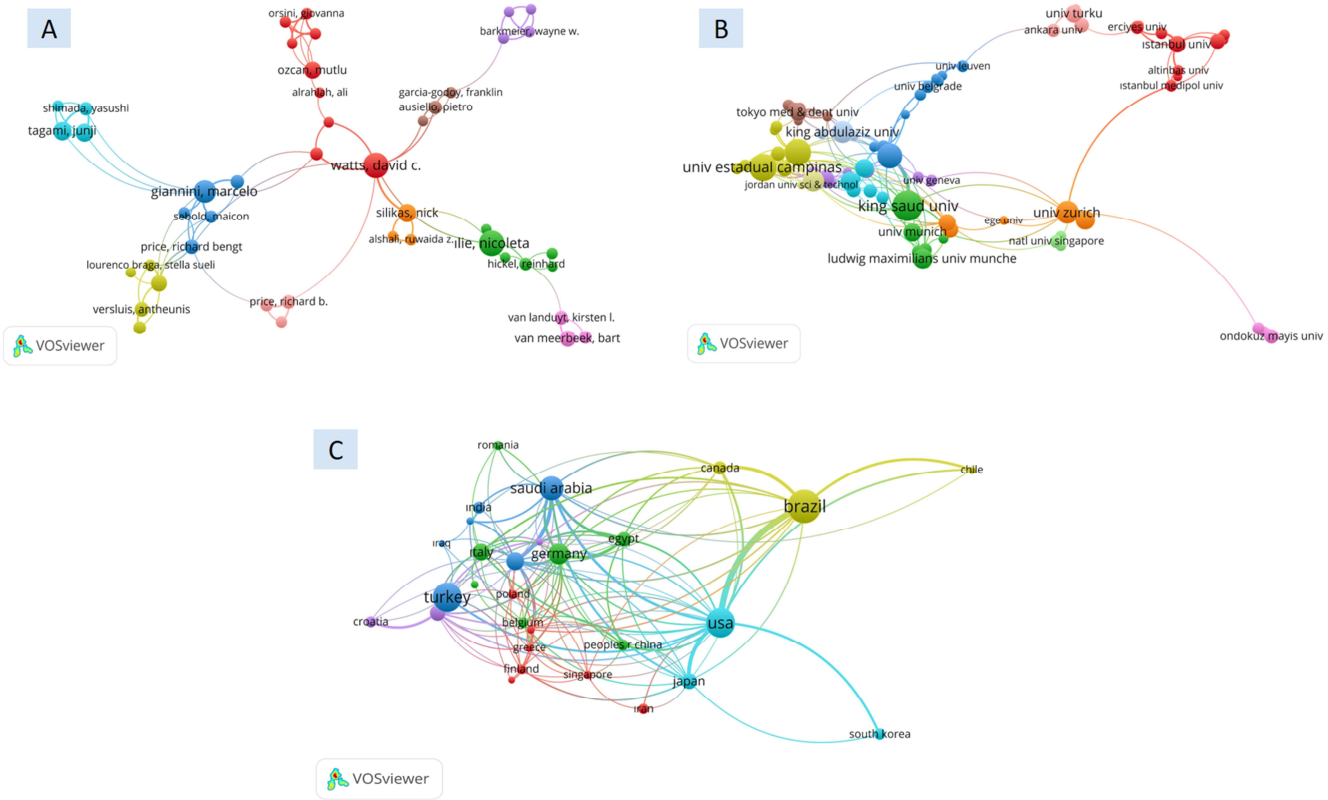

Fig 2. The chart shows collaboration networks based on publications. The bubbles represent authors (A), institutions (B), or countries/regions (C) depending on the category, with larger bubbles indicating a higher number of publications. The links between bubbles indicate the level of collaboration, with shorter links indicating closer collaboration. Only those with more than 5 publications (authors) or 10 publications (institutions and countries/regions) are included in the chart.

