

A half-century of the *Journal of Endodontics* — Part 2: a scientometric analysis of collaboration networks, authorship patterns, and thematic trends

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Abstract

Objective: In recognition of the *Journal of Endodontics* (JOE)'s fiftieth anniversary, a scientometric approach was used to evaluate patterns of scholarly collaboration, authorship trends, and thematic evolution within the journal's publications over the past five decades.

Methods: There were 8,753 articles published in JOE from 1975 to 2024, extracted from the Scopus database. Scientometric analyses included co-authorship mapping, institutional and international collaboration trends, keyword co-occurrence analysis, and topic modelling using Latent Dirichlet Allocation. VOSviewer® was used for network visualization.

Results: Multi-authored publications represented 91.3% of all articles, indicating a clear shift toward collaborative research. International collaborations increased over time, with researchers from the United States, Brazil, and China accounting for the largest contributions. Co-authorship network analysis identified prominent research clusters centered on endodontic microbiology, biomaterials, and adhesive technologies. Keyword analysis and topic modeling revealed five dominant themes: pulp biology, endodontic materials, imaging and anatomy, root canal treatment, and instrument evaluation, highlighting the journal's focus on both foundational and emerging research areas.

Conclusions: This scientometric analysis shows the growth of collaborative research and changes in the thematic structure of JOE. The findings highlight the journal's role in shaping global research trends in endodontics and provide a data-driven foundation for future editorial planning.

Keywords: Authorship, Endodontics, Research collaboration, Scientometrics

Introduction

The development of endodontic science relies not only on the quantity and quality of published research but also on the processes through which knowledge is generated, shared, and translated into practice. While bibliometric indicators such as publication and citation counts provide important measures of scholarly output and influence, they offer a limited view of the structural and thematic forces shaping the scientific landscape (1). To gain a broader understanding of research activity within a journal, scientometric analysis offers a

complementary approach, one that captures patterns of authorship, collaboration, and intellectual evolution over time (2).

Scientometrics extends traditional bibliometric analysis by focusing on the “invisible colleges” of science: the networks of authors, institutions, and keywords that underlie the social and intellectual organization of research fields. It enables the visualization of scientific collaboration, identification of thematic clusters, and detection of emergent trends in scholarly communication (3-5). Such analyses are particularly relevant in biomedical research, where the increasing complexity of investigations has led to a marked shift from single-author publications toward interdisciplinary and multi-institutional collaboration. In endodontics, this evolution has been mirrored by the *Journal of Endodontics* (JOE), which has served as a platform for sharing scientific advances since its establishment in 1975.

Although the JOE has had an extensive role in shaping endodontic discourse, no previous study has comprehensively analyzed its collaborative structure,

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authorship patterns, and thematic evolution throughout its five-decade history. Understanding these trends provides critical insights into the journal's scientific identity and its responsiveness to emerging priorities in clinical care, biomaterials, diagnostic imaging, regenerative therapy, and translational research. It also supports editorial planning by identifying prolific contributors, influential research domains, and areas of underrepresentation or fragmentation.

In this study, scientometric methods are applied to a curated dataset of 8,753 scientific articles published between 1975 and 2024. The study examines the journal's evolving co-authorship networks, institutional and international collaborations, keyword co-occurrence patterns, and thematic trajectories. By mapping the structural and conceptual architecture of the JOE's research corpus, the study provides a deeper understanding of the journal's contribution to the global development of endodontics.

Materials and methods

Ethical approval

This study was formally approved as Non-Human Subject Research (NHSR) by the Institutional Review Board (IRB) / Ethics Committee of West Virginia University, Morgantown, WV, USA (Protocol #0887).

Data collection

On December 31, 2024, a comprehensive search of Elsevier's Scopus database was performed to retrieve all publications from the JOE. The search covered the full span of the journal's publication history, from its launch in January 1975 through December 2024. Using the "Sources" interface in Scopus, the search was carried out by selecting the "Source Title" field and entering "Journal of Endodontics."

The search results were exported in CSV format, involving essential metadata fields such as authors, title, publication year, volume, issue, page numbers, keywords, citation count, affiliations, corresponding author, document type, and references. This search resulted in a comprehensive dataset for in-depth analysis.

Data cleaning and processing

The initial dataset export included all JOE publications indexed in Scopus. However, this raw data required significant preprocessing to ensure accuracy, consistency, and relevance. As detailed in Part 1, this process involved removing irrelevant document types,

resolving metadata inconsistencies, and standardizing entries across various fields.

Due to inconsistencies in author name spellings—caused by typographical errors or variations in preferred naming conventions over time—author publication counts were recalculated and verified using each author's unique Scopus ID, as outlined in Part 1. Furthermore, country names were standardized to account for variations such as "PRC" or "People's Republic of China" for China, "Deutschland" for Germany, "Russian Federation" for Russia, and both "Korea" and "Republic of Korea" for South Korea.

After these refinements, the cleaned dataset included 8,753 records, representing only relevant scientific articles suitable for bibliometric and scientometric analysis.

Scientometric parameters

Ten scientometric indicators were computed to characterize the collaborative structure, intellectual organization, and thematic evolution of the JOE from 1975 to 2024. These parameters were selected to align with the structure of the results and reflect key aspects of research organization, authorship behavior, and thematic focus over the journal's 50-year history. The specific variables analyzed include:

- International collaboration: The frequency and patterns of articles co-authored by researchers from multiple countries.
- Co-authorship networks: Visualization of collaborative clusters among individual authors and institutions to identify influential research groups and their thematic focus.
- Country-level collaboration networks: Mapping of international collaboration intensity and geographic research hubs using co-authorship data.
- Bibliographic coupling networks: Analysis of documents that share common references to identify intellectual linkages and thematic similarities.
- Journal co-citation networks: Visualization of journals frequently cited together to identify citation communities and disciplinary connections.
- Keyword co-occurrence networks: Detection of conceptual relationships and thematic clusters through frequently co-occurring keywords.
- Title and keyword frequency analysis: Identification of the most frequently used words and terms in article titles and keywords across decades.
- Topic modeling: Identification of five major research themes based on a probabilistic analysis of article titles.

