

Evolving trend of systematic reviews and meta-analyses in endodontics: A bibliometric study

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Abstract

Introduction: Endodontics is rapidly evolving with the emergence of various research publications. The present bibliometric study aimed to identify and analyze the trends of systematic reviews and meta-analyses in endodontics.

Materials and Methods: An electronic literature search using Scopus[®] and Web of Science databases was performed from January 2001 till August 2021. Only systematic reviews and meta-analyses published in English were retrieved. The following parameters were recorded and analyzed: Title, citation counts, authors, year of publication, institutions, countries, journals, type of article, source of articles, thematic categories, keywords, and source of fundings. Data were analyzed using Microsoft Excel software, Visualization of Similarities viewer software, and SPSS software with a significance level set at $P = 0.05$.

Results: Among the 149 articles included, the top-cited article was cited 184 times with 27 of them receiving more than 50 citations. 17 authors have contributed at least four publications, and most of the papers were published in 2020 ($n = 26$). Furthermore, the number of articles published increased substantially over the two decades ($P < 0.05$), but the citation counts decreased considerably ($P < 0.05$). The International Medical University Malaysia and the University of Hong Kong published the most articles, while Brazil was the most prolific country. The Journal of Endodontics published the most articles ($n = 46$) and more than half of the articles were published in Quartile 1 and Quartile 2 journals. The bulk of articles were published dealing with clinical or radiographic outcomes.

Conclusion: This study revealed significant information on the trends of systematic reviews and meta-analyses in endodontics providing a comprehensive understanding and direction of future research.

Keywords: Bibliographic database, citation analysis, dental informatics, endodontics, root canal

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INTRODUCTION

Scientometrics, also referred to as scientific mapping, is a method of studying a vast body of bibliographic data and measuring various types of scientific activity that are frequently used in conjunction with data visualization. To examine the evolution of many disciplines in science, scientometricians have integrated numerous approaches from scientometrics, data visualization, and text analytics.^[1] On the other hand, a bibliometric analysis is a statistical study of written publications that uses quantitative techniques to assess research subjects, research state, and publication quality.^[2] Bibliometrics is also the study of strategies for retrieving and statistically analyzing quantifiable data in scholarly papers. It allows researchers to rapidly summarize and visualize the structure of a collection of publications and suggests prospective future research directions.^[1]

Evidence-based healthcare necessitates up-to-date syntheses of existing evidence.^[3] With the current advancement of technology, the appearance of new treatment options, new diagnostic tools, and the volume of articles with overwhelming amounts of new evidence, it is difficult for clinicians to incorporate research into practice as it is time-consuming.^[4] Hence, systematic reviews are useful tools for clinicians, patients, and decision-makers to summarize and synthesize the available evidence related to diagnosis, therapy, and prognosis. Systematic reviews are described as reviews of the existing evidence on an explicitly articulated research topic that apply systematic techniques to identify and critically review selected studies, incorporate and synthesize the included research papers, as part of evidence-based healthcare studies.^[5] This type of evaluation incorporated with meta-analysis is one of the most effective methods in translating knowledge into practice. It incorporates data from several studies using clear and transparent techniques, eliminating the need for decision-makers to review, interpret, and synthesize findings from multiple studies.^[5,6]

Endodontics has evolved tremendously in recent years, as seen by an increase in the number of articles in the endodontic literature. The first bibliometric analysis in endodontics was published in 2011, which identified the top 100 most-cited articles from five different endodontics-related journals.^[7] Another bibliometric study was conducted later in 2015 to analyze and categorize papers published between 2009 and 2013 into sixteen thematic categories. It was observed that the number of reviews published in the two most prestigious endodontic journals (Journal of Endodontics and International

Endodontic Journal) increased significantly, indicating a shift in the endodontic literature toward evidence-based endodontics.^[8] Thus, identifying and analyzing trends of systematic reviews and meta-analyses in endodontics may aid in comprehending the field and direct future research. To the best of the author's knowledge, no bibliometric analysis has been conducted to determine the evolving trend of systematic reviews and meta-analyses in endodontics. Hence, the goal of the present analysis was to determine the characteristics of systematic reviews and meta-analyses in endodontics and offer insight into current and historical publishing patterns in the field.

MATERIALS AND METHODS

Search strategy

An electronic literature search using Scopus® and Thomas Reuter's Web of Science – Science Citation Index Expanded (SCIE) databases was conducted by two independent investigators (GSSL, JZL) in September 2021 to identify the published systematic reviews and meta-analyses in endodontics. The following search equation was applied: TITLE-ABS-KEY (((endodontics) OR (endodontic) OR (root AND canal) OR (root AND canals)) AND ((systematic AND review) OR (meta AND analysis))) and confined to the “final” stage of publication in the category of “Dentistry” and “Dentistry, Oral Surgery and Medicine” for Scopus® and Web of Science databases, respectively. Only systematic reviews with or without meta-analysis in the field of endodontics published in English between January 2001 and August 2021 were included. Original research articles, literature reviews, scoping reviews, umbrella reviews, case reports, case series, commentaries, editorials, letters to the editor, conference abstracts, and opinions were excluded. Furthermore, the number of publications and journals that may be included was not restricted. Any disagreements about articles that may be included or excluded during the search were discussed with the assistance of the third and fourth investigators (WXC, MCKC) who are senior investigators. The total citations, citation density, journal impact, and ranking of each selected article were determined using the Journal Citation Reports (JCR) and SCImago Journal and Country Rank (SJR) databases.