Table 3. Top 10 contributing institutions

Institution	Country	Number of Articles	Number of Citations	Citations per Article	H-Index
King Saud University	Saudi Arabia	56	898	16.04	15
University of Munich	Germany	49	1672	34.12	21
Universidade Estadual de Campinas	Brazil	48	836	17.42	15
N8 Research Partnership	England	42	1544	36.76	23
Universidade Sao Paulo	Brazil	41	804	19.61	16
Egyptian Knowlege Bank EKB	Egypt	38	630	16.58	13
University of Manchester	England	38	1435	37.76	23
University of Zurich	Switzerland	31	466	15.03	11
Universidade Estadual Paulista	Brazil	30	316	10.53	9
King Abdulaziz University	Saudi Arabia	28	536	19.14	9

Of the 203 journals with publications on bulk-fill composites, only two have published over 100 articles on the subject. These journals are Operative Dentistry, which accounts for 106 publications (10.46%), and Dental Materials, which accounts for 101 (9.97%). Additionally, the Journal of Dentistry published 50 articles (4.94%), and Clinical Oral Investigations published 44 (4.34%). While Operative Dentistry was the most productive regarding the number of publications, Dental Materials and Journal of Dentistry had higher average normalised citations, as illustrated in Figure 3.

The term map for keywords showed which words were used most frequently in publications about bulk-fill composites. The top keyword was "bulk-fill," appearing 90 times. "Composite resins" was the second most used word with 84 occurrences, followed by "resin composite" with 81, "bulk fill" with 58, and "degree of conversion" with 51 (Fig. 4).

4. Discussion

Bulk-fill composites are currently one of the most popular materials for reconstructing posterior teeth. Since 2011 it was introduced to use, and the number of publications on this subject has been growing. Thanks to their mechanical properties and easy restoration procedure, they are present in almost every dental office. Figure 1 shows the number of articles per year. The slight decline after 2021 may be due to the COVID-19 pandemic, which affected all aspects of society. Researchers worldwide are still working to provide new solutions and better understand this occurrence.[2,8] Due to a large number of bulk-fill publications, Table 1 lists the twenty most cited articles and analyses their main features. In this study, the most common article type used is an original article - a scientific article presenting the results of original research of an empirical, theoretical, technical or analytical nature. The subject of physicochemical properties is particularly exploited; the three most cited articles on bulk-fill relate to this area of research.[3,9,10] Another topic of particular interest to researchers is bulk-fill polymerisation. The degree of conversion, irradiation depth and polymerisation shrinkage were analysed.[11-13] The next highly cited topic is the 4mm layer thickness of the application.[14-16] The range of analysed topics is also presented in a graphical form, allowing for a quicker visual assessment, especially for researchers planning new research projects (Fig.4). Among the most cited articles, those based on surveys are missing. This may indicate that scientists do not value surveys or that there is a lack of good survey research. The second hypothesis seems to be more proper. There is a lack of scientific articles based on well-designed and wide-ranging surveys, e.g., conducted in many countries with different economic and health development levels. This may be another clue for future researchers.

It seems that the clinical aspects of working with bulk-fill composite are still unexplored. Among other things, the literature does not answer which polymerisation mode is best for bulk-fill. Manufacturers of polymerisation lamps release new models yearly, so the need to research the subject is still valid. The same problem is with the finishing of this material. How to polish the bulk-fill composite to get the best durability of the filling?

Another thing is that the best-cited scientific papers usually present the results of complicated physicochemical analyses, often incomprehensible to the average clinician.[17-19] Consequently, only other scientists are interested in scientific results. Maybe it would be worth trying to bring this advanced science closer to an ordinary dentist but in a more accessible way.

Our analysis showed that most bulk-fill articles come from Brazil (Table 4). Ülkü et al.[1] noticed a similar relationship in their analysis of reports about the conventional composite. Turkey and the USA are also very active countries, which is also determined and confirmed by Ülkü et al.[1]

According to Yang et al.[20], an article with≥400 citations is considered a "classic" article. In our work, the best-cited articles ranged between 247 and 123. Perhaps the next decade will significantly increase the citation rate, and bulk-fill articles will become classics.

International research cooperation is the foundation of modern higher education and science systems. The number and percentage of internationally co-authored publications, as does the average distance between collaborating scientists, continues to grow. The data best illustrate the huge scale of international cooperation in global terms: in the years 1996–2018, the share of publications indexed in the Scopus database with authors from at least two countries almost doubled, from 24.2% to 45.7%, and their number increased almost quadrupled from 75,000 to 279,000 items per year.[21] The global scientific model has a strong pull effect on scientists and is supported by new indicators used in individual and institutional research quality assessment procedures. Thus, while the role of national collaboration is weakening, the role of international cooperation seems to be growing. Our analysis showed that countries such as Brazil, Turkey, the USA and Saudi Arabia seem to be the best candidates for international cooperation.