- Keyword co-occurrence map: Visualization of the relationships and strength of associations among keywords to reveal conceptual centrality and emerging areas of interest.
- Temporal theme evolution: Analysis of research priorities by tracking the rise, stability, or decline of topics over time.

Statistical analysis and software overview

In this study, a combination of descriptive statistics and visualization techniques was employed to analyze the scientometric parameters. VOSviewer® software (6), which is a versatile tool for creating and visualizing scientometric networks, was utilized to map scientometric data, including co-citation analysis (7), bibliographic coupling (8), collaboration networks among authors and countries, and keyword co-occurrence networks. VOSviewer® helps researchers examine connections among publications, authors, journals, institutions, and keywords. Its intuitive interface offers flexible options for analyzing and interpreting scientific data, making it a useful tool for bibliometric and scientometric research.

Datawrapper® was used to create selected graphs, providing clear and professional visualizations of the data. OpenAI was used to support bibliometric research analysis through various techniques. For text analysis, it was used to assist with keyword extraction and content summarization, helping to identify key themes and findings across a large volume of articles.

For topic modeling, Latent Dirichlet Allocation (LDA), a probabilistic topic modeling algorithm, was used to identify latent themes in the dataset. The analysis included the following steps:

- Data preprocessing: Article titles were cleaned by converting them to lowercase, removing common stopwords, and excluding short, irrelevant terms. Only words relevant to the research topics were retained.
- Feature extraction: A bag-of-words model was created using a vectorization technique to capture the frequency of meaningful words.
- Modeling: LDA was applied to identify five distinct topics. Each topic was characterized by a set of keywords with the highest probability of association with that topic.

Results

The analysis of all articles published in the JOE yielded the following results:

International collaboration

Of the 8,753 articles, country-level affiliation data were available for 6,782 articles (77.5%). The remaining 1,971 articles (22.5%), predominantly published between 1975 and 1989, lacked complete country information for authors in the Scopus database due to historical indexing limitations and were excluded from this specific analysis.

Of the total articles analyzed, 1,623 (23.9%) involved researchers with affiliations in multiple countries. However, 5,159 (76.1%) were authored by researchers from a single country, indicating the continued predominance of national-level research.

Co-authorship network (Authors)

The co-authorship network map (Figure 1), generated using VOSviewer®, showed distinct clusters of influential researchers whose collaborations reflected major themes and the evolution of endodontic science. The red cluster, anchored by Dr. Mahmoud Torabinejad and his collaborators, is primarily associated with the development and clinical adoption of mineral trioxide aggregate (MTA) and regenerative endodontic procedures. This cluster represents foundational research that has influenced core clinical practices over the past two decades. The green cluster, centered around Drs. José F. Siqueira Jr. and Isabela N. Rôças, highlights a concentration of microbiological and molecular research that has improved understanding of endodontic infection dynamics and microbial diagnostics. The blue cluster, linked to Drs. David H. Pashley and Franklin R. Tay, reflects interdisciplinary work connecting adhesive dentistry and endodontics, particularly in the areas of dentin bonding and hybrid layer stability.

Co-authorship network (Countries)

Figure 2 shows a heatmap of co-authorship networks at the country level. The United States appears as the central hub with the highest intensity, indicating its strong role in global research collaboration. Other countries, including Brazil, China, and Canada, also show strong contributions, forming important nodes in the network. European countries such as Germany, Italy, and Switzerland demonstrate significant collaboration both within the region and with global partners, while Brazil has the strongest presence in South America. In Asia, China, Japan, South Korea, Iran, and India contribute substantially to research output. Taiwan appears as an isolated node, reflecting specialized yet impactful research contribution.

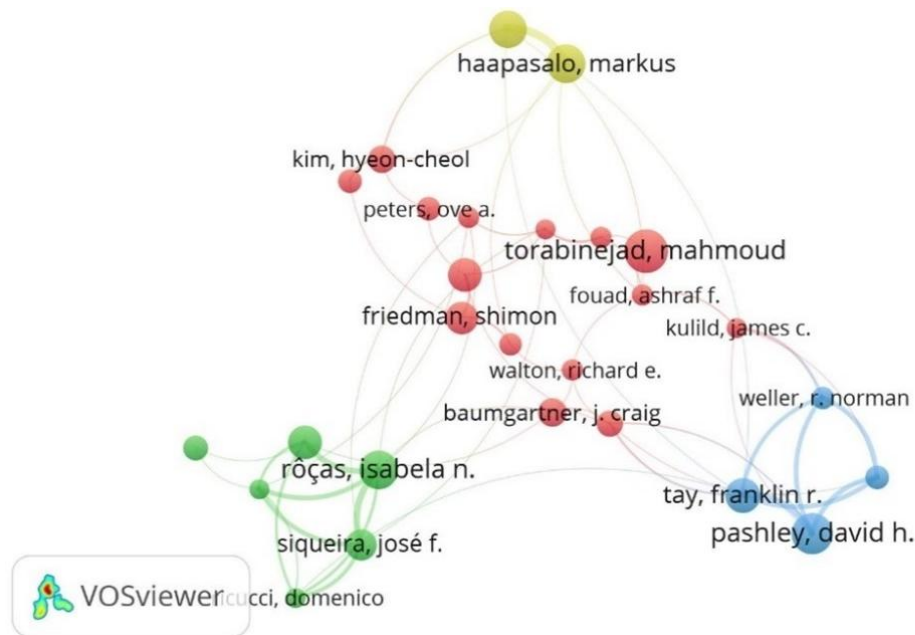


Figure 1. Co-authorship network of leading researchers in endodontics, highlighting distinct clusters of collaboration across foundational research, microbiology, and restorative dentistry (Visualization created using VOSviewer® [www.vosviewer.com]).

Network and structural metrics

Citation networks: how articles cite one another

A visualization of bibliographic coupling between key documents in endodontic research is available in Supplementary Figure S1. Bibliographic coupling occurs when two documents cite the same references, indicating a shared intellectual foundation or research focus. The map shows two distinct clusters, representing

groups of papers with overlapping references and thematic similarities.

