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Trends in endodontics research in leading dental vs. endodontic journals: Bibliometric analysis of 2019–2023

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Knowing the endodontic research trends in Q1 dental journals can guide researchers during the submission process. Therefore, this study aimed to evaluate endodontic research trends in Q1 dental journals over the last five years. The manuscripts published in these journals were retrieved using the Web of Science database. The VOS viewer software was used to analyze the saved articles. Only 4.3% (574 of 13,245) of articles published in Q1 dental journals were endodontics-related. The percentage of studies conducted with the cooperation of various dental and medical specialties was 73.5%. The majority of published articles were about devices and materials. Studies on regenerative endodontics, vital pulp therapy, and artificial intelligence were published in both journal groups. There is little research on post-endodontic restorations in endodontic journals compared to Q1 dental journals. The most frequently used keywords were "endodontics" and "dental pulp stem cell" in endodontic and other Q1 journals. In vitro studies were the most frequent study type (44.4%), followed by clinical studies (20.2%). Only 0.5% of articles were cited 100 or more times in both journal groups. Publication rates of endodontic articles are quite low in other Q1 journals. Conducting studies on topics that are more likely to be published may increase the acceptance rate of research.

Keywords: Bibliometrics; endodontics; journal impact factor; publications.

Introduction

Endodontics addresses conditions, injuries, and illnesses affecting the pulp and periradicular region, as well as how they relate to overall health and well-being in the body. A broad spectrum of clinical, biological, microbiological, mechanical, and materials-based research subjects is of interest to endodontics, with the goal of advancing disease process comprehension, diagnosis, and treatment of both healthy and damaged dental pulps and periradicular tissues (1). A growing number of articles in the endodontic literature over the past few years attest to the enormous transformation that endodontics has undergone. The result of this evolution has been a high number of publications in each issue of major endodontic journals and/or a corresponding increase in articles released ahead of print.

The primary method of evaluating the caliber of research conducted in any scientific discipline is the publication of original scientific articles in peer-reviewed journals (2). Notwithstanding its shortcomings, the impact factor (IF) of a journal is frequently used to gauge its relative significance within its field and is regarded as a reliable indicator of a journal's caliber (3). The frequency with which the

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journal's articles are cited in the endodontic literature is indicated by the IF. IF values are a journal-level measure that are commonly used as a stand-in for a journal's relative relevance within its area; journals with higher values are considered more influential or prestigious within their respective fields.

The Science Citation Index Expanded (SCIE), formerly known as the Science Citation Index, is a citation index that was developed by Eugene Garfield and initially produced by the Institute for Scientific Information (ISI) (4). Currently owned by Clarivate, it was first introduced in 1964. Furthermore, Eugene Garfield created the IF. For journals included in the Journal Citation Reports (JCR), IFs were first computed annually in 1975. The indexing database includes about 9,200 important journals from 1900 to the present, spanning 178 fields. There are four quartiles (Q1, Q2, Q3, and Q4) for each subject area of journals. The top 25 percent of the list's journals are listed in Q1, followed by those in the 25–50% group in Q2, the 50–75% group in Q3, and the 75–100% group in Q4. The journals that are in the top quartile, or Q1, are the most distinguished within a given subject area. Since 1997, quartiles have been available.

The SCIE contains three endodontic journals: Australian Endodontic Journal (AEJ), International Endodontic Journal (IEJ), and Journal of Endodontics (JOE). The 2022 Journal Impact Factor (JIF) ranking places AEJ as a Q4 journal and JOE and IEJ as Q1 journals. The limited number of endodontic journals in SCIE and their low acceptance rate (16% for IEJ and JOE, 18% for AEJ) may lead endodontic researchers to submit their studies to general dentistry journals. To increase the chances of acceptance in such a situation, it is necessary to have an idea about the topics that general dentistry journals are more likely to accept.

In a world that is changing quickly, it will help to properly plan projects by recognizing the shifting trends in study subjects. Because of this, bibliometric studies are essential for determining hot research subjects and providing direction for investigators on new projects. Bibliometric analysis is a methodical approach to assessing how influential scientific publications are on other publications within the same field (5). It provides guidance to researchers on selecting study topics, looking up preexisting theories, and choosing the appropriate research techniques (5). Journals should be thoroughly examined using bibliometric methods and techniques to analyze the trends and impact of publications in depth (6,7). Through bibliometric analysis, the evolution and focus of treatments and techniques in the same field can also be highlighted. As a result, the scientific community has given bibliometric analysis a lot of attention.

Numerous dental specialties, including pedodontics (8), prosthodontics (9), periodontology (10), orthodontics (11), and endodontics (1,5,6,12), have seen a rise in the popularity of bibliometric studies in recent years. Popular topics, such as the development and application of MTA, the discovery and use of nickel-titanium, the outcomes of endodontic treatments, and the basis for regenerative endodontic procedures published in endodontic journals, were reported several times (1,5,6,12). However, data on general dental journals that have also published articles related to endodontics is limited (13). Therefore, this study's objective was to assess and examine the changing patterns in endodontic research published in Q1 dental journals (non-endodontic journals) between January 2019 and December 2023 and to compare the findings with those published in endodontic journals (JOE and IEJ).

Materials and Methods

The online web edition of the Q1 journals was accessed based on the JIF list released in 2022 (https://jcr.clarivate.com/jcr/browse-journals). The keywords "endodontics," "endodontic," "endodontology," "root," "canal," "root canal," "root canals," "dental pulp," and "pulp" were used in conjunction with time refinement (January 2019–December 2023) in the "search in this journal" tool of each journal to include articles related to endodontics. Since searching with these keywords led to the extraction of all articles published in IEJ and JOE, they were also used in the search of other journals. Additionally, an electronic search in the Web of Science (WOS) database was performed using the same keywords. Relevant articles were saved to a folder. The "save other file formats" and "RIS" formats were used for data export.

To ensure consistency of the analysis, two different endodontic specialists repeated the search three different times. When consensus could not be reached regarding the articles to be included, a third expert's opinion was sought. The following publications were not included in the analysis: conference abstracts, reprints, software or book reviews, editorials, position statements, consensus articles, letters to the editor, articles in press, and articles in remembrance, as in previous studies (1,12).

The following parameters were recorded for each article:

A. Number of affiliations: All affiliations for an author with two or more affiliations were counted toward the final total; hence, the precise number of affiliations was determined.

B. Authors' names and places of origin: Scimago Graphica software was used to plot each author's country of origin

on a global map based on numerical data, while VOSviewer software was used to map all authors in the dataset.

