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Research Article

Scientific Reflections of the Concept of Sustainability in Dentistry: A Bibliometric Analysis

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Abstract

Aim: This study analyzed the academic literature on sustainability in the field of dentistry using bibliometric methods. The development trends in the literature, including leading authors, prominent studies, and institutions, were identified. Author collaborations and cited publications were analyzed to provide a structural roadmap for future research.

Material and Method: A literature review was conducted using the Web of Science database, covering articles published in the last 10 years before June 5, 2025. As a result of pilot searches, 196 studies were reached. After the specified screening and filtering processes, a study was carried out on 93 publications. VOSviewer software was used for visualizations in the bibliometric analysis.

Results: There has been a general increase in the number of articles published each year. The country with the highest number of publications on sustainability in dentistry (30 articles) and the highest number of citations (402 citations) was the UK. The most influential author was determined as Duane B. The highest contribution by the institution was provided by Trinity College Dublin in Ireland. In the keyword analysis, it was determined that the most frequently used terms were “sustainability”, “environmental sustainability”, and “green dentistry”.

Conclusion: This bibliometric analysis revealed that the number of publications and citations on sustainability in dentistry has increased significantly in recent years. The findings can guide researchers in identifying trends in the field and planning future studies.

Keywords: Bibliometric analysis, sustainability, environmental sustainability, green dentistry, dentistry

INTRODUCTION

Climate change and environmental pollution are among the major global health problems that pose serious threats to human health and biodiversity by disrupting the ecological balance of the planet Scientific evidence of human-induced climate change is getting stronger and societies are experiencing the effects of this change more frequently and distinctly (1). According to The Lancet, climate change is the biggest global health threat of the 21st century (2). This situation has increased worldwide interest and determination towards sustainability. Signed in 2015, the Paris Agreement set ambitious targets for combating climate change and influenced the direction of policies in this field. The main objective of the Paris Agreement is to limit global warming to 1,5 °C compared to pre-industrial levels. Accordingly, the agreement envisages restricting greenhouse gas emissions as soon as possible to achieve long-term climate goals (3). The COVID-19 pandemic, which has emerged in recent years, has increased the interest in sustainability concepts and made the importance of this issue more visible, especially in terms of the environmental impacts of healthcare services (4).

The healthcare sector has a significant negative impact on the environment through various factors such as transport, waste generation, energy consumption, and supply chain. In the United Kingdom (UK), the healthcare sector generates more than 5% of the country's total emissions, with greenhouse gas emissions estimated at more than 20 million tonnes per year (5). Similarly, in the United States, the healthcare sector accounts for approximately 10 percent of total greenhouse gas emissions (6). Oral and dental health services also account for a significant portion of this environmental burden (7-9).

Dental practices have a significant ecological footprint due to their high energy and material requirements. Dental clinics produce a large amount of waste annually, emit

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ionizing radiation, and consume high levels of energy and water (10). Dental wastes are generally categorized as hazardous biomedical wastes. These wastes include cotton contaminated with body fluids such as blood and saliva, disposable plastics, sharps (e.g. needles), extracted teeth, human tissue fragments, and various other biological materials (11). Dental practice also results in the generation of different types of wastes such as mercury, silver amalgam, and various chemical solvents (12). If amalgam and other waste products are not properly managed, they can lead not only to environmental pollution but also to occupational exposure (13). The effects of dental wastes can be evaluated under two main headings, both for environmental health and for the health of individuals who are in direct contact with these wastes (14). Therefore, more emphasis needs to be placed on the development of environmentally friendly practices in the dental profession. This approach will contribute to building a more sustainable future. To have a meaningful and lasting impact on a global scale, it is essential that all individuals and organizations, including dentists, patients, governments, non-governmental organizations, universities, researchers, industrial organizations, manufacturers, distributors, dental auxiliary staff, and units responsible for waste management, work in collaboration to address environmental challenges at all levels (15).

Bibliometric analysis has received increasing attention in academic research in recent years and has emerged as an important methodological approach (16). Bibliometrics is an applicable method that allows the systematic analysis of large scientific data and makes significant contributions to the evaluation of the scientific impact of research. Various factors, such as the development of analysis tools such as R and VOSviewer and scientific databases such as Google Scholar, Scopus, and Web of Science (WoS), increased accessibility, and ease of use play an important role in the increasing prevalence of bibliometric analyses (17).