The green cluster includes foundational studies by Torabinejad and Chivian (1999) and Parirokh and Torabinejad (2010), focusing on materials such as MTA and regenerative endodontics. These papers are connected to others in the cluster, such as Sonoyama et al. (2008) and Banchs and Trope (2004), which explore

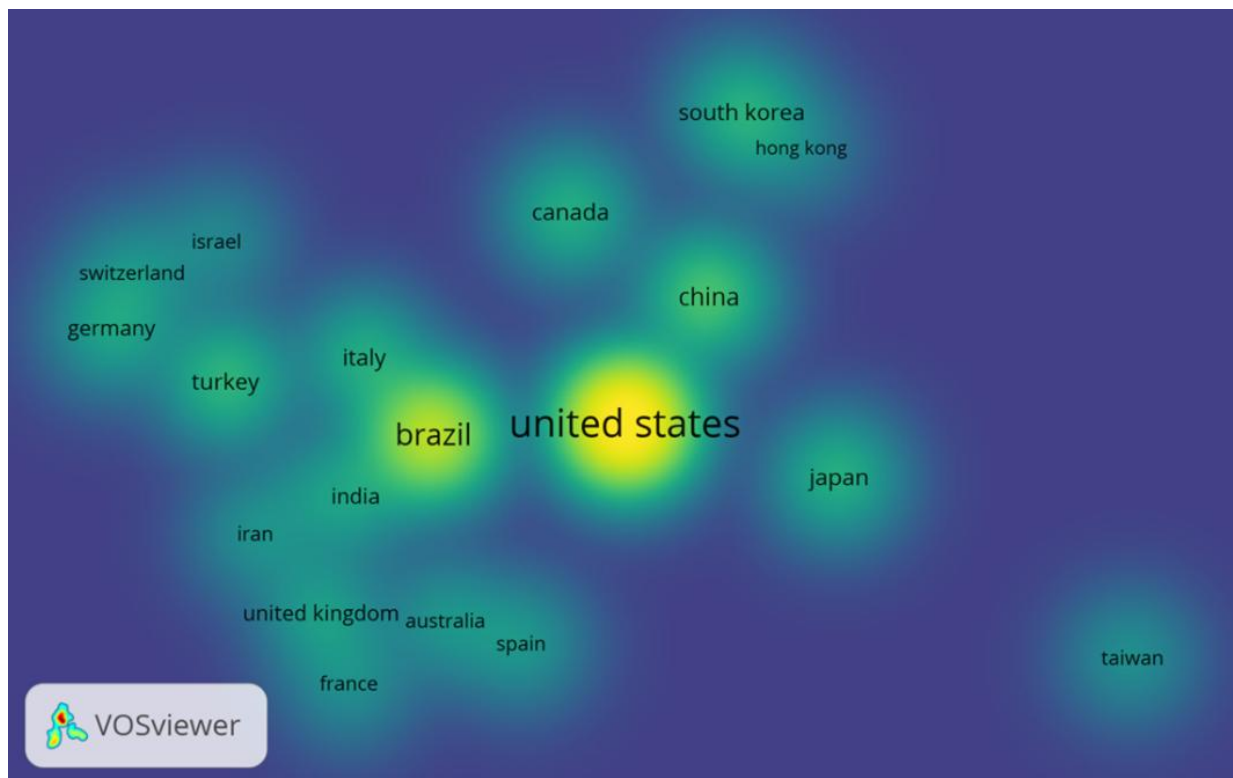


Figure 2. Heatmap of co-authorship networks at the country level (Visualization created using VOSviewer® [www.vosviewer.com]).

stem cell applications and biological approaches in endodontics.

The blue cluster, led by papers such as Zehnder (2006) and Peters (2004), focuses on cleaning and shaping techniques, irrigation protocols, and microbial aspects of root canal treatment. Authors like Siqueira Jr. and Rôças (2008) and Schwartz and Robbins (2004) contribute to this cluster with insights on microbial reduction and restorative-endodontic aspects.

The map highlights two thematic areas, including biological and regenerative approaches as well as technical and procedural advancements. The connections between clusters indicate shared references, reflecting the interdisciplinary nature of endodontic research.

Co-citation networks: journals frequently cited together

Supplementary Figure S2 shows a VOSviewer® map of the co-citation network of journals in endodontics and related fields, illustrating how frequently journals are cited together. At the center, the JOE (J Endod) dominates the map, reflecting its central position in the field. It is closely connected to other major journals, including the IEJ (Int Endod J) and Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology (Oral Surg Oral Med Oral Pathol), indicating substantial citation overlap.

In this map, the red cluster, led by the JOE, is strongly connected to journals like the Journal of Dental

Research (J Dent Res) and Dental Materials, indicating overlap with broader dental and biomaterial research. The purple cluster, centered on the IEJ, suggests a focus on international contributions and advancements in endodontics. The blue cluster includes trauma-focused journals like Endodontic & Dental Traumatology, reflecting research on traumatic dental injuries. The green cluster involves journals like Clinical Oral Investigations (Clin Oral Investig) and the Australian Endodontic Journal (Aust Endod J), which highlight clinical and regional research emphasis.

Keyword co-occurrence networks: thematic relationships among topics

Figure 3 illustrates Keyword co-occurrence in endodontic research. The color gradient from purple (older terms) to yellow (more recent ones) represents the average publication year of the studies in which the keywords appear. The term "effect" is central and connected to various research topics, suggesting its widespread relevance in experimental and clinical studies. Terms like "treatment," "periapical lesion," and "systematic review" represent clinical and diagnostic approaches, while "calcium hydroxide," "sealer," and "bond strength" focus on materials science and endodontic techniques.