C. Maps of terms used in titles and abstracts: Using term maps, researchers were able to see how terms appearing in the titles and abstracts of papers published over the last five years were distributed in two dimensions. Using VOS software and the binary counting option (which only took a term's presence or absence into account), the most frequently occurring terms in article titles and abstracts were extracted. Terms with fewer than ten occurrences were eliminated for both journal groups.

D. Maps of keywords: VOSviewer software was used to select keywords. In the mapping process, any keywords that appeared fewer than four times were eliminated for IEJ and JOE, and those that appeared fewer than three times were eliminated for other Q1 journals.

E. Citation Numbers: Citation numbers of articles were categorized as 0, 1, 2–50, 51–99, and 100 and above. WOS and VOSviewer software were used to determine which authors, articles, organizations, and nations received the greatest number of citations.

For every article included from non-endodontic journals, the following additional parameters were also noted:

1. Each journal's total number of articles as well as the percentage of those included.

2. Author count: Each article's precise count was noted and divided into four groups: 1, 2–5, 6–10, and 11 or more.

3. Type of article: The articles were categorized as case reports/clinical techniques, reviews, and research. Research articles were further categorized as basic in vitro, animal, survey, or clinical. Reviews were divided into systematic, narrative, scoping, and systematic-meta-analyses.

4. National and international cooperation: It was recognized as international cooperation if there were authors from several nations (the author's primary country of affiliation was taken into consideration if the author had two or more affiliations from different nations). It was considered national cooperation if the authors came from various universities or institutes within the same nation (the university or institute of the author's first affiliation was taken into consideration if the author had multiple affiliations).

5. Department/specialty of corresponding author: If there were two or more corresponding authors, the department of the last author was noted with one exception (in this case, the department of the first author was mentioned when the first author was also a corresponding author).

6. Collaboration between various dental and medical specialties: An article was assigned a "Y" (yes) rating if it included at least two authors from separate departments, such as the pediatric dentistry and endodontics departments.

7. Study field: Based on the American Association of Endodontists (AAE) research priorities (https://www.aae.org/specialty/publications-research/research/research-priorities/), articles were categorized into 11 thematic groups (Table 1).

WOS, VOSviewer (version 1.6.20), and Scimago Graphica (version 1.0.39) were the three software programs used to perform the bibliometric analysis. An automatic term detection algorithm is used by VOSviewer for bibliometric networking and visualization. The distance between two elements is used in distance-based maps to indicate the strength of the relationship between the elements; a smaller distance denotes a stronger relationship.

The software contains 60% of the terms with the highest relevance scores by default, and this setting was utilized during keyword and term maps visualization. Items in label view are shown with a label and a circle; the label's size and the surrounding area indicate the item's significance. When elements are given colors, the circle of each element is shown in the corresponding color. To avoid overlapping, only a subset of labels are shown by default. The two-dimensional distributions of data from articles published in the last five years in endodontic and other dental journals were shown using the software's maps. For a thorough analysis of a map, the label view is especially helpful (14).

A VOSviewer thesaurus file (thesaurus_authors.txt, thesaurus_terms.txt) was used to integrate terms, synonyms, and shortened terms with full terms (e.g., "dental pulp stem cells" vs. "DPSC"). It was also used to ignore phrases and indicate that different names relate to the same researcher (e.g., "Paul Dummer" or "P.M.H. Dummer") (14). The study's data was also cleaned using a thesaurus file. Furthermore, all brand-related and time-related (e.g., "month," "day," "January," etc.) terms were eliminated during map visualization.

The data was categorized using Microsoft Excel (version 2016) and visualized using Scimago Graphica software if maps were not available through VOSviewer. Scimago Graphica is a free software tool that offers a straightforward method for researchers to investigate, communicate, and interpret data without the need for any coding, using data from Microsoft Excel. Researchers can simply drag and place the variables into the visual attributes to visualize data.

Statistical Analysis

Initially, the classification of scientific articles in respect to the 11 categories designated as the "study field" was calibrated by three experienced endodontists. If there was a disagreement, the articles were examined until all evaluators arrived at a consensus. The interexaminer agreement between the evaluators was then evaluated using a kappa test. The three evaluators had very good levels of concordance for study field parameter (kappa coefficient > 0.86). At first, descriptive statistics were used to analyze the data. A significance threshold of 5% was used to compare all reported probability values (P values). The statistical software SPSS version 21.0 (IBM, Armonk, NY) was used to process and analyze the data.

Results

Q1 Journals versus Endodontic Journals

According to the JIF list published in 2022, there were 25 Q1 journals. Supplement 1 contains a list of journals. Articles (consisting of original research, case reports, animal, and clinical studies) and reviews published in the IEJ and JOE between January 2019 and December 2023 (a total of 1,771 documents, 994 from JOE and 777 from IEJ) were included in the study via WOS. A total of 13,245 articles were examined in the remaining Q1 journals using both manual and keyword scanning techniques to extract the related articles. According to the search's parameters, only 574 were included. The quantity of articles released in every journal during the assessed time frame and the proportion of included articles are listed in Supplement 2.

In non-endodontic journals, the most cited universities were Air Force Military Medical University, Augusta University, and Pennsylvania University. In endodontic journals, the most cited universities were Rio Grande University, Cardiff University, and Federal Fluminense University.

The most cited countries in non-endodontic journals were the United States of America (USA), followed by the People's Republic of China (PRC). The most cited countries in endodontic journals were Brazil, followed by the USA. Based on the number of articles and citations, Table 2 lists the top ten authors, affiliations, and nations. A density map based on article numbers and collaborations between nations is shown in Figure 1.

Seventy-five countries contributed to articles published in endodontic journals (1,771 articles, Fig. 1c & 1d), whereas 68 countries contributed to articles published in non-endodontic journals (574 articles, Fig. 1a & 1b). Although the number of articles published in non-endodontic journals was one-third of the number of articles published in endodontic journals in the last five years, the number of countries contributing to the studies has not changed much. This revealed that the studies in non-endodontic journals are carried out in cooperation with more countries.

The results of clustering parameters for keywords and terms are shown in Table 3. VOSviewer identified 1,437 keywords; a threshold of three occurrences was chosen, and from those, 60% of the terms with the highest relevance scores were included. The thesaurus file was also used to merge different forms of the same keyword. This left 102 keywords in non-endodontic journals. Similarly, VOSviewer identified 3,772 keywords in endodontic journals. A threshold of four occurrences was chosen, and 60% of the terms with the highest relevance scores were included following changes via thesaurus files, leaving 244 keywords.