This study aims to analyze the existing academic literature on sustainability in dentistry using bibliometric methods. Specifically, it will examine development trends and research dynamics in this field, identify leading authors and notable studies, as well as the institutions at the forefront of this research. Additionally, the study will highlight the most cited publications and explore collaborations among authors. By conducting this bibliometric analysis, we will evaluate the strengths and areas for improvement within the current literature, ultimately providing a structured roadmap for future research.

MATERIAL AND METHOD

This study does not require ethics committee approval as it is based solely on bibliometric data of publications in a specific database. The current bibliometric study was conducted on 5 June 2025 in the Web of Science Core Collection (WoS-CC) database. The electronic literature search was performed using the 'All Fields' option to cover all searchable fields in the database. The search strategy was kept broad to avoid missing relevant publications, and the results obtained were manually analysed and sifted to increase the accuracy of the dataset. The last 10 years (between 2015 and 2025) and document type were filtered as 'article'. Studies with a publication language other than English were excluded from the study. In the literature search, Boolean operators were used to combine keywords in order to reach the most comprehensive and relevant results. During the literature search; ("dentistry" OR "restorative materials") AND ("sustainability" OR ("green dentistry" OR "environmentally friendly" OR "dental waste") keywords were used. A total of 196 studies were identified as a result of the search. These studies were evaluated for relevance and appropriateness by a single researcher by analyzing the titles and abstracts and accessing the full texts when necessary. As a result of this process, 103 irrelevant records were excluded from the study. The eligible publications were recorded in a special list created in the WoS database. Finally, 93 articles were selected for analysis. The researcher checked the timeliness and accuracy of the process by repeating the inclusion and exclusion criteria three times at different time intervals to minimize possible errors. VOSviewer (VOSviewer v1.6.20.; Center for Science and Technology Studies, Leiden University) was used for bibliometric analysis and visualization of the data.

RESULTS

Number of Articles and Citations

Upon analyzing the number of publications by year, we found that the highest number of publications occurred in 2024, while the lowest was in 2015, which had no publications at all. Out of a total of 93 publications, 28 (30.1%) were published in 2024. Notably, there was a significant increase in the number of publications between the periods of 2015-2019 and 2020-2025. When examining citations by year, we noted that the highest number of citations was received in 2024, with a total of 248 citations. In contrast, both 2015 and 2016 had the lowest citation counts, with no records found for these two years. The distribution of publications and citations by year is illustrated in Figure 1.

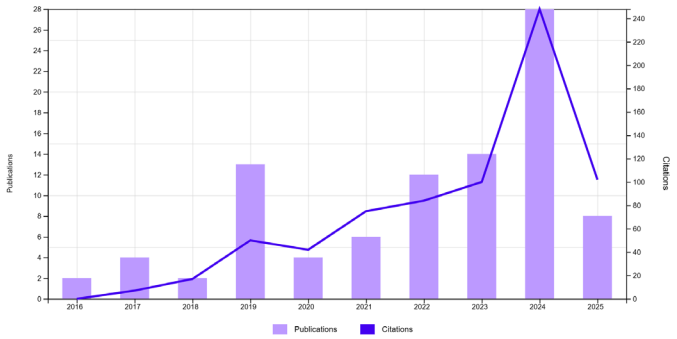

Figure 1. Number of publications and citations on sustainability in dentistry by years

Distribution of Publications by Country

This study found that over the past 10 years, a total of 36 different countries have published research on sustainability in dentistry. Table 1 lists the number of publications and

citations for the top 10 countries with the highest volume of work in this area. The UK had the most publications, with 30 articles, followed by Ireland, which published 19 articles, and India, with 17 articles. Regarding citations, the UK also leads with 402 citations, followed by Ireland with 348 citations and India with 107 citations.