The blue cluster (older terms) emphasizes foundational research on materials like "calcium hydroxide" and cellular studies (e.g., "human dental

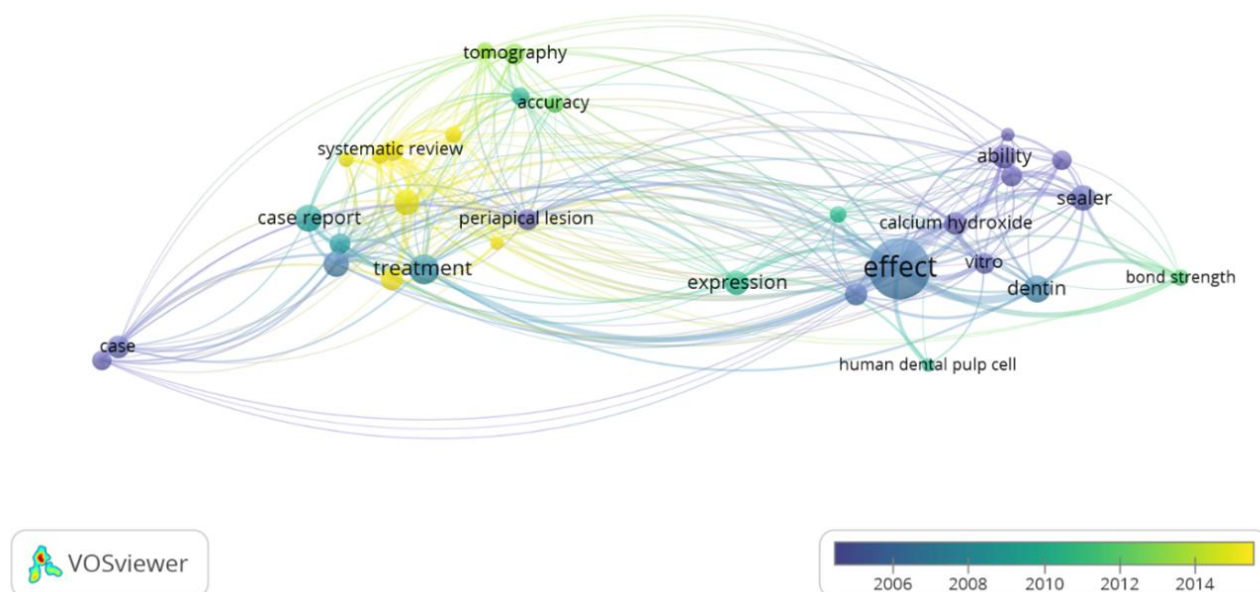


Figure 3. Keyword co-occurrence network in endodontic research, showing the temporal evolution from materials and cellular studies to advanced diagnostic tools and evidence-based practices (Visualization created using VOSviewer® [www.vosviewer.com].)

pulp cell"). The green and yellow clusters (more recent terms) focus on diagnostic tools like "tomography" and advances in clinical accuracy. "Systematic review" highlights the trend toward evidence-based approaches. The map shows the temporal evolution from the earlier research on materials and cellular studies (e.g., "calcium hydroxide", "human dental pulp cell") to more recent research on advanced diagnostic and clinical methods (e.g., "tomography," "accuracy," "systematic review").

Thematic and content metrics

Frequency of words in title and keywords sections (popular research topics)

Key themes in an article's title (Figure 4) include words such as "Root" (15.2% of articles), "Canal or canals" (13.7% of articles), and "Endodontic" (11.2% of articles). Other terms like "Pulp," "Apical," and "Evaluation" reflect biological and clinical aspects, while "Treatment," "Periapical," and "In vitro" indicate therapeutic and experimental studies. Also, Supplementary Figure S3 shows the most frequently used keywords. Keywords such as "Endodontics," "Apical periodontitis," and "Mineral trioxide aggregate" occupy larger portions of the chart, implying their central role in the research literature. These terms are closely associated with fundamental topics in endodontics and related fields, indicating their sustained relevance across studies.

Smaller slices represent less frequent but still important keywords like "Inflammation" and "EDTA".

Topic modeling: identifying themes or topics in the corpus

This analysis aimed to identify dominant research themes within the JOE by applying topic modeling techniques to article titles. Understanding these themes provides insight into the journal's intellectual structure and evolving areas of focus. Using the LDA algorithm, five key topics were identified, with each representing a distinct area of research within endodontics. The top 10 keywords for each topic were used to interpret the themes (Table 1). Notably, the prominence of topics such as "Pulp Biology and Stem Cells" and "Periapical and Endodontic Materials" highlights the ongoing emphasis on translational research and material science.

Keyword co-occurrence analysis: relationships between terms

Supplementary Figure S4 shows the keyword co-occurrence map. The keyword co-occurrence map visualizes the relationships between the most frequently used keywords in the dataset. This map was constructed by first extracting keywords from all articles in the