Data collection

Data extraction after the full-text assessment was performed by the other two investigators independently (CSL, MCKC). The following parameters were extracted from each article: Title of the articles, author's name (s), number of author (s), year of publication, institution (s) or affiliation (s), country (s), name of journal (s), types of

articles, thematic categories, sources of articles, keywords, and number of citations. The authors' names were manually revised and normalized to avoid typographical, transcribing, and/or indexing flaws, as well as to standardize terminology. If more than one entry for the same author was found, the author's institutional affiliations were checked to determine if the entries belonged to the same individual. The articles were sorted in descending order based on the number of citations they received. If two articles had the same citation number, the one with a higher impact factor (IF) or JCR score was ranked first. The number of articles published was also used to rank the institutions, countries, and journals.

The types of articles were divided into either systematic review only or systematic review with meta-analysis. Each article was further classified into twelve thematic categories, including microbiology, pulp biology or pathology, root canal morphology, chemical preparation, mechanical preparation and instrumentation, working length determination, obturation, endodontic materials, restorations, endodontic surgery, epidemiological studies, and clinical or radiographic outcomes.^[8] Articles that did not fall into one of these categories were classified as "others." The classification of thematic categories was calibrated for all four investigators (JZL, WXC, MCKC, CSL), and any discrepancies were discussed with the fifth and sixth investigators (GSSL, TYN). The first author's affiliation was used to determine the sources of the article. They were also divided into "academic" for research publications from universities and "non-academic" for articles from private practices or groups. Each article's financial source was also listed.

Data analysis

Descriptive analysis was performed using the Microsoft Excel software (One Microsoft Way Redmond, WA 98052-6399, USA). The Visualization of Similarities viewer (VOSviewer) software (VOSviewer v. 1.6.15; Centre for Science and Technology Studies, Leiden University, Netherlands) was used to create bibliographic networks based on co-authorships and keyword co-occurrences. The minimum number of articles by an author was set to two, while the minimum number of co-occurrences of keyword was set to eight. The size of the node showed how often co-authorships or keyword co-occurrences occurred. Meanwhile, the colors of the nodes reflect the various clusters to which the analyzed objects belonged. A *t*-test was performed with a significant level set at $P = 0.05$ to assess the possible significant differences in publication and citation count parameters over two timeframes (2001–2010 and 2011–2021). Data analysis

was performed using SPSS version 24.0 software (IBM, Armonk, NY, USA).

RESULTS

A total of 184 articles were chosen from primary research, but only 149 of the 184 articles were eligible for further analysis after a thorough full-text assessment. Table 1 shows all the 149 articles sorted by the number of citations in descending order. The article with the most citations was "Outcomes of nonsurgical retreatment and endodontic surgery: A systematic review," cited 184 (Scopus) and 153 (WOS) times, with a citation density of 15.33.^[9] This is followed by the second most-cited article entitled "Outcome of secondary root canal treatment: A systematic review of the literature" with 182 (Scopus) and 168 (WOS) citations, and a citation density of 14.^[10] The third most-cited article was "Tooth survival following non-surgical root canal treatment: A systematic review of the literature" with 182 (Scopus) and 159 (WOS) citations, and a citation density of 16.55.^[11] In addition, five articles were found to have a citation density >15,^[12-16] despite not being the top-three most-cited articles. Only 27 of the chosen articles received more than 50 citations, making them citation classics, and ranking in the top 18.1%. On the other hand, 20 articles had no citation.

Authors, year of publication, institutions, country

Lists the authors [Table 2] who have published at least four articles on systematic review and metal analysis in endodontics [Appendix 1]. A total of 17 authors had contributed at least four publications. The author with the greatest number of publications was Shane N. White (8 articles), followed by Venkateshbabu Nagendrababu (7 articles), and Emmanuel João Nogueira Leal Silva (6 articles) [Figure 1a]. In contrast, Mahmoud Torabinejad was the first author with the most publications ($n = 5$), followed by Jorge N. R. Martins and Prasanna Neelakantan, each with four articles as first author [Figure 1b]. The trend of authorships among the selected articles is illustrated in Figure 2, with the mean number of authors being 4.9, the median being 5, and a range of 1–13 authors. The state-wise distribution of publications also revealed the maximum number of authors was 6 (22.1%), followed by five authors (20.3%) and three authors (17.4%). A collaboration network was created for co-authors who contributed two or more articles from the chosen article list [Figure 3]. Among the 583 authors, only 29 authors met the threshold. The node size represents the number of articles each author has published, while the joining lines reflect the strength of their cooperation. The co-authorship bibliometric network revealed four