Table 4. Top 10 contributing institutions

Country	Number of Articles	Proportion of Articles (%)	Number of Citations	Citations per Article	H-Index
Brazil	219	21.62	2688	12.27	27
Turkey	164	16.19	1083	6.6	17
U.S.A	164	16.19	3030	18.48	30
Saudi Arabia	117	11.55	1690	14.44	23
Germany	88	8.687	2472	28.09	24
England	65	6.417	2125	32.69	27
Italy	56	5.528	882	15.75	18
Japan	49	4.837	623	12.71	14
Switzerland	48	4.738	873	18.19	15
Egypt	41	4.047	638	15.56	13

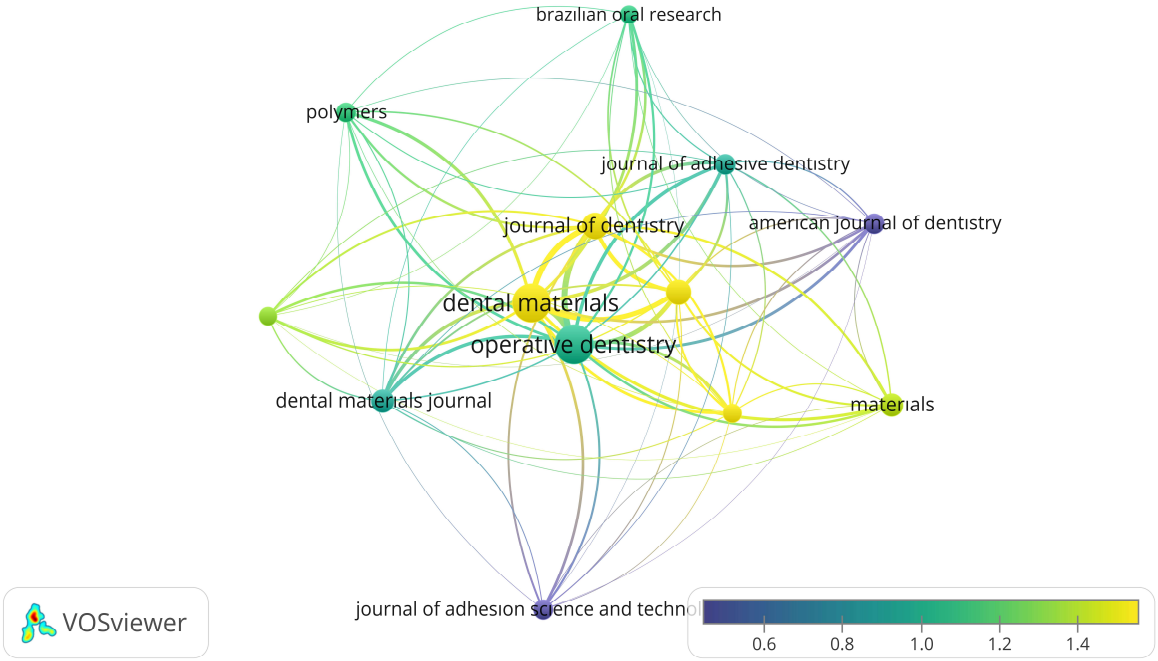

Fig 3. The chart displays a citation map of a journal, with larger bubbles indicating a higher number of publications. The yellow colour represents a higher average normalised citation, while blue represents a lower one. Only journals with more than 20 publications were included in the analysis.