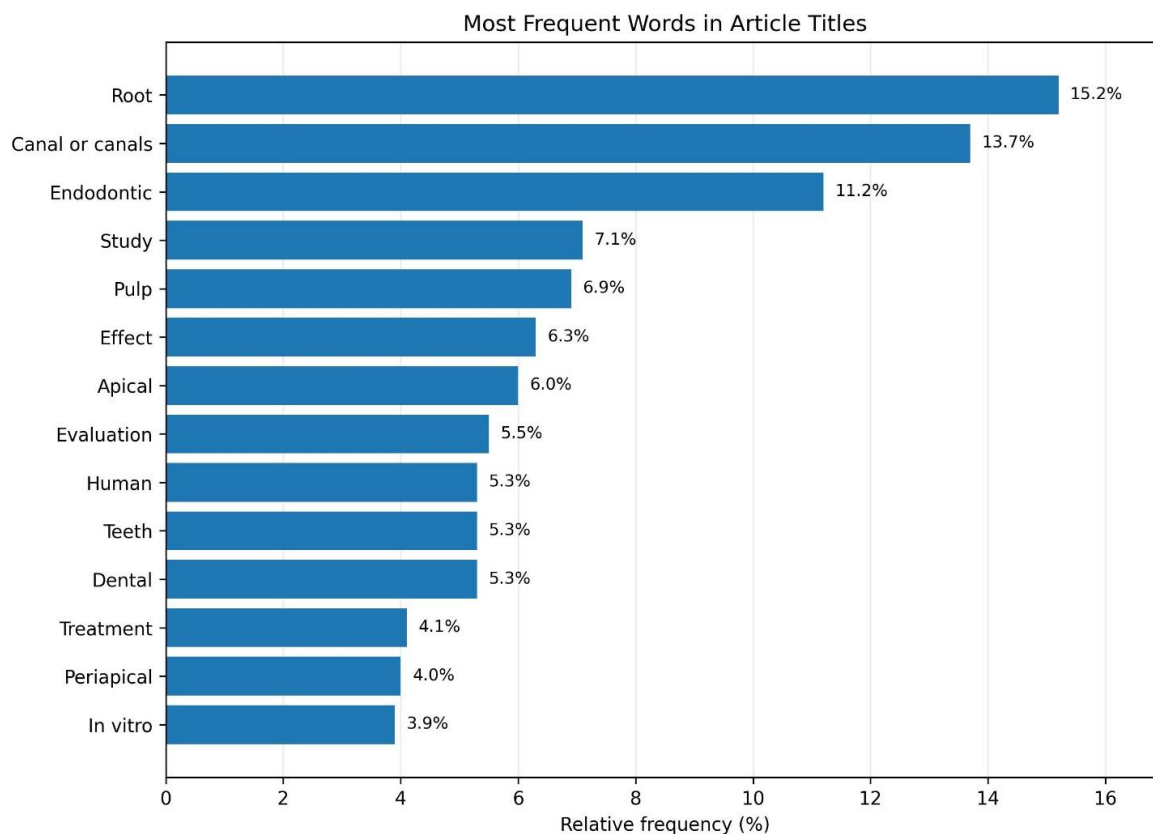


Figure 4. A donut chart illustrating the relative frequency of the most pervasive words in article titles

Table 1. Latent topics identified through LDA topic modeling of article titles in the JOE

Topic No.	Thematic label	Scope and focus	Key terms
Topic 1	Pulp biology and stem cells	Research on pulp biology, stem cell differentiation, and growth factors influence on cellular processes	Pulp, dental, cells, expression, stem
Topic 2	Periapical and endodontic materials	Focus on calcium-based and other materials used in endodontics (e.g., MTA, gutta-percha)	Periapical, endodontic, calcium, lesions
Topic 3	Imaging and anatomy	Anatomical studies and imaging advances such as CBCT in root canal morphology	Root, teeth, canal, mandibular, maxillary
Topic 4	Root canal and dentin studies	Evaluation of chemical irrigants (e.g., NaOCl), root canal procedures, and dentin structure	Root, canal, dentin, evaluation, apical
Topic 5	Endodontic instruments and case reports	Research on NiTi rotary systems, clinical instrumentation, and illustrative case reports	Instruments, rotary, case, report, comparison

dataset and then identifying pairs of keywords that co-occurred within the same article. Each node represents a keyword, with its size proportional to its frequency in the dataset. Larger nodes, such as those corresponding to "Endodontics" or "Apical *Periodontitis*," indicate terms that are highly prevalent. The edges connecting the nodes represent the co-occurrence of keywords, with the thickness of the edges reflecting the strength of the connection. For instance, keywords like "Mineral Trioxide Aggregate" and "Regenerative Endodontics" may have thicker connecting edges. Keywords with greater importance, based on their frequency or connectivity, were further emphasized with larger font sizes for their labels. Clusters around "Cone-Beam Computed Tomography" and "Root Canal Treatment" might reflect a concentration of studies on advanced diagnostic tools and treatment techniques.

Supplementary Figure S5 reveals changes in research themes over time by tracking the dominant topics:

- Rising topics: Pulp biology, stem cells, and regenerative endodontics have shown significant growth, especially in recent years. Anatomy and imaging have also increased steadily, likely due to advancements in CBCT for diagnosis and treatment.
- Stable topics: Root canal preparation and dentin-related studies have remained consistently represented throughout the journal's history. Periapical disease and endodontic materials have also maintained a strong presence.
- Declining topics: Endodontic instruments and case reports were more prominent in earlier periods, reflecting priorities in clinical innovations at that time. However, they have become less prominent as research has shifted toward broader biological topics.

Discussion

The present study applied scientometric techniques to analyze the collaborative structure and thematic evolution of the JOE over 50 years. The Scopus database was selected for this study, as it is a leading platform for scientometric research with extensive coverage of peer-reviewed publications across disciplines. The quality of publications indexed in Scopus is rigorously controlled by an independent selection board. It indexes content from more than 7,000 publishers, including scientific journals, books, and conference proceedings, and comprises over 91 million records, 17 million author profiles, and 94,000 institutional affiliation profiles.

The Scopus database provides advanced search and analytical tools, as well as author and institution profiles, enabling researchers, librarians, and funders to track research trends, identify experts, and visualize and compare data with high accuracy and reliability. Another key point is that the Scopus database currently provides citation data dating back to 1970, making it suitable for analyzing the JOE, which was established in 1975.

Other studies have used Scopus for similar scientometric analyses (9). In contrast, Ordinola-Zapata et al. (10) employed Web of Science as the primary database, based on its extensive coverage of high-impact journals and its long-standing role in citation analysis. While Web of Science is a highly respected platform, its more selective journal indexing policy, focusing on high-impact journals, can sometimes limit its representation of niche or emerging research areas, such as those found in specialty journals like the JOE. Scopus covers a broader range of journals (12,850) compared to Web of Science (8,700) and includes a larger number of indexed documents, which may provide broader coverage for scientometric analyses (11). In addition, a previous study reported missing and

incorrect references in Web of Science records, including 55% missing references, a 26.7% error rate in references, and 16.7% incorrect references (12). Moreover, Web of Science does not include some metrics available in Scopus, such as CiteScore, and does not provide the same level of user-friendly citation tracking and analytic tools as Scopus.

CSV was selected as the export format for results from the Scopus database due to its universal compatibility with a wide range of tools, including spreadsheet programs, data analysis software, and bibliometric and scientometric tools. The structured tabular format of CSV files facilitates the organization and analysis of large datasets while allowing efficient loading and processing due to its lightweight nature. This format also allows customized exports, enabling researchers to select specific fields, such as citations, keywords, and affiliations, according to their analytical needs.