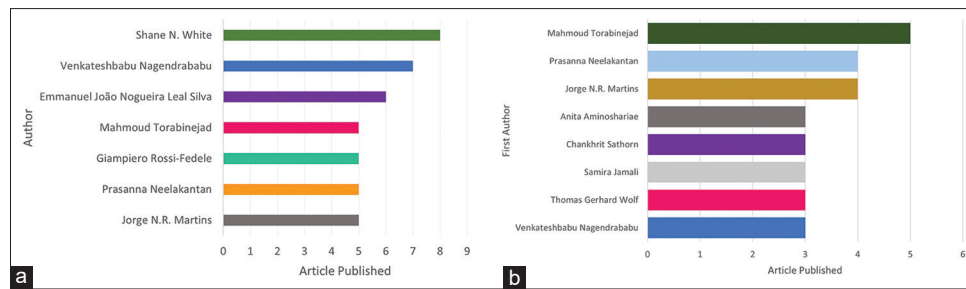


Figure 1: (a). Authors with five or more articles published. (b). First authors with at least three articles published

Table 1: The most-cited articles based on the citation counts

Rank	Article	Citations (scopus)	Citations (WOS)	CD
1	Torabinejad M, Corr R, Handysides R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: A systematic review. J Endod 2009;35:930-7.	184	153	15.33
2	Ng YL, Mann V, Gulabivala K. Outcome of secondary root canal treatment: A systematic review of the literature. Int Endod J 2008;41:1026-46.	182	168	14.00
3	Ng YL, Mann V, Gulabivala K. Tooth survival following non-surgical root canal treatment: A systematic review of the literature. Int Endod J 2010;43:171-89.	182	159	16.55
4	Sathorn C, Parashos P, Messer H. The prevalence of postoperative pain and flare-up in single- and multiple-visit endodontic treatment: A systematic review. Int Endod J 2008;41:91-9.	164	129	12.62
5	Shahravan A, Haghdoust AA, Adl A, Rahimi H, Shadifar F. Effect of smear layer on sealing ability of canal obturation: A systematic review and meta-analysis. J Endod 2007;33:96-105.	163	126	11.64
6	Torabinejad M, Anderson P, Bader J, Brown LJ, Chen LH, Goodacre CJ, et al. Outcomes of root canal treatment and restoration, implant-supported single crowns, fixed partial dentures, and extraction without replacement: A systematic review. J Prosthet Dent 2007;98:285-311.	163	143	11.64
7	Pak JG, White SN. Pain prevalence and severity before, during, and after root canal treatment: A systematic review. J Endod 2011;37:429-38.	161	140	16.10
8	Gillen BM, Looney SW, Gu LS, Loushine BA, Weller RN, Loushine RJ, et al. Impact of the quality of coronal restoration versus the quality of root canal fillings on success of root canal treatment: A systematic review and meta-analysis. J Endod 2011;37:895-902.	152	143	15.20
9	Sarkis-Onofre R, Skupien JA, Cenci MS, Moraes RR, Pereira-Cenci T. The role of resin cement on bond strength of glass-fiber posts luted into root canals: A systematic review and metaanalysis of <i>in vitro</i> studies. Oper Dent 2014;39:E31-44.	140	89	20.00
10	Sathorn C, Parashos P, Messer H. Antibacterial efficacy of calcium hydroxide intracanal dressing: A systematic review and meta-analysis. Int Endod J 2007;40:2-10.	121	93	8.64
11	Tsesis I, Rosen E, Taschieri S, Telishevsky Strauss Y, Ceresoli V, Del Fabbro M. Outcomes of surgical endodontic treatment performed by a modern technique: An updated meta-analysis of the literature. J Endod 2013;39:332-9.	115	91	14.38
12	Sathorn C, Parashos P, Messer HH. Effectiveness of single- versus multiple-visit endodontic treatment of teeth with apical periodontitis: A systematic review and meta-analysis. Int Endod J 2005;38:347-55.	110	89	6.88
13	Setzer FC, Kohli MR, Shah SB, Karabucak B, Kim S. Outcome of endodontic surgery: A meta-analysis of the literature - Part 2: Comparison of endodontic microsurgical techniques with and without the use of higher magnification. J Endod 2012;38:1-10.	103	99	11.44
14	Pak JG, Fayazi S, White SN. Prevalence of periapical radiolucency and root canal treatment: A systematic review of cross-sectional studies. J Endod 2012;38:1170-6.	102	85	11.33
15	Peng L, Ye L, Tan H, Zhou X. Outcome of root canal obturation by warm gutta-percha versus cold lateral condensation: A meta-analysis. J Endod 2007;33:106-9.	94	75	6.71
16	Figini L, Lodi G, Gorni F, Gagliani M. Single versus multiple visits for endodontic treatment of permanent teeth: A cochrane systematic review. J Endod 2008;34:1041-7.	89	67	6.85
17	Nixdorf DR, Moana-Filho EJ, Law AS, McGuire LA, Hodges JS, John MT. Frequency of persistent tooth pain after root canal therapy: A systematic review and meta-analysis. J Endod 2010;36:224-30.	88	71	8.00
18	Zhang C, Du J, Peng Z. Correlation between <i>Enterococcus faecalis</i> and persistent intraradicular infection compared with primary intraradicular infection: A systematic review. J Endod 2015;41:1207-13.	85	77	14.17
19	Panitvisai P, Parunnit P, Sathorn C, Messer HH. Impact of a retained instrument on treatment outcome: A systematic review and meta-analysis. J Endod 2010;36:775-80.	74	71	6.73
20	Chala S, Abouqal R, Rida S. Apexification of immature teeth with calcium hydroxide or mineral trioxide aggregate: Systematic review and meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:e36-42.	68	51	6.80
21	Chrepa V, Kotsakis GA, Pagonis TC, Hargreaves KM. The effect of photodynamic therapy in root canal disinfection: A systematic review. J Endod 2014;40:891-8.	67	60	9.57
22	Torabinejad M, Nosrat A, Verma P, Udochukwu O. Regenerative endodontic treatment or mineral trioxide aggregate apical plug in teeth with necrotic pulps and open apices: A systematic review and meta-analysis. J Endod 2017;43:1806-20.	63	63	15.75
23	Almeida LH, Moraes RR, Morgental RD, Pappen FG. Are premixed calcium silicate-based endodontic sealers comparable to conventional materials? A systematic review of <i>in vitro</i> studies. J Endod 2017;43:527-35.	63	39	15.75