Table 4 lists the top 10 terms and keywords based on the number of occurrences and the specified criteria for endodontic journals and other journals. "Endodontics" (merged with "endodontic" and "endodontology") was the keyword with the highest frequency in endodontic journals, while "dental pulp stem cell" was the keyword with the highest frequency in other Q1 journals. This revealed that regenerative endodontics is a popular topic, and articles on this topic have a chance of publication in other Q1 journals. Endodontic journals contain eight clusters of keywords, whereas other Q1 journals have six clusters of keywords (Fig. 2a & 2b).

Evaluations of terms taken from titles and abstracts were also conducted (Fig. 2c & 2d). VOSviewer identified 38,195 terms in endodontic journals; a threshold of 10 occurrences was chosen, leaving 747 terms. In other Q1 journals, 15,795 title terms were found, and the same threshold left 188 terms. This is an expected result, as the

Table 1. Research priorities of the American Association of Endodontists (AAE)

A. Assessment of Clinical Outcomes
B. Assessment of New Methods of Diagnosis, Treatment Modalities and Technology, such as Devices and Materials
C. Biology of Pulpal and Periradicular Tissues
D. Cracks and Fractures in Teeth
E. Demographics/Epidemiology of Pulpal and Periradicular Disease
F. Endodontic/Implant Relationships
G. External and Internal Resorption
H. Educational Research
I. Tissue Engineering—Regeneration of the Pulpodentin Complex and Periradicular Tissues
J. Trauma
K. COVID-19 Focused Studies

Table 2. Top 10 Authors/ Countries/ Affiliations according to citation number and article number

Authors	Number Of Articles	Authors	Number Of Citations	Countries	Number Of Articles	Countries	Number Of Citations	Affiliations	Number Of Articles	Affiliations	Number Of Citations
Other Q1 Journals											
Tay, Franklin R	18	Tay, Franklin R	311	USA	147	USA	1608	Sichuan University	34	Air Force Military Medical University	416
Bergeron, Brian E	10	Jin, Yan	220	PRC	133	PRC	1539	Peking University	23	Augusta University	330
Camilleri, Josette	9	Schwendicke, Falk	196	Brazil	96	Brazil	926	Augusta University	21	University of Pennsylvania	268
Zhou, Xuedong	7	Krois, Joachim	196	Japan	42	UK	727	University of Michigan	21	University of Birmingham	254
Ferracane, Jack I.	7	Dreher, Martin	168	UK	38	Germany	472	De Sao Paulo University	21	Sichuan University	239
Bakopoulou, Athina	6	Golla, Tatiana	168	Germany	31	Japan	348	Osaka University	19	Charité – Universitätsmedizin Berlin	203
Van Meerbeek, Bart	6	Fouad, Ashraf F	155	Türkiye	24	Ireland	277	Wuhan University	18	Sun Yat Sen University	187
Tampi, Malavika P.	5	Li, Yuanyuan	146	Saudi Arabia	23	France	248	São Paulo State University	17	De Sao Paulo University	184
Schwendicke, Falk	5	Camilleri, Josette	145	Italy	23	Canada	242	University of Pennsylvania	16	King's College London	178
Krois, Joachim	5	Sui, Bingdong	142	Canada	22	Saudi Arabia	230	Fluminense Federal University	13	Wuhan University	177
JOE&IEJ											
Authors	**Number Of Articles**	**Authors**	**Number Of Citations**	**Countries**	**Number Of Articles**	**Countries**	**Number Of Citations**	**Affiliations**	**Number of Articles**	**Affiliations**	**Number Of Citations**
Silva, Emmanuel J. N. L.	79	Dummer, Paul M. H.	1510	USA	422	Brazil	4522	Rio Grande University	101	Rio Grande University	1551
Venkateshbabu, Nagendrababu	61	Silva, Emmanuel J. N. L.	1121	Brazil	413	USA	4502	De Sao Paulo University	94	Cardiff University	1234
Dummer, Paul M. H.	60	Duncan, Henry	1056	PRC	200	UK	2657	Federal Fluminense University	69	Federal Fluminense University	840
Versiani, Marco Aurélio	49	Venkateshbabu, Nagendrababu	1034	UK	160	PRC	1914	Cardiff University	67	International Medical University	803
Duncan, Henry	42	Versiani, Marco Aurélio	654	Germany	96	Germany	1477	São Paulo State University	67	De Sao Paulo University	726
Kishen, Anil	41	De-Deus, Gustavo	589	Canada	92	Spain	1397	University of Toronto	60	International University of Catalonia	604
	37	Bjørndal, Lars	564	Spain	90	Malaysia	1113	University of London	47	University of Copenhagen	573
De-Deus, Gustavo	34	Belladonna, Felipe G.	558	India	76	Türkiye	1022	University of Maryland Baltimore	46	University of Amsterdam	541
Belladonna, Felipe G.	31	Diogenes, Anibal	547	Türkiye	76	Canada	911	Universidade Estadual de Campinas	44	University of Birmingham	534
Martins, Jorge	31	Martins, Jorge	510	Australia	75	Switzerland	860	Trinity College Dublin	43	University of Zurich	522
Cintra, Luciano Tavares Angelo											

*The significant differences are shown with different superscript capital letters and lowercase letters in column and row, respectively.

number of articles and the number of terms found are proportional.

In endodontic journals, “canal,” “system,” and “cell” were the most frequently used terms. The most frequently used terms in other Q1 journals were “cell,” “canal,” and “expression.” Terms in the titles and abstracts of the endodontic journals formed three clusters, while those in other Q1 journals formed four clusters. Clusters extracted from articles in other Q1 journals focused on post-endodontic restorations, regenerative endodontic treatments,