Additionally, CSV files can be easily processed programmatically while preserving data integrity and remaining human-readable. This format facilitates the cleaning, processing, and analysis of data using Python and Microsoft Excel. Furthermore, it is fully compatible with VOSviewer®, ensuring an efficient workflow from data extraction to analysis. In contrast, Ordinola-Zapata et al. (10) utilized the “save other file formats” option for exporting data, which, while functional, may lack the universal compatibility and ease of processing offered by CSV files. Formats other than CSV may require additional conversion or specialized software, which can complicate workflows and increase the risk of errors during data handling.

Certain document types, such as editorials, conference abstracts, and letters to the editor, were excluded to maintain the study's focus on original research, review articles, and case reports/clinical techniques. These exclusions ensured that the analyses reflected the journal's scientific contributions rather than administrative or supplementary content. Similar exclusion criteria have been employed in prior bibliometric studies to maintain consistency and reliability in results. In contrast, Moraes et al. (13) did not exclude any document types, opting instead to analyze all available content. While this approach provides a broader perspective, it may dilute the focus on the core scientific contributions of the journal by including documents that do not represent primary research or reviews.

VOSviewer® was chosen for network visualization due to its user-friendly interface, specialized algorithms for constructing bibliometric maps, and ability to process

large datasets efficiently. Although other tools such as CiteSpace® and Bibliometrix® can be considered, VOSviewer® offers superior capabilities for co-authorship, co-citation, and keyword co-occurrence mapping, with clear and interpretable visual outputs, making it an optimal choice for this study. The tool's graphical output provided clear insights into collaboration patterns and thematic trends, enabling a deeper understanding of the journal's evolution. Additionally, Microsoft Excel was utilized for manual verification and organization of key variables to ensure the accuracy and consistency of the dataset.

Co-authorship network analysis revealed three major collaborative clusters that reflected major thematic areas within the journal. The red cluster, centered on Mahmoud Torabinejad, highlighted foundational research in MTA and regenerative endodontics. The green cluster, led by José F. Siqueira Jr. and Isabela N. Rôças, concentrated on microbiological and molecular research. The blue cluster, associated with David H. Pashley and Franklin R. Tay, represented interdisciplinary research in dentin bonding and adhesive dentistry. These networks illustrate how the JOE has supported the development of distinct research areas through collaborations among influential contributors.

At the international level, United States researchers remained major contributors and a central hub in co-authorship networks. However, researchers from Brazil, China, and South Korea also formed important nodes, reflecting the journal's growing global reach. While many articles remained authored within a single country, international collaboration accounted for nearly one-quarter of the journal's output, indicating a gradual increase in cross-border collaboration.

Citation-based analyses, including bibliographic coupling, further demonstrated the journal's two main intellectual areas. One thematic cluster emphasized biological and regenerative topics, with anchor papers by Torabinejad and colleagues on MTA and stem cell therapy. The other cluster focused on procedural and microbial aspects of endodontic treatment, including studies on canal shaping, irrigation protocols, and microbial persistence. This thematic bifurcation was reinforced by journal co-citation networks, in which the JOE, IEJ, and trauma-oriented publications were grouped into distinct citation communities, reflecting the interdisciplinary nature of contemporary endodontic research.

Keyword co-occurrence and temporal trend analyses provided additional insights into the evolution of

research themes. Earlier articles predominantly addressed materials science and clinical instrumentation—such as gutta-percha, sealers, and mechanical file systems—while more recent publications showed increasing attention to diagnostic technologies (e.g., CBCT), regenerative therapies, and systematic reviews. Topic modeling confirmed this thematic shift, identifying five dominant clusters: pulp biology and stem cells; periapical and endodontic materials; imaging and root anatomy; root canal and dentin studies; and endodontic instruments and case reports. Notably, instrument-related research, while historically prominent, has declined in recent years, indicating a shift from technical innovation toward biologically oriented and evidence-based research.

Citation trends supported this transition. MTA-related research was the most frequently cited, appearing in 18 of the top 100 articles, followed by studies in regenerative endodontics and CBCT. These findings reflect a sustained interest in translational material science and biologically based diagnostic approaches. Conversely, the declining prominence of case reports and isolated technical innovations may indicate a growing emphasis on research designs that provide more generalizable outcomes and stronger methodological approaches.

The insights obtained from this study are not only relevant to understanding the historical trajectory of the JOE but also provide useful information for editorial planning. The evolving structure of collaboration networks, thematic priorities, and research ranging from materials science to molecular biology and diagnostic imaging are important in understanding the trends and characteristics that may shape the JOE over the next 50 years. Recognizing and responding to these patterns will be essential for maintaining the journal's relevance and scientific leadership in the decades ahead.

Conclusion

This scientometric analysis of the JOE reveals substantial shifts over 50 years in collaboration, authorship, and research themes. The journal has moved toward a predominantly multi-authored model and increased international collaboration, with researchers from the U.S., Brazil, and China as key contributors. Keyword and topic modeling identified five main research domains, reflecting a shift from materials-based studies toward diagnostics technologies and evidence-based research.

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The thesis will be archived under embargo in the West Virginia University institutional repository and the ProQuest database, in accordance with the prior publication policies of the *Journal of Endodontics*.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

H.J. developed the project, helped with data analysis, and edited the manuscript. M.A.B. and S.B.W. helped with data collection, analyzed the data, and wrote the manuscript. R.C.W. and S.O.D. collected the data and edited the manuscript. All authors read and approved the final manuscript.

Ethical considerations

This study was formally approved as Non-Human Subject Research (NHSR) by the Institutional Review Board (IRB) / Ethics Committee of West Virginia University, Morgantown, WV, USA (Protocol#0887).