Contd...

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Rank	Article	Citations (scopus)	Citations (WOS)	CD
24	Stavropoulou AF, Koidis PT. A systematic review of single crowns on endodontically treated teeth. J Dent 2007;35:761-7.	59	47	4.21
25	Nixdorf DR, Moana-Filho EJ, Law AS, McGuire LA, Hodges JS, John MT. Frequency of nonodontogenic pain after endodontic therapy: A systematic review and meta-analysis. J Endod 2010;36:1494-8.	58	52	5.27
26	Caviedes-Bucheli J, Castellanos F, Vasquez N, Ulate E, Munoz HR. The influence of two reciprocating single-file and two rotary-file systems on the apical extrusion of debris and its biological relationship with symptomatic apical periodontitis. A systematic review and meta-analysis. Int Endod J 2016;49:255-70.	56	44	11.20
27	Guivarc'h M, Ordioni U, Ahmed HM, Cohen S, Catherine JH, Bukiet F. Sodium hypochlorite accident: A systematic review. J Endod 2017;43:16-24.	51	34	12.75
28	AlShwaimi E, Bogari D, Ajaj R, Al-Shahrani S, Almas K, Majeed A. <i>In vitro</i> antimicrobial effectiveness of root canal sealers against <i>Enterococcus faecalis</i> : A systematic review. J Endod 2016;42:1588-97.	46	34	9.20
29	Gonçalves LS, Rodrigues RC, Andrade Junior CV, Soares RG, Vettore MV. The effect of sodium hypochlorite and chlorhexidine as irrigant solutions for root canal disinfection: A systematic review of clinical trials. J Endod 2016;42:527-32.	46	44	9.20
30	Estrela C, Silva JA, de Alencar AH, Leles CR, Decurcio DA. Efficacy of sodium hypochlorite and chlorhexidine against <i>Enterococcus faecalis</i> – A systematic review. J Appl Oral Sci 2008;16:364-8.	46	39	3.54
31	Alqaderi H, Lee CT, Borzangy S, Pagonis TC. Coronal pulpotomy for cariously exposed permanent posterior teeth with closed apices: A systematic review and meta-analysis. J Dent 2016;44:1-7.	44	41	8.80
32	Talwar S, Utneja S, Nawal RR, Kaushik A, Srivastava D, Oberoy SS. Role of cone-beam computed tomography in diagnosis of vertical root fractures: A systematic review and meta-analysis. J Endod 2016;42:12-24.	43	44	8.60
33	Berlin S, Utneja S, Nawal RR, Kaushik A, Srivastava D, Oberoy SS. Role of cone-beam computed tomography in dA systematic review of the literature. Int Endod J 2017;50:847-59.	42	45	10.50
34	Peterson J, Gutmann JL. The outcome of endodontic resurgery: A systematic review. Int Endod J 2001;34:169-75.	36	45	1.80
35	Smith EA, Marshall JG, Selph SS, Barker DR, Sedgley CM. Nonsteroidal anti-inflammatory drugs for managing postoperative endodontic pain in patients who present with preoperative pain: A systematic review and meta-analysis. J Endod 2017;43:7-15.	36	30	9.00
36	Virdee SS, Seymour DW, Farnell D, Bhamra G, Bhakta S. Efficacy of irrigant activation techniques in removing intracanal smear layer and debris from mature permanent teeth: A systematic review and meta-analysis. Int Endod J 2018;51:605-21.	33	26	11.00
37	Torabinejad M, Dinsbach NA, Turman M, Handysides R, Bahjri K, White SN. Survival of intentionally replanted teeth and implant-supported single crowns: A systematic review. J Endod 2015;41:992-8.	32	29	5.33
38	Segura-Egea JJ, Martín-González J, Cabanillas-Balsera D, Fouad AF, Velasco-Ortega E, López-López J. Association between diabetes and the prevalence of radiolucent periapical lesions in root-filled teeth: systematic review and meta-analysis. Clin Oral Invest 2016;20:1133-41.	32	30	6.40
39	Fernandez Yanez Sanchez Á, Leco Berrocal MI, Martínez González JM. Metaanalysis of filler materials in periapical surgery. Med Oral Patol Oral Cir Bucal 2008;13:180-5.	32	26	2.46
40	Siew K, Lee AH, Cheung GS. Treatment outcome of repaired root perforation: A systematic review and meta-analysis. J Endod 2015;41:1795-804.	31	5	5.17
41	Wong AW, Zhang C, Chu CH. A systematic review of nonsurgical single-visit versus multiple-visit endodontic treatment. Clin Cosmet Invest Dent 2014;6:45-56.	31	/	4.43
42	Collares FM, Portella FF, Rodrigues SB, Celeste RK, Leitune VC, Samuel SM. The influence of methodological variables on the push-out resistance to dislodgement of root filling materials: A meta-regression analysis. Int Endod J 2015;49:836-49.	30	16	5.00
43	Moraes A, Sarkis-Onofre R, Moraes R, Cenci M, Soares C, Pereira-Cenci T. Can silanization increase the retention of glass-fiber posts? A systematic review and meta-analysis of <i>in vitro</i> studies. Oper Dent 2015;40:567-80.	30	26	5.00
44	Aminoshariae A, Kulild J. Master apical file size – smaller or larger: A systematic review of microbial reduction. Int Endod J 2015;48:1007-22.	28	24	4.67
45	Ethem Yaylali I, Kececi AD, Ureyen Kaya B. Ultrasonically activated irrigation to remove calcium hydroxide from apical third of human root canal system: A systematic review of <i>in vitro</i> studies. J Endod 2015;41:1589-99.	28	25	4.67
46	Ribeiro DM, Réus JC, Felipe WT, Pacheco-Pereira C, Dutra KL, Santos JN, et al. Technical quality of root canal treatment performed by undergraduate students using hand instrumentation: A meta-analysis. Int Endod J 2018;51:269-83.	27	23	9.00
47	Altmann AS, Leitune VC, Collares FM. Influence of eugenol-based sealers on push-out bond strength of fiber post luted with resin cement: Systematic review and meta-analysis. J Endod 2015;41:1418-23.	27	20	4.50
48	Tsesis I, Blazer T, Ben-Izhack G, Taschieri S, Del Fabbro M, Corbella S, et al. The precision of electronic apex locators in working length determination: A systematic review and meta-analysis of the literature. J Endod 2015;41:1818-23.	27	16	4.50
49	Saatchi M, Shokraneh A, Navaei H, Maracy MR, Shojaei H. Antibacterial effect of calcium hydroxide combined with chlorhexidine on <i>Enterococcus faecalis</i> : A systematic review and meta-analysis. J Appl Oral Sci 2014;22:356-65.	25	18	3.57
50	Persoon IF, Crielaard W, Özok AR. Prevalence and nature of fungi in root canal infections: A systematic review and meta-analysis. Int Endod J 2017;50:1055-66.	23	23	5.75
51	Tang Y, Li X, Yin S. Outcomes of MTA as root-end filling in endodontic surgery: A systematic review. Quintessence Int 2010;41:557-66.	23	23	2.09