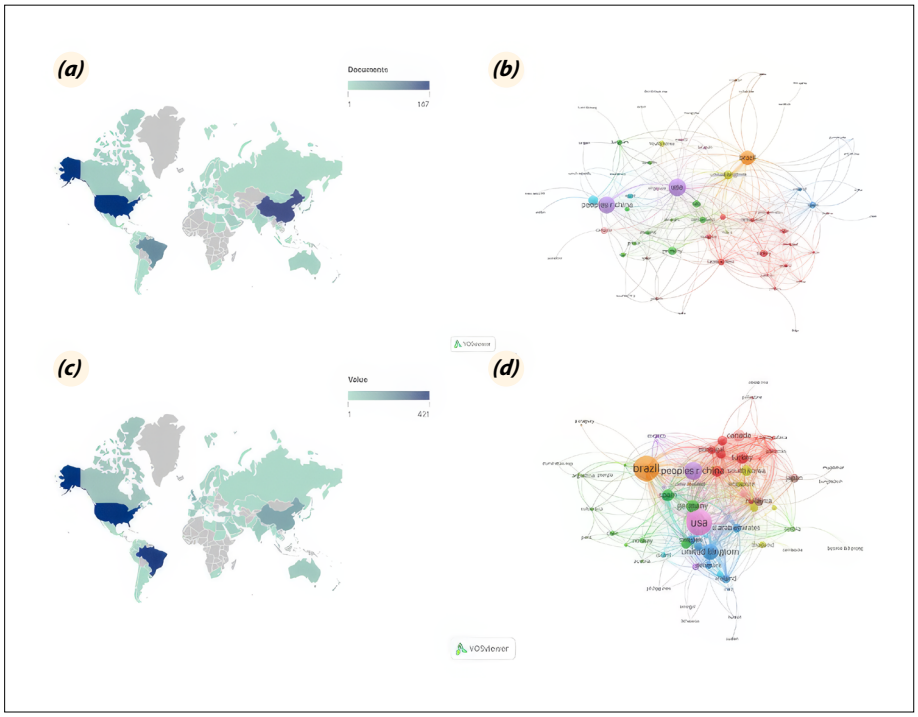

Fig. 1. Collaboration networks between countries extracted from the included articles of each group of journals and a density map based on article numbers. a-b: Results of non-endodontic Q1 journals, c-d: Results of IEJ&JOE.

clinical studies, and endodontic diagnosis. Clusters in endodontic journals focused on evidence-based endodontics, endodontic microsurgery, regenerative endodontic treatments, post-operative pain, and preparation/obturation of root canal systems (Fig. 2c & 2d).

Figure 3 displays the article citation counts. The results of endodontic journals and Q1 journals are shown in Figures 3a and 3b, respectively. Journals showed comparable outcomes. Only 0.5% of the articles had 100 or more citations within a five-year timeframe. Table 5 lists the five most cited articles.

In JOE, the most cited article was released in 2020. It dealt with coronavirus illness. The most cited article from other Q1 journals appeared in the Journal of Dentistry and was published in 2019. It was about the role of deep learning in dental imaging. This data suggests that artificial intelligence, which has brought a new dimension to medicine and dentistry, will continue to be a popular research topic in dentistry.

Other Parameters of Non-Endodontic Q1 Journals

Author Count: More than half of the included articles were written by 6–10 authors (52.4%), followed by 2–5 authors (41.5%). Studies written by 11 or more authors accounted for 5.6%. Only three articles were written by a single author.

Article Type: Figure 4 shows the article type distribution. Basic in vitro studies were the most frequent study type (44.4%), followed by clinical studies (20.2%). Among review types, systematic reviews and meta-analyses were the most frequent (34.3%), followed by systematic reviews alone (28.6%).

Cooperation: National cooperation was observed in 54.5% of the studies, and international cooperation in 33.5%. Collaboration between various dental and medical specialties was seen in 73.5% of the studies.

Department/specialty of corresponding author: Some of the corresponding authors were from medical departments such as department of pathology, department of pharmacology and physiology, department of microbiology and immunology, etc. While there were corresponding authors from department of endodontics, there were also from endodontic-related departments such as department of cariology and endodontics, department of cariology, endodontology and operative dentistry, department of conservative dentistry and endodontics, department of endodontics and operative dentistry, department of endodontics and periodontics, etc. There were different department names, and it has been observed that depart-

Table 3. Results of clustering parameters for keywords and terms extracted from included articles TITLE/ABSTRACT TERM

	Other Q1 Journals	IEJ-JOE
Number of titles	574	1771
Number of total terms	15795	38195
Number of remaining terms	188	747
Percentage of Remaining terms	1.2%	2%
Occurrences	Binary	Binary
Min occ. threshold for terms	10	10
Min occ. threshold for terms % default	60%	60%
Items connected	188	747
Nb of clusters	4	3
Links	7845	69814
Total link Strength	25915	187428
Min Strength	0	0
Min cluster size	1	1

KEYWORD

	Other Q1 Journals	IEJ-JOE
Number of titles	574	1771
Number of keywords	1437	3772
Number of remaining keywords	102	244
Percentage of remaining keywords	7.1%	6.5%
Occurrences	Full	Full
Min occ. threshold for terms	3	4
Min occ. threshold for terms % default	60%	60%
Items connected	102	244
Nb of clusters	6	8
Links	569	2093
Total link Strength	828	3897
Min Strength	0	0
Min cluster size	1	1

JOE: Journal of Endodontics, IEJ: International Endodontic Journal.

ment names vary by country. Top 5 departments of corresponding authors were as follows: department of endodontics (n = 58), department of prosthodontics (n = 48), department of pediatric dentistry (n = 42), department of restorative dentistry (n = 28) and department of orthodontics (n = 24).

Study field: Levels of concordance among the three evaluators were exceedingly high for the parameter (kappa coefficient > 0.83). The results of study field were displayed in Figure 5. 38.8% (n = 200) of the included articles belonged to category B, while the percentages for categories A and I were 19.5% (n = 112) and 25.1% (n = 144), respectively ($p < 0.05$). This showed that most of the current studies were about the properties of materials and devices.

Discussion

The aim of this study was to reveal the bibliometric characteristics of endodontic research published in Q1 dental journals and compare them with articles published in Q1 endodontic journals. Only 4.3% of the published articles in Q1 dental journals were related to endodontics. Previous research indicates that the most significant factors influencing the choice of where to submit include readership, journal quality (generally measured by IF), journal scope, and speed of review (15–17). Institutions and universities use the Q ranking and the IF of journals to evaluate the performance of their staff (18), so publishing in a high-IF journal can affect tenure and promotion. Given the significance of this data, only journals with the highest IF were included in the current study.

No articles about endodontics were published in journals

Table 4. Top 10 terms and keywords according to the number of occurrences

Other Q1 Journals		IEJ&JOE	
Keywords	**Occurrences**	**Keyword**	**Occurrences**
Dental pulp stem cell	42	Endodontics	255
Endodontics	31	Apical periodontitis	202
Regenerative endodontics	25	Cone beam computed tomography	172
Dental pulp	24	Dental pulp stem cell	121
Apical periodontitis	20	Root canal treatment	113
Cone beam computed tomography	20	Regenerative endodontics	109
Root canal treatment	19	Micro-computed tomography	103
Tissue engineering	19	Inflammation	59
Dentin	19	Systematic review	53
Primary teeth	19	Pulpitis	48
Terms of title and abstract	**Occurrences**	**Terms of title and abstract**	**Occurrences**
Cell	116	Canal	508
Canal	100	System	261
Expression	93	Cell	229
Formation	86	Expression	206
Evidence	76	Instrument	187
Activity	71	Preparation	176
Tissue	70	Endodontic	164
Risk	68	Formation	163
Regeneration	68	Risk	160
Failure	67	Quality	147
Differentiation	65	Evidence	146

JOE: Journal of Endodontics, IEJ: International Endodontic Journal

such as Oral Oncology, Periodontology 2000, Clinical Oral Implants Research, Clinical Implant Dentistry and Related Research, and Seminars in Orthodontics. Additionally, in the past five years, fewer than ten articles on endodontic topics have been published in the Journal of Clinical Periodontology, Molecular Oral Microbiology, and Caries Research. The two journals with the highest publication percentages were the International Journal of Paediatric Dentistry (10.3%) and the International Journal of Oral Science (13.6%) in this study. Although research trends in other dentistry specialties were not examined, it is possible to conclude that endodontic topics are not very popular among these Q1 journals.