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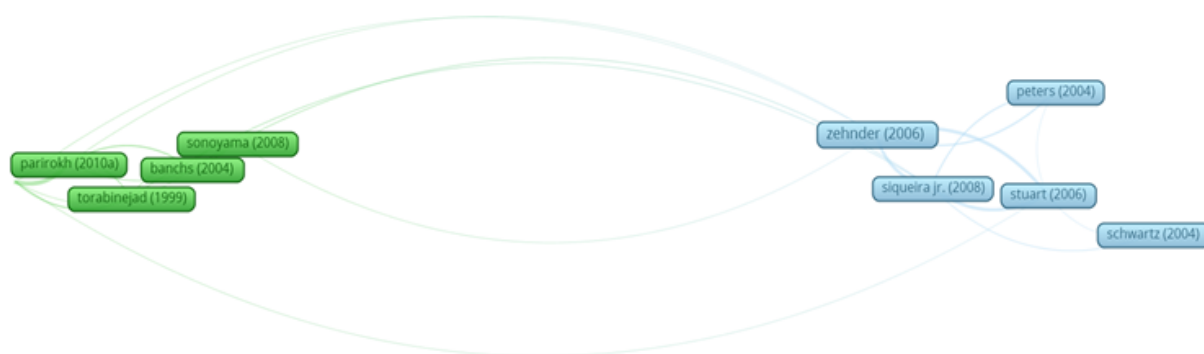
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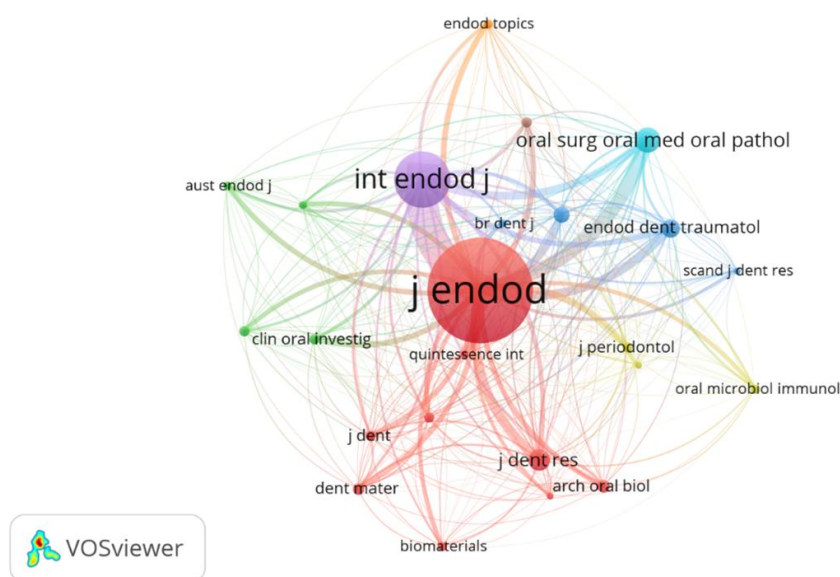
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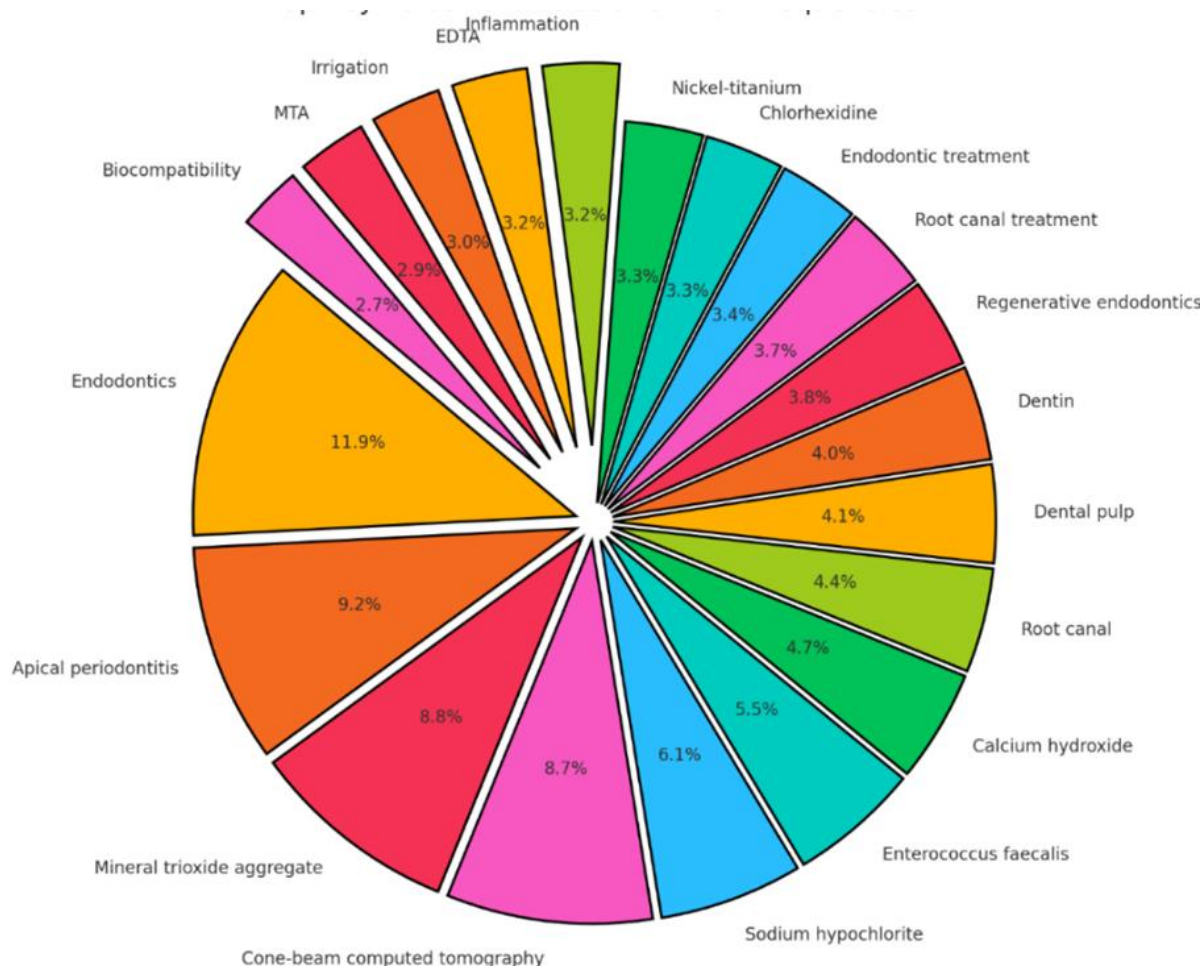
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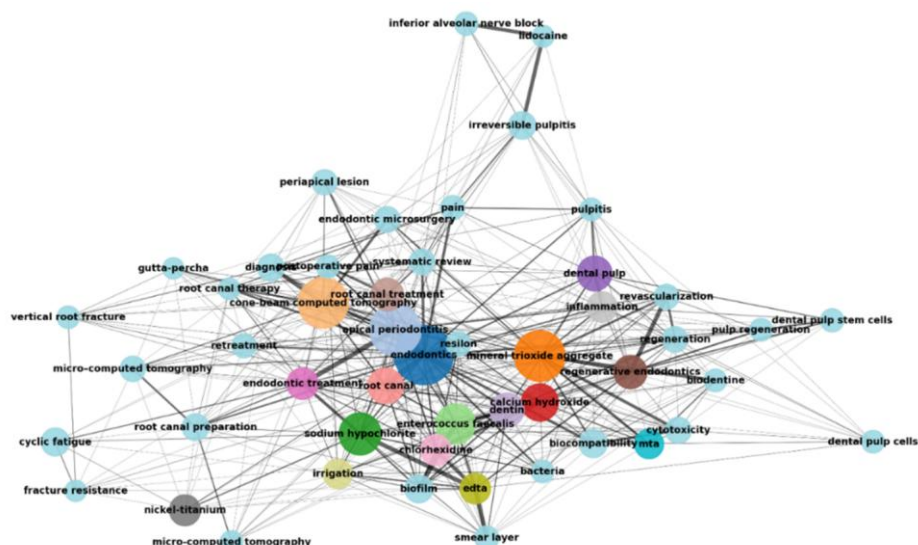
Supplementary Figure S1. Bibliographic coupling network of key documents in endodontic research, illustrating two major thematic areas: regenerative approaches (green cluster) and technical advancements in cleaning & shaping (blue cluster) (Visualization created using VOSviewer® [www.vosviewer.com].)