Contd...

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Rank	Article	Citations (scopus)	Citations (WOS)	CD
52	Del Fabbro M, Afrashtehfar KI, Corbella S, El-Kabbaney A, Perondi I, Taschieri S. <i>In vivo</i> and <i>in vitro</i> effectiveness of rotary nickel-titanium vs. manual stainless-steel instruments for root canal therapy: Systematic review and meta-analysis. J Evid Based Dent Pract 2018;18:59-69.	22	22	7.33
53	Martins JN, Marques D, Silva EJ, Caramês J, Mata A, Versiani MA. Prevalence of C-shaped canal morphology using cone beam computed tomography – A systematic review with meta-analysis. Int Endod J 2019;52:1556-72.	21	16	10.50
54	Li Y, Sui B, Dahl C, Bergeron B, Shipman P, Niu L, et al. Pulpotomy for carious pulp exposures in permanent teeth: A systematic review and meta-analysis. J Dent 2019;84:1-8.	21	22	10.50
55	Nagendrababu V, Jayaraman J, Suresh A, Kalyanasundaram S, Neelakantan P. Effectiveness of ultrasonically activated irrigation on root canal disinfection: A systematic review of in vitro studies. Clin Oral Invest 2018;22:655-70.	21	16	7.00
56	Zhu Z, Dong XY, He S, Pan X, Tang L. Effect of post placement on the restoration of endodontically treated teeth: A systematic review. Int J Prosthodont 2015;28:475-83.	20	16	3.33
57	Fransson H, Larsson KM, Wolf E. Efficacy of lasers as an adjunct to chemo-mechanical disinfection of infected root canals: A systematic review. Int Endod J 2013;46:296-307.	19	19	2.38
58	Gundappa M, Bansal R, Khoriya S, Mohan R. Root canal centering ability of rotary cutting nickel titanium instruments: A meta-analysis. J Conserv Dent 2014;17:504-9.	18	/	2.57
59	Hamedy R, Shakiba B, Pak JG, Barbizam JV, Ogawa RS, White SN. Prevalence of root canal treatment and periapical radiolucency in elders: A systematic review. Gerodontology 2016;33:116-27.	16	11	3.20
60	Cabanillas-Balsera D, Martín-González J, Montero-Mirallès P, Sánchez-Domínguez B, Jiménez-Sánchez MC, Segura-Egea JJ. Association between diabetes and nonretention of root filled teeth: A systematic review and meta-analysis. Int Endod J 2019;52:297-306.	15	19	7.50
61	Kohli MR, Berenji H, Setzer FC, Lee SM, Karabucak B. Outcome of endodontic surgery: A meta-analysis of the literature – Part 3: Comparison of endodontic microsurgical techniques with 2 different root-end filling materials. J Endod 2018;44:923-31.	15	14	5.00
62	Martins JN, Marques D, Silva EJ, Caramês J, Mata A, Versiani MA. Second mesiobuccal root canal in maxillary molars – A systematic review and meta-analysis of prevalence studies using cone beam computed tomography. Arch Oral Biol 2020;113:104589.	15	10	15.00
63	Martinho FC, de Rabello DG, Ferreira LL, Nascimento GG. Participation of endotoxin in root canal infections: A systematic review and meta-analysis. Eur J Dent 2017;11:398-406.	15	/	3.75
64	Nagendrababu V, Pulikkotil SJ, Suresh A, Veettil SK, Bhatia S, Setzer FC. Efficacy of local anaesthetic solutions on the success of inferior alveolar nerve block in patients with irreversible pulpitis: A systematic review and network meta-analysis of randomized clinical trials. Int Endod J 2019;52:779-89.	14	18	7.00
65	Jakovljevic A, Nikolic N, Jacimovic J, Pavlovic O, Milicic B, Beljic-Ivanovic K, et al. Prevalence of apical periodontitis and conventional nonsurgical root canal treatment in general adult population: An updated systematic review and meta-analysis of cross-sectional studies published between 2012 and 2020. J Endod 2020;46:1371-86.e8.	14	21	14.00
66	Sun C, Sun J, Tan M, Hu B, Gao X, Song J. Pain after root canal treatment with different instruments: A systematic review and meta-analysis. Oral Dis 2018;24:908-19.	14	12	4.67
67	Torabinejad M, Lozada J, Puterman I, White SN. Endodontic therapy or single tooth implant? A systematic review. J Calif Dent Assoc 2008;36:429-37.	14	/	1.08
68	Nagendrababu V, Pulikkotil SJ, Jinatongthai P, Veettil SK, Teerawattananpong N, Gutmann JL. Efficacy and safety of oral premedication on pain after nonsurgical root canal treatment: A systematic review and network meta-analysis of randomized controlled trials. J Endod 2019;45:364-71.	13	16	6.50
69	Tupyota P, Chailertvanitkul P, Laopaiboon M, Ngamjarus C, Abbott PV, Krisanaprakornkit S. Supplementary techniques for pain control during root canal treatment of lower posterior teeth with irreversible pulpitis: A systematic review and meta-analysis. Aust Endod J 2018;44:14-25.	13	15	4.33
70	Serrano-Giménez M, Sánchez-Torres A, Gay-Escoda C. Prognostic factors on periapical surgery: A systematic review. Med Oral Patol Oral Cir Bucal 2015;20:e715-22.	13	13	2.17
71	Neelakantan P, Ahmed HM, Wong MC, Matinlinna JP, Cheung GS. Effect of root canal irrigation protocols on the dislocation resistance of mineral trioxide aggregate-based materials: A systematic review of laboratory studies. Int Endod J 2018;51:847-61.	12	10	4.00
72	Hartmann RC, Fensterseifer M, Peters OA, de Figueiredo JA, Gomes MS, Rossi-Fedele G. Methods for measurement of root canal curvature: A systematic and critical review. Int Endod J 2019;52:169-80.	12	11	6.00
73	Khan S, Hamedy R, Lei Y, Ogawa RS, White SN. Anxiety related to nonsurgical root canal treatment: A systematic review. J Endod 2016;42:1726-36.	12	12	2.40
74	Mergoni G, Percudani D, Lodi G, Bertani P, Manfredi M. Prevalence of <i>Candida</i> species in endodontic infections: Systematic review and meta-analysis. J Endod 2018;44:1616-25.e9.	11	12	3.67
75	Metterska J, Fagogeni I, Nowicka A. Efficacy of autologous platelet concentrates in regenerative endodontic treatment: A systematic review of human studies. J Endod 2019;45:20-30.e1.	11	12	5.50
76	Gorman CM, Ray NJ, Burke FM. The effect of endodontic access on all-ceramic crowns: A systematic review of <i>in vitro</i> studies. J Dent 2016;53:22-9.	11	11	2.20
77	Shirvani A, Shamszadeh S, Eghbal M, Asgary S. The efficacy of non-narcotic analgesics on post-operative endodontic pain: A systematic review and meta-analysis: The efficacy of non-steroidal anti-inflammatory drugs and/or paracetamol on post-operative endodontic pain. J Oral Rehabil 2017;44:709-21.	11	10	2.75