In terms of publications, a prior study found that endodontics was not among the specialties (prosthodontics, orthodontics, and general dentistry) that encompassed the remaining specialties (19). This outcome does not seem to have changed much over time. The Q1 journals' scope demonstrates diversity, and these variations in scope could account for the low publication rate.

Bibliometrics, used in the scientific world for the evaluation of academic productivity, scientific articles, teams, and the authors themselves, has received significant attention in recent years (1,5–12) due to its usefulness in measuring the impact and influence of multiple publications in the scientific literature. In this study, the bibliometric indices of other Q1 journals were evaluated and compared with those of the two top endodontic journals using VOSviewer, a bibliometric program capable of a wide range of analyses, including co-authorship and keyword co-occurrence analyses, and citation network visualization. Title/abstract term maps and keyword maps obtained via VOSviewer were used to reveal research trends.

Essential components that grab readers' attention and make it easier to find relevant articles are the titles and keywords. Additionally, a paper's citation count may rise depending on the type and quantity of keywords it contains (20). To focus on the more informative terms, as found in a previous study (1), the software identifies relevant terms using noun phrases and linguistic filters (21). By default, the software selects 60% of the most relevant terms used in at least three documents (for articles extracted from other Q1 journals, this value was four in IEJ & JOE).

The keywords "dental pulp stem cell," "endodontics,"

Table 5. Top 5 most-cited articles in the evaluated period

Title	Source Title	Total Citations	Publication Year	Type Of Journal
Coronavirus disease 19 (COVID-19): implications for clinical dental care	Journal of endodontics	369	2020	Endodontic journals
European society of endodontology position statement: management of deep caries and the exposed pulp	International endodontic journal	214	2019	
The global prevalence of apical periodontitis: a systematic review and meta-analysis	International endodontic journal	165	2021	
Management of deep caries and the exposed pulp	International endodontic journal	163	2019	
European society of endodontology position statement: use of cone beam computed tomography in endodontics european society of endodontology (ESE) developed by	International endodontic journal	154	2019	
Convolutional neural networks for dental image diagnostics: a scoping review	Journal of dentistry	168	2019	Other Q1 journals
Current uses of chlorhexidine for management of oral disease: a narrative review	Journal of dentistry	131	2020	
Stem cell-based bone and dental regeneration: a view of microenvironmental modulation	International journal of oral science	130	2019	
NLRP3 inflammasome mediates M1 macrophage polarization and IL-1β production in inflammatory root resorption	Journal of clinical periodontology	106	2020	
Vital pulp therapy: histopathology and histobacteriology-based guidelines to treat teeth with deep caries and pulp exposure	Journal of dentistry	94	2019	

"regenerative endodontics," "root canal treatment," "apical periodontitis," and "cone-beam computed tomography (CBCT)" were frequently used in both groups. Unsurprisingly, "endodontics" was the most frequently used keyword in endodontic journals, as reported in a study evaluating keywords of articles published in the IEJ over the last 50 years (6). It was second in the top 10 list of keywords in other Q1 journals. Keywords such as "inflammation," "pulpitis," "micro-computed tomography (micro-CT)," and "systematic review" were also common in the IEJ and JOE, while "dentin," "tissue engineering," "dental pulp," and "primary teeth" were common in other Q1 journals.

A recent study reported that the keywords CBCT and micro-CT are still popular in IEJ & JOE (6). This pattern is consistent with the growing availability and demand for CBCT scanners in academic and clinical settings. According to the term map, the most frequently occurring word in other Q1 journals is "cell," whereas the most frequently occurring word in IEJ and JOE is "canal." Since the title and abstract serve as the "first impressions" of a research article, they must be meticulously crafted with precision, accuracy, and thoroughness. The majority of readers only read the title and abstract of a research paper, while a minority will read the entire paper (22).

The titles and abstracts of the included articles from both journal groups frequently included terms such as "cell," "canal," "risk," "formation," "expression," and "evidence." This result shows that studies related to regenerative therapies are popular in both groups. Researchers and clinicians are increasingly interested in this topic. Over 3,300 citations were accumulated in 24 years for the study by Gronthos et al. (23), which described the histologic characteristics of mesenchymal stem cells isolated from human dental pulp. Regenerative treatments have been popular over the last 25 years and will continue to grow with advances in material and cell sciences.

Terms such as "instrument" and "preparation" frequently occurred in articles extracted from IEJ & JOE. The term "instrument" also appeared in the titles of articles published in IEJ & JOE between 2000 and 2019 (1). Technological developments and increasing variations in file systems have contributed to this trend (24). This topic is unlikely to lose popularity with ongoing innovations in nickel-titanium alloys.

The survival and prognosis of endodontically treated teeth greatly depend on the restoration of those teeth. Regard-