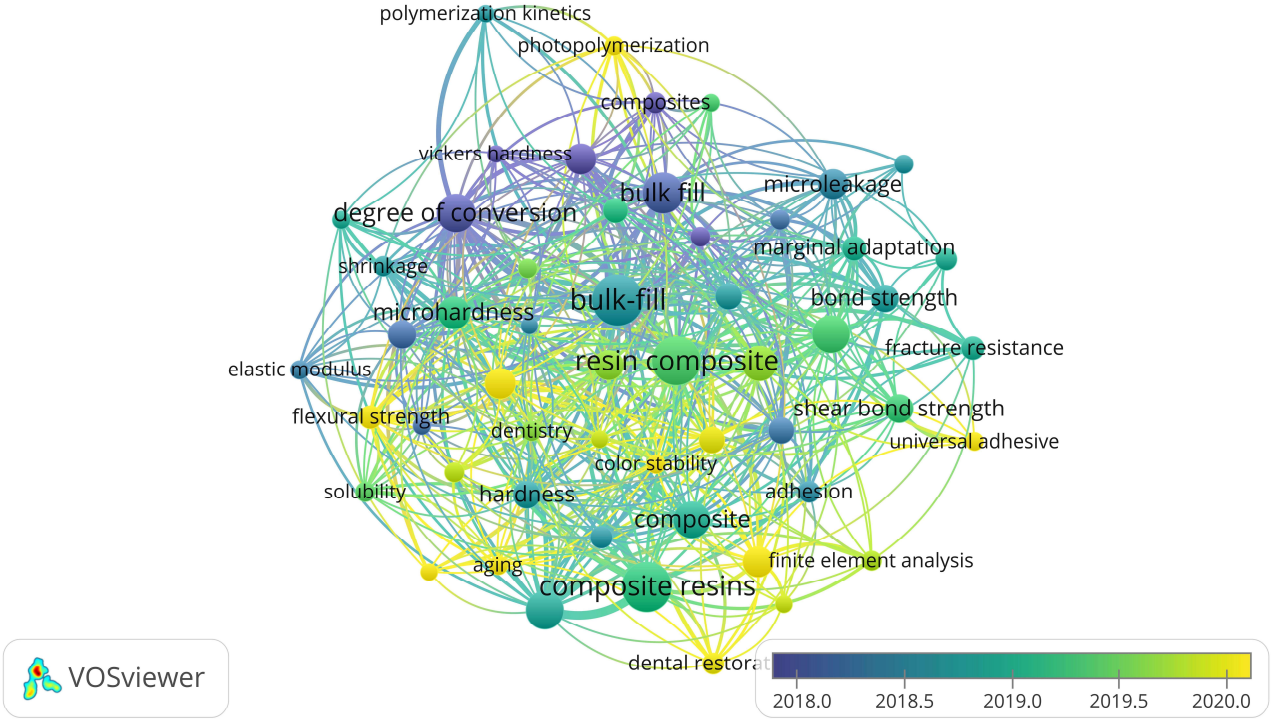

Fig 4. The chart displays a map of keywords, with larger bubbles indicating a higher number of publications. The yellow colour represents a higher average publication year, while blue represents a lower one. Only journals with more than 10 publications were included in the analysis.

The journals listed in our analysis (Fig.3), such as Operative Dentistry, Dental Materials, Journal of Dentistry, Polymers, and Clinical Oral Investigations are among the most read and recognised worldwide. The requirements for authors are understandable and logical, and the publication procedure is very transparent. When choosing a journal for publication, it is worth taking into account the index values and the speed of reviews and publication.

There are some limitations in this bibliometric analysis. Only Web of Science database was analysed. Not all scientific books, articles or conference proceedings have been included in the Web of Science. In the future, analysis of other databases, such as Scopus and GoogleScolar, is planned to compare the differences. Second, almost all Web of Science reports are in English, which can generate language bias and ignore other languages. Thirdly, the number of citations may or may not reflect the article's impact on the scientific world.

5. Conclusion

In summary, within the limitations of this study, the bibliometric provides a helpful perspective on the impact and changing research trends of bulk-fill composites over the past 11 years. Perhaps new digital tools will soon be created for an even better analysis of the impact of a given scientific work on the reality that surrounds us.