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Rank	Article	Citations (scopus)	Citations (WOS)	CD
78	Martins CM, Batista VE, Souza AC, Andrada AC, Mori GG, Filho JE. Reciprocating kinematics leads to lower incidences of postoperative pain than rotary kinematics after endodontic treatment: A systematic review and meta-analysis of randomized controlled trial. <i>J Conserv Dent</i> 2019;22:320-31.	11	/	5.50
79	Romualdo PC, de Oliveira KM, Nemezio MA, Küchler EC, Silva RA, Nelson-Filho P, et al. Does apical negative pressure prevent the apical extrusion of debris and irrigant compared with conventional irrigation? A systematic review and meta-analysis. <i>Aust Endod J</i> 2017;43: 129-37.	10	8	2.50
80	Nogueira BM, Silva LG, Mesquita CR, Menezes SA, Menezes TO, Faria AG, et al. Is the use of dexamethasone effective in controlling pain associated with symptomatic irreversible pulpitis? A systematic review. <i>J Endod</i> 2018;44:703-10.	9	9	3.00
81	Neelakantan P, Herrera DR, Pecorari VG, Gomes BP. Endotoxin levels after chemomechanical preparation of root canals with sodium hypochlorite or chlorhexidine: A systematic review of clinical trials and meta-analysis. <i>Int Endod J</i> 2019;52:19-27.	9	9	4.50
82	Shakiba B, Hamedy R, Pak JG, Barbizam JV, Ogawa R, White SN. Influence of increased patient age on longitudinal outcomes of root canal treatment: A systematic review. <i>Gerodontology</i> 2017;34:101-9.	9	9	2.25
83	Ong TK, Lim GS, Singh M, Fial AV. Quantitative assessment of root development after regenerative endodontic therapy: A systematic review and meta-analysis. <i>J Endod</i> 2020;46:1856-66.e2.	8	9	8.00
84	Plotino G, Nagendrababu V, Bukiet F, Grande NM, Veettil SK, De-Deus G, et al. Influence of negotiation, glide path, and preflaring procedures on root canal shaping – Terminology, basic concepts, and a systematic review. <i>J Endod</i> 2020;46:707-29.	8	9	8.00
85	Iranmanesh F, Pariohkh M, Haghdoust AA, Abbott PV. Effect of corticosteroids on pain relief following root canal treatment: A systematic review. <i>Iran Endod J</i> 2017;12:123-30.	8	/	2.00
86	Suneelkumar C, Subha A, Gogala D. Effect of preoperative corticosteroids in patients with symptomatic pulpitis on postoperative pain after single-visit root canal treatment: A systematic review and meta-analysis. <i>J Endod</i> 2018;44:1347-54.	7	5	2.33
87	Borges Silva EA, Guimarães LS, Küchler EC, Antunes LA, Antunes LS. Evaluation of effect of foraminal enlargement of necrotic teeth on postoperative symptoms: A systematic review and meta-analysis. <i>J Endod</i> 2017;43:1969-77.	7	7	1.75
88	Martins JN, Marques D, Leal Silva EJ, Caramês J, Mata A, Versiani MA. Influence of demographic factors on the prevalence of a second root canal in mandibular anterior teeth – A systematic review and meta-analysis of cross-sectional studies using cone beam computed tomography. <i>Arch Oral Biol</i> 2020;116:104749.	7	8	7.00