Table 1. Number of publications and citations for the top 10 countries with the highest number of publications on spreadability in dentistry

Countries/regions	Number of publications	Citation count
United Kingdom	30	402
Ireland	19	348
India	17	107
Scotland	7	45
Portugal	6	48
Saudi Arabia	6	28
USA	6	78
Walles	6	46
Greece	5	28
Iran	4	69

Distribution of Publications by Institutions

In this study, it was determined that 78 institutions have published on sustainability in dentistry in the last 10 years. Among the institutions that contributed to the articles published on the subject, the highest contribution was Trinity College Dublin with 19 articles. Figure 2 shows the top 10 institutions that published the most on sustainability in dentistry.

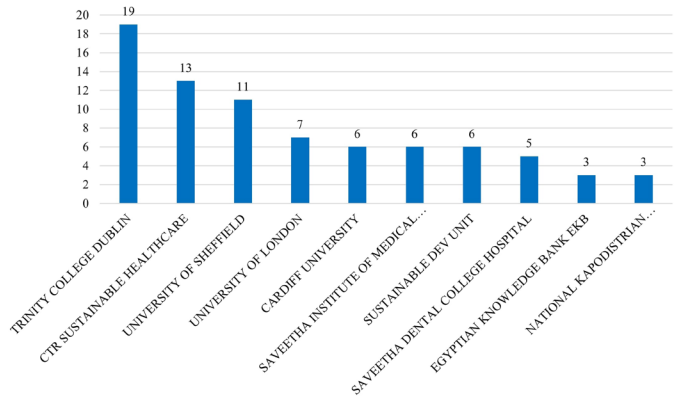

Figure 2. Top 10 institutions with the highest number of publications on sustainability in dentistry

Distribution of Publications According to Journals

When analyzing the studies based on the journal indices, it was found that 68% of the studies were published in journals listed in the Science Citation Index Expanded (SCI-Expanded), while the remaining 32% appeared in Emerging Sources Citation Index (ESCI) journals (see Figure 3). Among the journals with the highest number of publications on sustainability in dentistry, the British Dental Journal ranks first with 22 articles. It is followed by the Dentistry Journal, Journal of Clinical and Diagnostic Research, Journal of Pharmacy and Bioallied Sciences, Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial, and Sustainability, each contributing three publications. Figure 4 presents the distribution of the top 10 journals featuring the most sustainability-themed publications in dentistry.

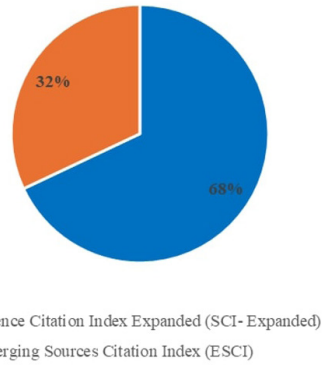

Figure 3. Ratio of journal indexes in which the studies are included

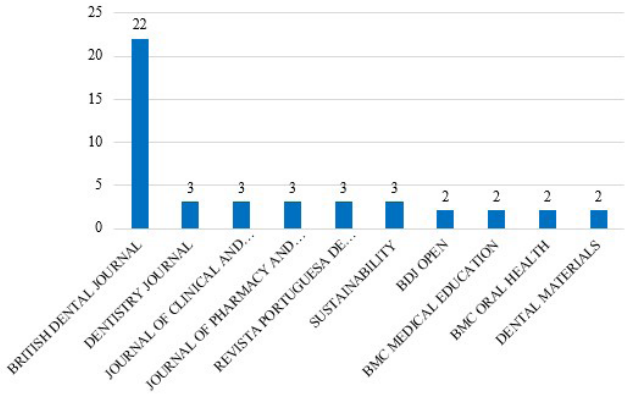

Figure 4. Top 10 journals in which the studies were published the most

Authors Contributing to Publications

In analyzing the authors who contributed to this field, it was found that Duane B. had the highest number of publications, with 18 studies. He was followed by Martin N., Ramasubbu D., and Stancliffe R., each of whom published 9 articles. Regarding citations, Duane B. was also the most cited author, with a total of 330 citations. He was followed by Stancliffe R. with 255 citations and Ramasubbu D. with 203 citations. The distribution of the top 10 authors with the highest number of publications on sustainability in dentistry is illustrated in Figure 5.