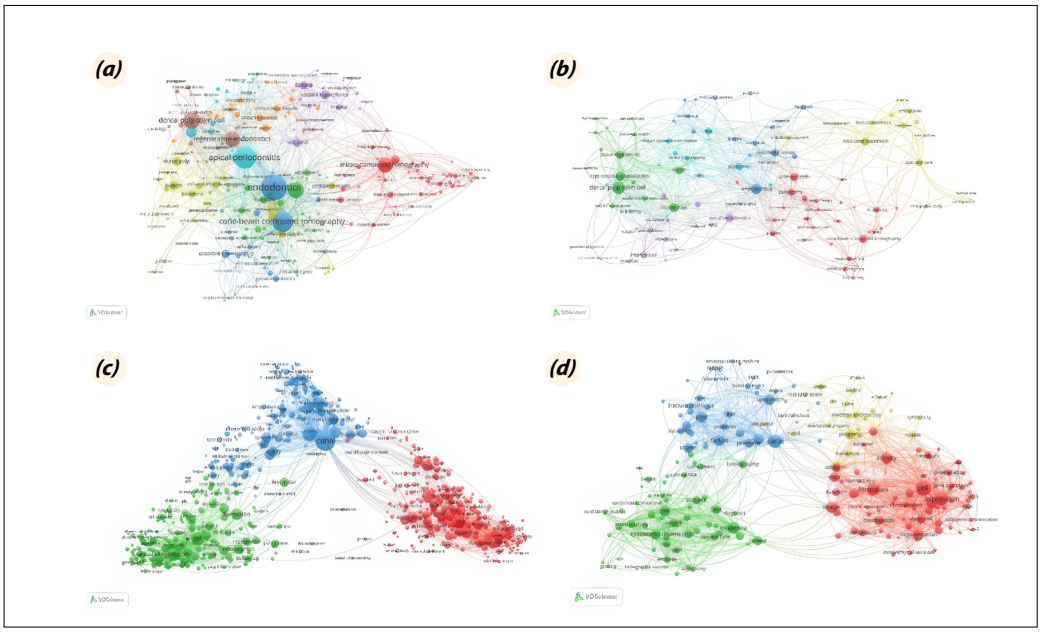

Fig. 2. Keyword and term map extracted from the manuscripts published between 2019 and 2023 in endodontic and other Q1 journals. a. keyword map of the endodontic journals formed 8 clusters: Cluster 1 (red) nickel-titanium and instruments research, cluster 2 (green) clinical aspects of the treatment including traumatic injuries and artificial intelligence applications, cluster 3 (blue) endodontic surgery and CBCT imaging, cluster 4 (yellow) vital pulp therapies, cluster 5 (purple) root canal disinfection, cluster 6 (light blue) periapical diseases, cluster 7 (orange) science of dental materials and cluster 8 (brown) regenerative endodontics. b. keyword map of the non-endodontic journals formed 6 clusters: cluster 1 (red) endodontic diagnosis, CBCT imaging and artificial intelligence applications, cluster 2 (green) regenerative endodontics, cluster 3 (blue) science of dental materials, cluster 4 (yellow) post-endodontic restorations, cluster 5 (purple) periapical diseases, cluster 6 (light blue) vital pulp therapies. c. Three clusters (red, green, blue) formed with the terms extracted form titles and abstracts of articles in endodontic journals. d. Four clusters (red, green, blue, yellow) formed with the terms extracted form titles and abstracts of articles in non-endodontic journals.

ing this subject, the European Society of Endodontology (ESE) recently released a position statement (25) emphasizing that additional clinical research is required to support the recommendations. There were many articles related to post-endodontic restorations in other Q1 journals. This was an expected result because, as stated in a recent study (26), post-endodontic studies are frequently published in prosthetic journals and subsequently in endodontic journals. Post-endodontic restorations were the subject of 21.4% (123/574) of the included studies pub-

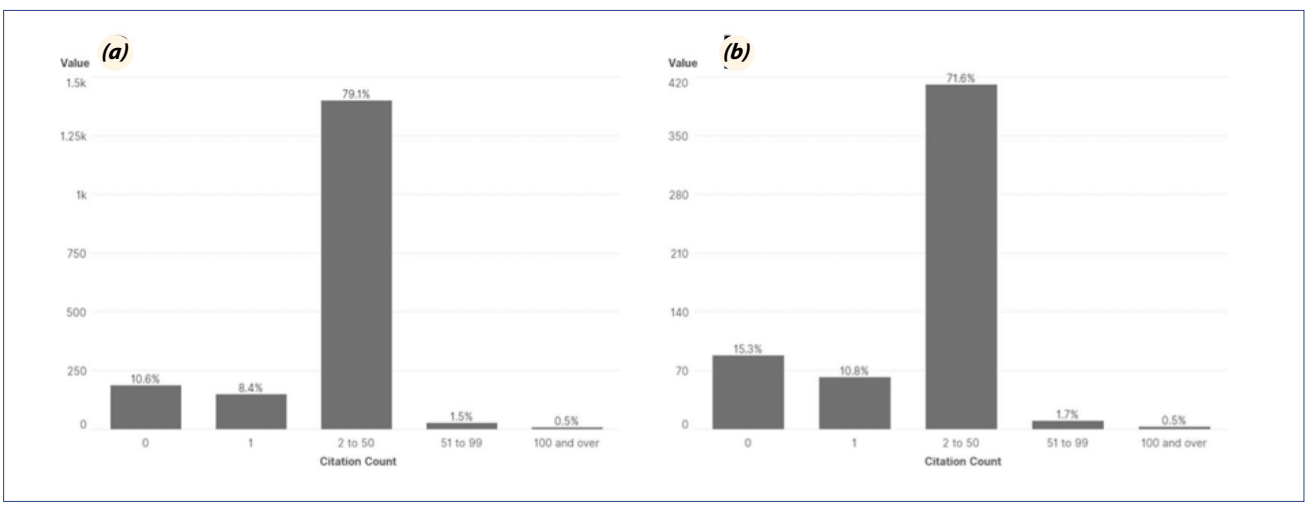

Fig. 3. Citations of included articles were categorized into 5 groups. a: Shows the results of IEJ&JOE, b: Shows the results of other Q1 journals. Graphs of 2 groups are seen similar. The most of the studies (over 70%) cited 2-50 times. A mere 0.5% of the articles garnered 100 or more citations within a 5-year timeframe in each group.

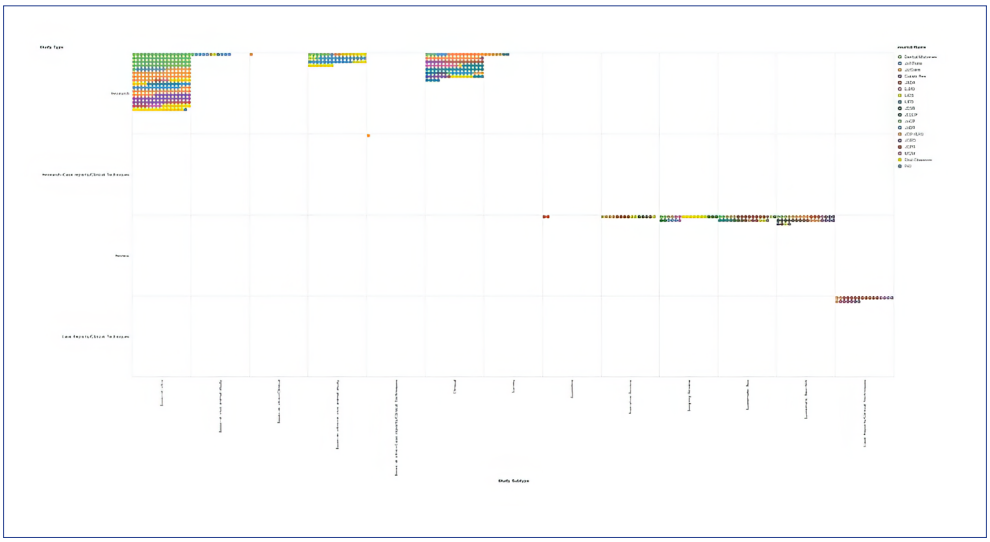

Fig. 4. Article type and subtype distribution of included articles from non-endodontic Q1 journals could be observed in Figure 4. Subtypes take place in X axis and main types take place in Y axis. Each journal is symbolized with colored circle.