89	Pinto K, Ferreira C, Maia L, Sassone L, Fidalgo T, Silva E. Does tobacco smoking predispose to apical periodontitis and endodontic treatment need? A systematic review and meta analysis. <i>Int Endod J</i> 2020;53:1068-83.	6	8	6.00
90	Yaylali IE, Demirci GK, Kurnaz S, Celik G, Kaya BU, Tunca YM. Does maintaining apical patency during instrumentation increase postoperative pain or flare-up rate after nonsurgical root canal treatment? A systematic review of randomized controlled trials. <i>J Endod</i> 2018;44:1228-36.	6	4	2.00
91	Neelakantan P, Liu P, Dummer PM, McGrath C. Oral health-related quality of life (OHRQoL) before and after endodontic treatment: A systematic review. <i>Clin Oral Invest</i> 2020;24:25-36.	6	7	6.00
92	Wong AW, Zhang S, Li SK, Zhang C, Chu CH. Clinical studies on core-carrier obturation: A systematic review and meta-analysis. <i>BMC Oral Health</i> 2017;17:167.	6	5	1.50
93	Leong DJ, Yap AU. Quality of life of patients with endodontically treated teeth: A systematic review. <i>Aust Endod J</i> 2020;46:130-9.	6	7	6.00
94	Wei X, Hu B, Peng H, Tang M, Song J. The incidence of dentinal cracks during root canal preparations with reciprocating single-file and rotary-file systems: A meta-analysis. <i>Dent Mater J</i> 2017;36:243-52.	6	4	1.50
95	Dos Santos LG, Chisini LA, Springmann CG, de Souza BD, Pappen FG, Demarco FF, et al. Alternative to avoidtooth discoloration after regenerative endodontic procedure: A systematic review. <i>Braz Dent J</i> 2018;29:409-18.	6	/	2.00
96	Najjar RS, Alamoudi NM, El-Housseiny AA, Al Tuwiriq AA, Sabbagh HJ. A comparison of calcium hydroxide/iodoform paste and zinc oxide eugenol as root filling materials for pulpectomy in primary teeth: A systematic review and meta-analysis. <i>Clin Exp Dent Res</i> 2019;5:294-310.	6	/	3.00
97	Silva EJ, Prado MC, Soares DN, Hecksher F, Martins JN, Fidalgo TK. The effect of ozone therapy in root canal disinfection: A systematic review. <i>Int Endod J</i> 2020;53:317-32.	5	8	5.00
98	Tibúrcio-Machado CS, Michelon C, Zanatta FB, Gomes MS, Marin JA, Bier CA. The global prevalence of apical periodontitis: A systematic review and meta-analysis. <i>Int Endod J</i> 2021;54:712-35.	5	9	0.00
99	Ruksakiet K, Hanák L, Farkas N, Hegyi P, Sadaeng W, Czumbel LM, et al. Antimicrobial efficacy of chlorhexidine and sodium hypochlorite in root canal disinfection: A systematic review and meta-analysis of randomized controlled trials. <i>J Endod</i> 2020;46:1032-41.e7.	5	8	5.00
100	Aminoshariae A, Kulild J, Gutmann J. The association between smoking and periapical periodontitis: A systematic review. <i>Clin Oral Invest</i> 2020;24:533-45.	5	6	5.00
101	Dioguardi M, Sovereto D, Illuzzi G, Laneve E, Raddato B, Arena C, et al. Management of instrument sterilization workflow in endodontics: A systematic review and meta-analysis. <i>Int J Dent</i> 2020;2020:5824369.	5	/	5.00
102	Vieira W, Paranhos L, Cericato G, Franco A, Ribeiro M. Is mepivacaine as effective as lidocaine during inferior alveolar nerve blocks in patients with symptomatic irreversible pulpitis? A systematic review and meta-analysis. <i>Int Endod J</i> 2018;51:1104-17.	4	6	1.33