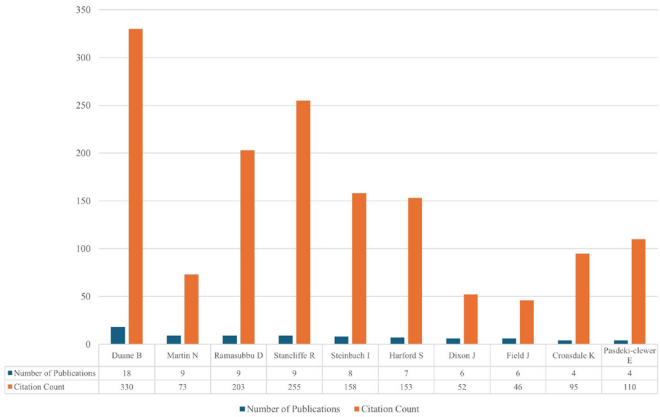

Figure 5. Top 10 authors with the most publications on sustainability in dentistry

Co-author Analysis

In Figure 6, the co-authorship relationships, which reflect the collaboration between authors, are presented as a network map. This map visually shows the connections and levels of collaboration among the authors. In the co-authorship analysis, a network map was created according to the criteria of having at least one publication and at least one citation. The result of this analysis was a structure with a total of 128 links, grouped into five different clusters. The results show that the authors with the most citations are also the authors with the most links; similarly, the authors with the most publications are also among the most connected authors.

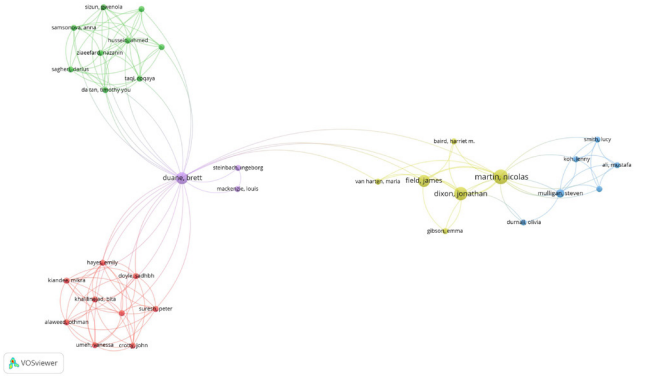

Figure 6. Co-author links showing collaboration between authors on sustainability in dentistry; **Citations are indicated by lines connecting authors; Authors with larger circle size or font size had more citations

Keyword Analysis

Figure 7 shows the relationships and connections between the most frequently used keywords in publications on sustainability in dentistry. When the most frequently used keywords in the publications on sustainability in dentistry were analyzed, it was found that sustainability with 8 repetitions, environmental sustainability with 7 repetitions, green dentistry with 6 repetitions, green synthesis with 6 repetitions, and sustainable dentistry with 6 repetitions. The most effective keywords in terms of total link strength were sustainability, environmental sustainability, and green dentistry. As a result of the bibliometric analysis, 13 clusters, 444 links, and 473 total link strengths were identified among the keywords.

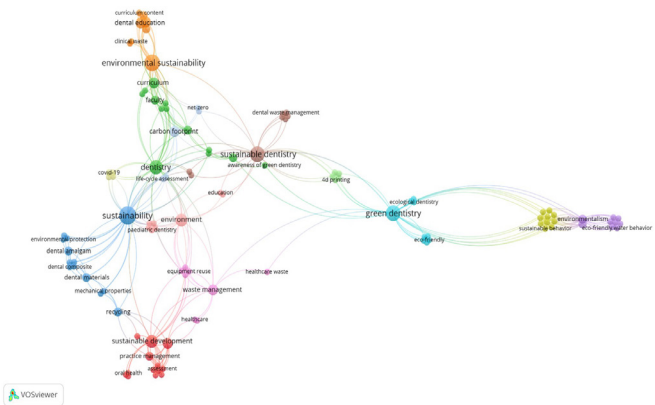

Figure 7. Most frequently used keyword links

DISCUSSION

Bibliometric analysis has gained considerable popularity in academic research in recent years. This method offers the opportunity to analyze academic productivity, structural trends, and scientific interactions related to a particular research topic or field through large data sets. In this study, the WoS database was used to analyze scientific publications on sustainability in dentistry. WoS was preferred because it contains more publications in the field of health sciences compared to similar databases. In addition, it is a reliable source frequently used in citation analyses thanks to its wide coverage extending back to 1945 (18).