References

1. Ülkü SG, Ünlü N. Bibliometric analysis of composite resin from 2000-2020; Available at: https://www.preprints.org/manuscript/202104.0741/v1. Accessed July 6, 2023.
2. Furstenau LB, Rabaioli B, Sott MK, Cossul D, Bender MS, Farina EMJDM, et al. A bibliometric network analysis of coronavirus during the first eight months of covid-19 in 2020. *Int J Environ Res Public Health*. 2021;18(3):952.
3. Leprince JG, Palin WM, Vanacker J, Sabbagh J, Devaux J, Leloup G. Physico-mechanical characteristics of commercially available bulk-fill composites. *J Dent*. 2014;42(8):993-1000.
4. Arbildo-Vega HI, Lapinska B, Panda S, Lamas-Lara C, Khan AS, Lukomska-Szymanska M. Clinical effectiveness of bulk-fill and conventional resin composite restorations: systematic review and meta-analysis. *Polymers*. 2020;12(8):1786.
5. Granat M, Cieloszyk J, Kowalska U, Buczkowska-Radlińska J, Łagocka R. Surface geometry of four conventional nanohybrid resin-based composites and four regular viscosity bulk fill resin-based composites after two-step polishing procedure. *BioMed Res Int*. 2020;2020:6203053.
6. Reis AF, Vestphal M, Amaral RC do, Rodrigues JA, Roulet JF, Roscoe MG. Efficiency of polymerisation of bulk-fill composite resins: a systematic review. *Braz Oral Res*. 2017;31(suppl 1):e59.
7. Yeung AWK, Goto TK, Leung WK. The changing landscape of neuroscience research, 2006-2015: a bibliometric study. *Front Neurosci*. 2017;11:120.
8. Hung M, Licari F, Hon E, Lauren E, Su S, Birmingham W, et al. In an era of uncertainty: impact of COVID-19 on dental education. *J Dent Educ*. 2020;85(2):148-156
9. Ilie N, Bucuta S, Draenert M. Bulk-fill resin-based composites: an in vitro assessment of their mechanical performance. *Oper Dent*. 2013;38(6):618–625.
10. Bucuta S, Ilie N. Light transmittance and micro-mechanical properties of bulk fill vs. conventional resin based composites. *Clin Oral Investig*. 2014;18(8):1991–2000.
11. El-Damanhoury H, Platt J. Polymerization shrinkage stress kinetics and related properties of bulk-fill resin composites. *Oper Dent*. 2014;39(4):374–382.
12. Flury S, Hayoz S, Peutzfeldt A, Hüsler J, Lussi A. Depth of cure of resin composites: is the ISO 4049 method suitable for bulk fill materials? *Dent Mater*. 2012;28(5):521–528.
13. Czasch P, Ilie N. In vitro comparison of mechanical properties and degree of cure of bulk fill composites. *Clin Oral Investig*. 2013;17(1):227–235.
14. Roggendorf MJ, Krämer N, Appelt A, Naumann M, Frankenberger R. Marginal quality of flowable 4-mm base vs. conventionally layered resin composite. *J Dent*. 2011;39(10):643–647.
15. Kwon Y, Ferracane J, Lee IB. Effect of layering methods, composite type, and flowable liner on the polymerisation shrinkage stress of light cured composites. *Dent Mater*. 2012;28(7):801–809.
16. Zorzin J, Maier E, Harre S, Fey T, Belli R, Lohbauer U, et al. Bulk-fill resin composites: polymerisation properties and extended light curing. *Dent Mater*. 2015;31(3):293–301.
17. Moorthy A, Hogg CH, Dowling AH, Grufferty BF, Benetti AR, Fleming GJP. Cuspal deflection and microleakage in premolar teeth restored with bulk-fill flowable resin-based composite base materials. *J Dent*. 2012;40(6):500–505.
18. Garoushi S, Säilynoja E, Vallittu PK, Lassila L. Physical properties and depth of cure of a new short fiber reinforced composite. *Dent Mater*. 2013;29(8):835-841.
19. Alshali RZ, Silikas N, Satterthwaite JD. Degree of conversion of bulk-fill compared to conventional resin-composites at two time intervals. *Dent Mater*. 2013;29(9):213-217.
20. Yang LC, Liu FH, Liu CM, Yu CH, Chang YC. Bibliometric analysis of top-cited articles in Journal of Dental Sciences. *J Dent Sci*. 2023;18(1):338–344.
21. Kwiek M. Międzynarodowa współpraca badawcza w Europie w świetle dużych danych i jej globalne konteksty. *Nauka.* 2020;2020(1):35-66

CRediT Author Statement

A. L. : Conceptualization, Methodology, Software, Validation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision, Project administration, Funding acquisition, K. N. : Formal analysis, Investigation, Resources, Data Curation, J. J. : Formal analysis, Investigation, Resources, Data Curation

Conflict of Interest

The authors declare that no conflict of interest is available

Funding

None

How to cite this article:

Nijakowski K, Jankowski J, Lehmann A. Bibliometric analysis of literature on bulk-fill composite resins in dentistry. J Endod Restor Dent. 2023;1(1):2-7. doi:10.5281/zenodo.8306021