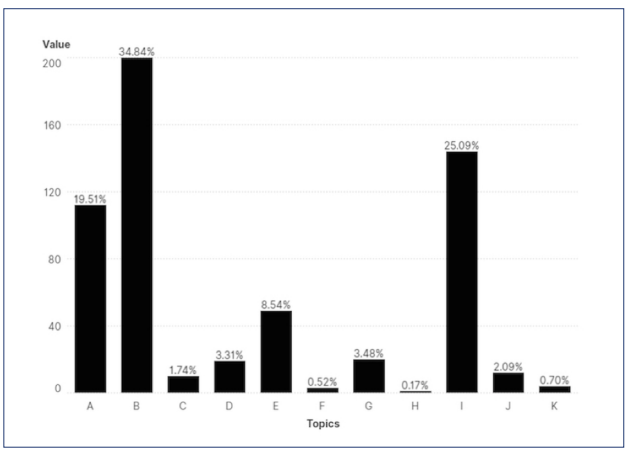

Fig. 5. The study field of articles included from non-endodontic Q1 journals is displayed in Figure 5. 38.8% (n = 200) of the included articles belonged to category B, while the percentages for categories A and I were 19.5% (n = 112) and 25.1% (n = 144), respectively ($p < 0.05$).

lished in other Q1 journals, while they were the subject of only 1% (17/1,771) of the studies in IEJ & JOE.

A cluster including keywords such as CAD-CAM, CAM systems, endocrowns, post and core, fiber post, and lithium disilicate formed in other Q1 journals (Fig. 2b, yellow cluster). However, no terms related to post-endodontic restorations were present in the keyword clusters of endodontic journals. This discrepancy may be because post-endodontic restoration studies often involve collaboration across different specialties (88/123, 71.5%), with the majority of corresponding authors belonging to prosthetics departments (n = 44).

Only 17 of the 123 studies (13.8%) were clinical research, indicating that clinical studies in this area are still limited. Conducting studies on post-endodontic restorations—especially clinical ones—might increase the acceptance rate of articles in these non-endodontic journals.

In both journal groups, there were clusters (Cluster 2-green color-Fig. 2a; Cluster 1-red color Fig. 2b) consisted keywords such as artificial intelligence (AI), deep learning or machine learning. In every facet of life, technological innovations (deep learning, AI, etc.,) are quickly replacing more traditional methods, particularly after the COVID-19 pandemic. Dental treatment procedures and dental education are impacted by AI applications (27,28). AI is used by practitioners in a variety of tasks, such as periapical lesion detection, tooth segmentation, pulp exposure prediction, and classifying canal morphologies. The current study's results indicate that an article on the radiographic detection of apical lesions using deep learning was one of the most cited ones published in endodontic journals (29). Furthermore, the highest citation count belongs to the article, which reviews the effect of deep learning on dental image diagnostics (30) published in 2019 in the Journal of Dentistry. It is important to keep in mind that the studies that examine the effects of technological innovations on endodontics will have a higher probability of being accepted.

Citations are crucial to an author's and journal's success in many ways. It is crucial that authors choose the best journal in which to publish their work as a result. "Citation classics" are articles with 400 citations or more, according to Eugene Garfield (31-33). A classic paper in endodon-

tics may require 11 to 31 years to approach 400 citations, according to a recent study by Ordinola-Zapata et al. (1). Conversely, in smaller specialties, an article with 100 citations or more might be regarded as a classic. Only 0.5% of the studies published in other Q1 journals or in endodontic journals received 100 or more citations during evaluated time period. It was observed that the majority of the studies were review studies. In the last 5 years, at least 249 reviews were published in JOE and IEJ, and at least 88 reviews were published in other Q1 journals, based on a WOS search. A recent study that analyzed the most-cited articles in the IEJ and JOE from 1980 to 2019 reported that at least 270 reviews were released between 2010 and 2019 (1). Based on the fact that almost same number of reviews are published in the last 5 years, these results indicate an exponential increase in the number of reviews. The article about the coronavirus disease (COVID-19) has the highest citation count (n = 369, almost 400 in this short period) (34). The SARS-CoV-2 virus is the source of the infectious disease COVID-19. When someone is infected, the virus can escape through their mouth or nose as tiny liquid particles when they speak, sing, cough, or breathe. Larger respiratory droplets and smaller aerosols are among these particles. Due to their exposure to high concentrations of droplets and aerosols created during specific dental procedures, dentists and dental staff are more likely to contract infections through the air, including SARS-CoV-2. As a result, thousands of publications in dentistry on this subject have been published in the last three years. There were 8 other articles with 100 and higher citations in endodontic journals and these were about management of deep caries and the exposed pulp (35,36), the global prevalence of apical periodontitis (37) and radiographic or tomographic detection of apical lesions via deep learning (29,38), cone-beam computed tomography (39,40) and guidelines for reporting laboratory studies in Endodontology (41). Only 4 articles, which were published in other Q1 journals, reached more than 100 citations. They were about effect of deep learning on dental image diagnostics as previously stated (30), chlorhexidine (CHX) use (42), regenerative treatments (43) and inflammatory root resorption (44). It could be concluded that popularity of deep learning and regenerative endodontics topics has prominent effect on gaining citation even the studies published in non-endodontic journals.

The study revealed that USA, Brazil, PRC and UK are superior to other countries regarding endodontics studies in both articles and citation numbers. Additionally, they collaborate more than other nations do. These outcomes are consistent with those of earlier research (1,6). The developed countries' productivity and input are indicative of the mechanisms for incentives put in place by research agencies, as well as the accessibility of research grants and facilities within research institutes. Even so, it was expected that authors and affiliations from these nations would have higher citation counts. The top 3 universities in terms of article numbers in other Q1 journals are from PRC (Sichuan University, Peking University) and USA (Augusta University); the top 3 universities in terms of article numbers in endodontic journals are from Brazil (Rio Grande University, De Sao Paulo University, Federal Fluminense University). When the number of citations evaluated, Air Force Military Medical University (PRC), Augusta University (USA) and University of Pennsylvania (USA) are in the top 3 places in other Q1 journals and Rio Grande University (Brazil), Cardiff University (UK) and Federal Fluminense University (Brazil) are in the top 3 places in endodontic journals. As previously noted in multiple studies (1,6,7,19), these universities have had a significant influence on the research era not only in endodontics but in all dental specialties.