The bibliometric analysis method preferred in this study has been widely used in the international dental literature, especially in recent years (19-22). Within the scope of the study, publications in the WoS-CC database for the last 10 years on sustainability in dentistry were analyzed. This analysis aims to provide an overview of sustainability research by revealing the main characteristics of publications in the field. However, mapping the most influential publications and trends can provide important guidance to researchers in identifying trends and potential gaps in the literature.

The citation of a scientific study after publication is important in terms of its scientific value. Because it shows that it attracts the attention of researchers and gives ideas to new studies (23). The 93 articles evaluated in this study received a total of 729 citations. This shows that the published articles were mentioned in a significant number of other studies. In addition, when the annual citation numbers were analyzed, it was seen that the number of citations increased from 2015 to 2024. This situation reveals that interest and awareness in the concept of sustainability are gradually increasing in the field of dentistry.

Highly cited articles are essential reference sources for researchers and clinicians. These studies shape the direction of future research and guide the development of evidence-based best practices in the field (24, 25). Looking at the total number of citations of the countries in this study, England (402 citations), Ireland (348 citations) and India (107 citations) stand out. This indicates that these countries have a higher academic influence on research on sustainability in dentistry (26). The results of the analysis revealed that the UK, Ireland, and India are the three most productive countries, with the UK leading in terms of both the number of publications and citations. This can be attributed to the existence of structures such as the Centre for Sustainable Healthcare in the UK, which provides active private and public sector funding support for sustainability-focused research.

Trinity College Dublin from Ireland was identified as the most productive institution in the analysis. This institution is the owner of all studies published in Ireland on sustainability in dentistry. The fact that the institution hosts Duane B, a

highly productive and highly cited researcher in this field, may have reinforced this leading position. In addition, this finding shows that researchers at Trinity College Dublin produce effective and high-quality publications and that the institution has become a leading research center in this field. Scientists who plan to conduct sustainability-themed research in the field of dentistry in the future should take into account the academic productivity and leadership of Trinity College Dublin in this field and closely follow the work of the institution.

British Dental Journal was the journal that included the highest number of publications in this field. This journal is included in the SCI-Expanded category (27). In addition, 63 of the 93 articles included in the study were published in SCI-Expanded journals. These findings indicate that studies on sustainability in dentistry have a high potential to be published in prestigious journals with high-impact factors and that studies in this field can make significant contributions in terms of academic visibility and impact.

Co-authorship analysis analyses intellectual collaborations and interaction networks between scientists in a research field. Since co-authorship is considered a formal form of scientific collaboration between researchers, analyzing these interactions together with author attributes such as affiliated institutions and countries is important for understanding the structure and dynamics of scientific production (28, 29). Duane B. stood out as the author with the highest total link strength in the co-authorship analysis. At the same time, the fact that he is the most cited and most productive author in this field supports his high level of co-authorship relationships.

Keywords play an important role in the discoverability of a published article (30, 31). Generally, when conducting a literature review, researchers tend to use various search terms related to the relevant field (32). In the keyword analysis conducted in this study, it was determined that 'sustainability', 'environmental sustainability', and 'green dentistry' were the most frequently used terms as keywords in the publications by the authors.

In this bibliometric analysis, it has been observed that there is a limited number of publications especially from low and middle-income countries. This situation leads to geographical imbalances in research outputs and makes it difficult to reach generalizable conclusions at the global level. Enriching future studies with interdisciplinary research in underrepresented regions such as Africa, Southeast Asia, and the Middle East may provide more inclusive contributions to global health policies. In this study, it was determined that the most frequently addressed themes in the literature focused on dentists' knowledge and attitudes toward sustainability, the use of environmentally friendly materials, and dental waste management. However, the majority of these studies are cross-sectional surveys or opinion reviews and do not cover long-term behavioral changes, the impact of educational interventions, or actual clinical practice data. In future research, it is recommended to evaluate sustainability themes not only at the awareness level, but also in more in-depth areas such as integration into clinical practice, the impact of educational programs, and the applicability of policies. In addition, life cycle analyses on the environmental impacts of dental materials may contribute to sustainable product development processes by integrating materials science and environmental awareness. Diversification of studies on waste management in terms of cost-effectiveness, compatibility with local regulations, and analyses of barriers to implementation will contribute to the elimination of existing gaps in the field.