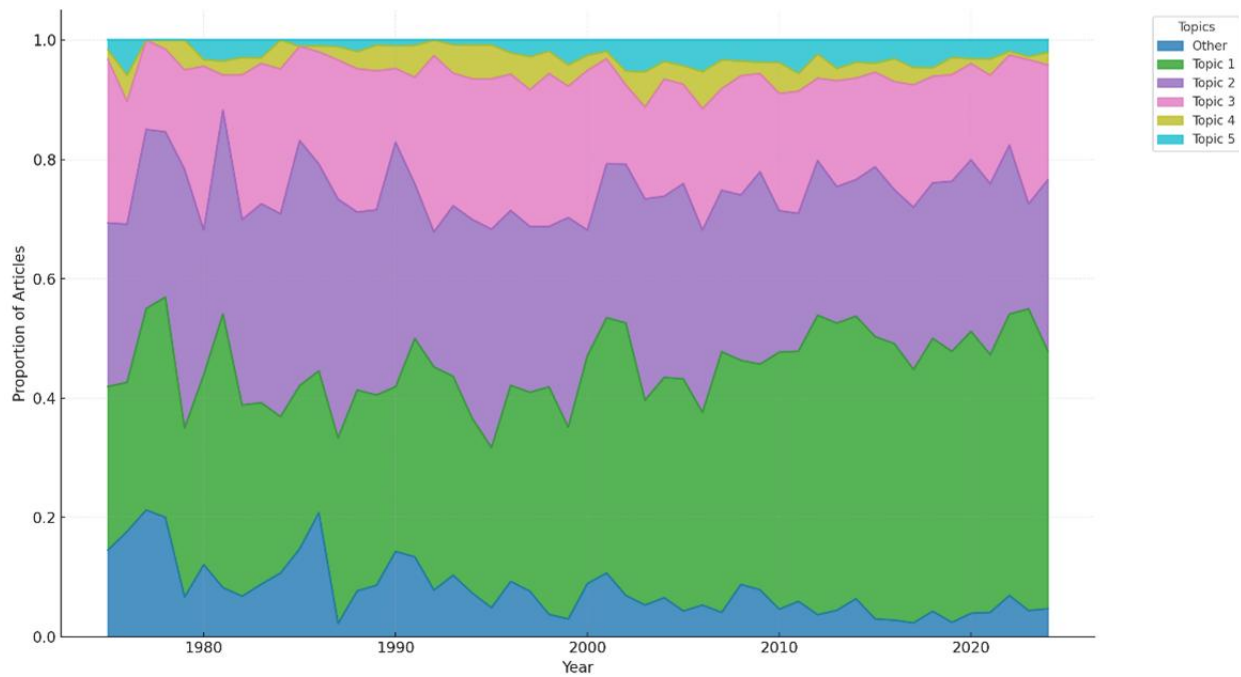
Supplementary Figure S2. Co-citation network of journals in endodontics, highlighting the central role of the JOE and its connections to prominent interdisciplinary and clinical research outlets (Visualization created using VOSviewer® [www.vosviewer.com].)



Supplementary Figure S3. Pie chart showcasing the top keywords from articles and their frequencies, highlighting major research areas such as “Endodontics,” “Apical Periodontitis,” and “Mineral Trioxide Aggregate.” The layout emphasizes smaller contributions for clarity.



Supplementary Figure S4. Keyword co-occurrence map visualizing relationships between the top 50 keywords. Node sizes represent frequency, and edge thickness indicates co-occurrence strength. Clusters reveal thematic focus areas like 'Root Canal Treatment' and 'Regenerative Endodontics' (Visualization created using VOSviewer® [www.vosviewer.com].)



Supplementary Figure S5. Evolutionary trends of research themes in the JOE. The stacked area chart shows the relative proportions of articles assigned to each theme over time.