Considering authors in non-endodontic journals, Franklin Tay (h-index 92 based on WOS, Augusta University, USA) is the leading author in both article and citations numbers. In IEJ&JOE, Emmanuel J. N. L. Silva (h-index 36 based on WOS, Rio Grande University, Brazil) is the leading author considering article numbers between 2019-2023, while Paul M. H. Dummer (h-index 50 based on WOS, Cardiff University, UK) is the leading author considering citations numbers. The 1771 papers published in IEJ&JOE included contributions from 6528 authors and 1361 universities/institutes; the 574 articles published in other Q1 journals included contributions from 2934 authors and 769 universities/institutes. It has been acknowledged that increased researcher collaboration is crucial to improving the translation and application of research in practice (45). It is also important to note that it may not be necessary to have a high volume of publications to obtain many citations, for example articles published by Air Force Military Medical University (formerly Fourth Military Medical University, PRC) ranked high in the list of top 10 articles in the last 5 years considering citations, however this institution published only 10 manuscripts, less than half of the Sichuan University. Similarly, International Medical University (Malaysia) ranked high in the list of top 10 articles considering citations in the last 5 years, however this university did not take place among the top 10 universities regarding article numbers. Accordingly, an institution's high number of publications does not ensure that a work will be widely cited or influential.

The number of articles with a single author was significantly lower (3/574, 0.52%) compared to articles with

multiple authors in non-endodontic journals. Although, authors number of articles published in endodontic Q1 journals was not noted, only articles with single authors were counted. Only 15 articles (0.85%) were written by 1 author which were reviews and case report studies. The results pertaining to the tendency of multiple authors' contributions are in line with earlier research (12). Due to the complexity and high level of difficulty of modern research projects, labor allocation is essential, and a collaborative team approach is recommended to generate high-quality studies. Furthermore, another factor that most likely explains the observed proliferation of authorship is the process of academic advancement (46). Collaboration between authors from different affiliations or geographical locations is crucial for the enhancement and better documentation of manuscripts under consideration for publication in the era of evidence-based endodontics (47). A previous study reported that international collaboration has positive effect on citation rates (48). The growing complexity of research may also have an impact on cooperation due to the increased need for funding. Research with multiple authors and collaborations is dependable, according to a prior investigation (49). Thus, it can be observed that 33.5% of the included studies had international cooperation and 54.5% of the included studies had national cooperation. In nearly three out of four (73.5%) of the studies, various dental and medical specialties worked together. This is yet another outcome that highlights the rise in cooperation. It's also crucial to note that, in terms of departments, the corresponding author's department appears to be only 10% endodontics in the current study. Nonetheless, there are academic institutions where the endodontic department is integrated into the "restorative," "conservative," or "preventive dentistry" departments; in these departments, the terms "endodontics" or "endodontology" are either combined or absent. Examples of these departments are the Department of Operative Dentistry and Endodontics, the Department of Cariology and Endodontics, and the Department of Endodontics and Restorative Dentistry. Even though only endodontic journals were examined, a study conducted ten years ago also revealed similar findings (12). Regarding the advancement of endodontology and its global recognition as a dental specialty, this is a critical issue.

Regarding the field of study, included articles from other Q1 journals were classified into 11 thematic categories according to research priorities of the AAE. Results of this study have indicated that the most popular articles were those pertaining to category B, which covers the assessment of new methods for diagnosis, treatment modalities, and technology, including devices and materials as previous studies (6,12). This finding might emerge because of the financial incentive to develop and introduce new materials/devices to endodontic practice. Category I, which deals with tissue engineering and the regeneration of the pulpodentin complex and periradicular tissues, was the second area of study. As mentioned previously, dental pulp stem cells, regenerative endodontics are the popular keywords extracted form included articles in both journal groups. Category A was in the third place, and it was about assessment of clinical outcomes, which reveal the increase of evidence-based research in endodontics.

Studies were categorized as case reports/clinical techniques, reviews, and research. Previous studies (12,50) have reported that basic in vitro studies were the most common study type as in the current study. In vitro studies offer valuable insights into future study designs and clinical applications, despite being at the base of the evidence pyramid. The trend toward in vitro studies may be explained by benefits like the lack of ethical issues and the ease, affordability, and speed with which samples can be obtained and prepared (51). Compared to in vitro tests, data from animal experiments are more realistic. While studies published in the endodontics journal were not categorized by study type, it was noted that the terms rat and animal study were frequently used in the titles and abstracts of articles published in IEJ&JOE. Animal experiments were conducted in 11.5% of the included studies published in non-endodontic journals. It's commonly known that neither animal experiments nor in vitro research can accurately represent clinical settings. Consequently, the data acquired should also be supported by clinical research (52). As per the study's findings, there is a higher percentage of clinical studies—one in five—than in the previous research (18). A total of 18.3% of the studies were reviews, with the most common review types being systematic reviews (30/105) and meta-analyses (36/105). Only 4% of the studies were clinical techniques and case reports. Based on the current findings, more high-level evidence studies (meta-analyses and systematic reviews) and fewer low-level evidence studies (case reports and clinical procedures) were published in other Q1 journals. While IEJ&JOE article types were not categorized, a term search indicated that case reports/series outnumbered meta-analysis words in these two journals. Despite the apparent disparities in research direction and publication volume, this fact illustrates the excellent caliber of articles published in both journals.

The current study had a number of limitations. For example, the author's affiliation at the time of publication was used to select the countries and institutions, and the author's affiliation at current time was not disclosed. Studies performed with stem cells obtained only from dental

pulp or periapical region were included, while studies performed with other mesenchymal stem cells such as periodontal ligament stem cells were excluded. Additionally, no evaluation was done on the precise author counts, article types, or topic categories of articles published in endodontic journals. Although utmost care is taken to combine author names and universities in different forms and to combine similar keywords with thesaurus files, it may not be possible to select all forms of some author names or all forms of universities used in abbreviation. It is thought that to overcome this limitation databases need additional technological applications.

Conclusion

This analysis identified common research interests in papers published in endodontic and non-endodontic Q1 journals over the last five years. Although common topics such as periapical diseases, CBCT imaging, vital pulp therapy, artificial intelligence in endodontics, and regenerative endodontics were popular in both journal groups, it can be concluded that there is little research on post-endodontic restorations in endodontic journals and very little research on endodontic surgery in non-endodontic journals.

Research on endodontics is rarely published, especially in other Q1 journals. For future studies, there are more general journals in the second quartile, and further research could compare the impact of quartiles on the publication of endodontic research.

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