Some methodological limitations should be taken into consideration when evaluating the results of this study. In particular, the fact that only the literature in the WoS database was analyzed within the scope of the study creates certain limitations in terms of scope. The fact that other leading databases such as Scopus (Elsevier, Amsterdam, The Netherlands), PubMed (U.S. National Library of Medicine, Bethesda, MD, USA), and Google Scholar (Google, USA) were not included in the analysis resulted in the exclusion of some qualified and up-to-date studies published on these platforms. PubMed is an important source of access to scientific data directly related to clinical practice, especially in the fields of medicine and dentistry, as it searches peer-reviewed journals with high-impact values (33). Exclusion of this database may weaken the study in terms of findings based on health-based evidence. Scopus, on the other hand, offers a wider interdisciplinary scope and can provide a more holistic perspective on the subject, especially by bringing together engineering, biomedical sciences, and social sciences (34, 35). Failure to include Scopus poses the risk of ignoring many studies related to the study area but not included in WoS. Therefore, the inclusion of these databases in the analysis process can increase the scientific validity and reliability of the study as well as expand the scope of the literature. Adopting the use of multiple databases in future research will provide more holistic and balanced results.

In this study, the year 2025 was also included in the scope of the analysis. However, since the year 2025 has not yet been completed, the data for this period do not represent the whole year and naturally show lower publication numbers compared to other years. This situation may underestimate the trend, especially in analyses where the distribution of publications by year is examined and requires caution in interpreting the results. For this reason, it is important to consider the findings for 2025 as preliminary data and to interpret this year's data considering its limited representativeness. In future studies, repeating the analyses with updated data after the completion of 2025 will provide a healthier presentation of the trends in the literature.

CONCLUSION

This bibliometric analysis revealed that the number of publications on sustainability in dentistry has increased in

recent years and in parallel with this increase, there has been a significant increase in the number of citations. The current findings provide guidance to students, researchers, and academics in categorizing scientific data in this field, identifying research trends, and identifying topics to focus on when planning future studies. In particular, the co-authorship analyses and the evaluation of the most cited publications contributed to the identification of the research community's areas of interest and future research directions. These findings allow us to understand the current potential for sustainability in dentistry and provide a valuable resource that can contribute to academic developments in this field.

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Conflict of interest: *The authors have no conflicts of interest to declare.*

Ethical approval: *This study does not require ethics committee approval as it is based solely on bibliometric data of publications in a specific database.*

REFERENCES

1. Duane B, Stancliffe R, Miller F, et al. Sustainability in dentistry: a multifaceted approach needed. J Dent Res. 2020;99:998-1003.
2. Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. Lancet. 2009;373:1693-733. Erratum in: Lancet. 2009;373:2200.
3. Paris agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf accessed date 3.06.2025.
4. Wolf TG, Campus G. Changing dental profession-modern forms and challenges in dental practice. Int J Environ Res Public Health. 2021;18:1945.
5. Torjesen I. NHS aims to become world's first "net zero" health service by 2040. BMJ. 2020;371:m3856.
6. Eckelman MJ, Sherman J. Environmental impacts of the US health care system and effects on public health. PloS One. 2016;11:e0157014.
7. Karliner J, Slotterback S, Boyd R, et al. Health care's climate footprint: the health sector contribution and opportunities for action. Eur J Public Health. 2020;30:ckaa165.843.
8. Watts N, Amann M, Arnell N, et al. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. Lancet. 2019;394:1836-78.
9. Wilson GJ, Shah S, Pugh H. What impact is dentistry having on the environment and how can dentistry lead the way?. Fac Dent J. 2020;11:110-3.
10. Martin N, Sheppard M, Gorasia G, et al. Awareness and barriers to sustainability in dentistry: a scoping review. J Dent. 2021;112:103735.
11. Sharma A, Sharma V, Sharma S, Singh P. Awareness of biomedical waste management among health care personnel in Jaipur, India. Oral Health Dent Manag. 2013;12:32-40.
12. Khandelwal V, Khandelwal S, Thakur JS. Health care waste disposal among private dentist in an Indian city: It's time to act. Int J Infect Control. 2013;9. doi: 10.3396/ijic.v9i2.016.13.
13. Ingle NA, Charania ZK. Awareness and practices of dental care waste management among dental practitioners in Chennai city. J Contemp Dent. 2003;1:15-21.
14. Turnberg WL, Frost F. Survey of occupational exposure of waste industry workers to infectious waste in Washington State. Am J Public Health. 1990;80:1262-4.
15. Wainer C. Discussing the environmental impact of dental-associated travel-how do we build from the current COVID-19 crisis towards a more sustainable future within dentistry?. Br Dent J. 2022;232:437-40.
16. Passas I. Bibliometric analysis: the main steps. Encyclopedia. 2024;4:1014-25.
17. Doulani A. A bibliometric analysis and science mapping of scientific publications of Alzahra University during 1986–2019. Library Hi Tech. 2021;39:915-35.
18. Jafarzadeh H, Sarraf Shirazi A, Andersson L. The most-cited articles in dental, oral, and maxillofacial traumatology during 64 years. Dent Traumatol. 2015;31:350-60.
19. Ahmad P, Slots J. A bibliometric analysis of periodontology. Periodontol 2000. 2021;85:237-40.
20. Aragao WaB, Chemelo VS, Melo WWP, et al. Trends and gaps in clinical research on tooth bleaching: a bibliometric analysis of studies published from 2001 to 2024. J Esthet Restor Dent. 2025;37:1392-406.
21. Qasim SSB, Ali D, Khan AS, et al. Evidence-based bibliometric analysis of research on silver diamine fluoride use in dentistry. Biomed Res Int. 2021;2021:9917408.
22. Shirani M. Trends and classification of artificial intelligence models utilized in dentistry: a bibliometric study. Cureus. 2025;17:e81836.
23. Aksnes DW, Rip A. Researchers' perceptions of citations. Res Policy. 2009;38:895-905.
24. Donthu N, Kumar S, Mukherjee D, et al. How to conduct a bibliometric analysis: an overview and guidelines. J Bus Res. 2021;133:285-96.
25. Joshi MA. Bibliometric indicators for evaluating the quality of scientific publications. J Contemp Dent Pract. 2011;15:258-62.
26. Kotanli S, Aydemir ME, Dogan ME, Kotanli MV. The use of ultrasonography in dentistry: a bibliometric analysis. Oral Radiol. 2025 May 30. doi: 10.1007/s11282-025-00830-5. Epub ahead of print.
27. Journal citation reports. https://clarivate.com/academia-government/scientific-and-academic-research/research-funding-analytics/journal-citation-reports/ accessed date 09.06.2025.
28. Acedo FJ, Barroso C, Casanueva C, Galán JL. Co-authorship in management and organizational studies: an empirical and network analysis. J Manag Stud. 2006;43:957-83.
29. Cisneros L, Ibanescu M, Keen C, et al. Bibliometric study of family business succession between 1939 and 2017: mapping and analyzing authors' networks. Scientometrics. 2018;117:919-51.

30. Arshad AI, Ahmad P, Karobari MI, et al. Antibiotics: a bibliometric analysis of top 100 classics. Antibiotics. 2020;9:219.

31. Karobari MI, Maqbool M, Ahmad P, et al. Endodontic microbiology: a bibliometric analysis of the top 50 classics. Biomed Res Int. 2021;2021:6657167.

32. Asghari S, Navimipour NJ. Nature inspired meta-heuristic algorithms for solving the service composition problem in the cloud environments. Int J Commun. 2018;31:e3708.

33. Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, Scopus, Web of Science, and Google scholar: strengths and weaknesses. FASEB J. 2008;22:338-42.

34. Kulkarni AV, Aziz B, Shams I, Busse JW. Comparisons of citations in Web of Science, Scopus, and Google Scholar for articles published in general medical journals. JAMA. 2009;302:1092-6.

35. Burnham JF. Scopus database: a review. Biomed Digit Libr. 2006;3:1.