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Rank	Article	Citations (scopus)	Citations (WOS)	CD
103	Decurcio DA, Lim E, Chaves GS, Nagendrababu V, Estrela C, Rossi-Fedele G. Pre-clinical endodontic education outcomes artificial versus extracted natural teeth: A systematic review. <i>Int Endod J</i> 2019;52:1153-61.	4	7	2.00
104	Abdulrab S, Rodrigues JC, Al-maweri SA, Halboub E, Alqutaibi AY, Alhadainy H. Effect of apical patency on postoperative pain: A meta-analysis. <i>J Endod</i> 2018;44:1467-73.	4	1	1.33
105	Decurcio DA, Rossi-Fedele G, Estrela C, Pulikkotil SJ, Nagendrababu V. Machine-assisted agitation reduces postoperative pain during root canal treatment: A systematic review and meta-analysis from randomized clinical trials. <i>J Endod</i> 2019;45:387-93.e2.	4	4	2.00
106	Olivieri JG, Elmsmari F, Miró Q, Ruiz XF, Krell KV, García-Font M, et al. Outcome and survival of endodontically treated cracked posterior permanent teeth: A systematic review and meta-analysis. <i>J Endod</i> 2020;46:455-63.	4	3	4.00
107	Silva EJ, Canabarro A, Andrade MR, Cavalcante DM, Von Stetten O, Fidalgo TK, et al. Dislodgment resistance of bioceramic and epoxy sealers: A systematic review and meta-analysis. <i>J Evid Based Dent Pract</i> 2019;19:221-35.	4	4	2.00
108	Leong DJ, de Souza NN, Sultana R, Yap AU. Outcomes of endodontically treated cracked teeth: A systematic review and meta-analysis. <i>Clin Oral Invest</i> 2020;24:465-73.	4	5	4.00
109	Neelakantan P, Ahmed HM, Chang JW, Nabhan MS, Wei X, Cheung GS, et al. Effect of instrumentation systems on endotoxin reduction from root canal systems: A systematic review of clinical studies and meta-analysis. <i>Aust Endod J</i> 2019;45:407-13.	4	5	2.00
110	Nguyen D, Nagendrababu V, Pulikkotil SJ, Rossi-Fedele G. Effect of occlusal reduction on postendodontic pain: A systematic review and meta-analysis of randomised clinical trials. <i>Aust Endod J</i> 2020;46:282-94.	4	5	4.00
111	Sivaramakrishnan G, Sridharan K. Oral ketorolac with inferior alveolar nerve block for irreversible pulpitis: A systematic review and meta-analysis. <i>Open Dent J</i> 2018;12:340-6.	4	/	1.33
112	Ahmed HM, Rossi-Fedele G. Preferred reporting items for root and canal anatomy in the human dentition (PROUD 2020) – A systematic review and a proposal for a standardized protocol. <i>Eur Endod J</i> 2020;5:159.	4	/	4.00
113	Gupta A, Aggarwal V, Mehta N, Abraham D, Singh A. Diabetes mellitus and the healing of periapical lesions in root filled teeth: A systematic review and meta-analysis. <i>Int Endod J</i> 2020;53:1472-84.	3	3	3.00
114	Wolf TG, Kozaczek C, Campus G, Paqué F, Wierichs RJ. Root canal morphology of 116 maxillary second premolars by micro-computed tomography in a mixed Swiss-German population with systematic review. <i>J Endod</i> 2020;46:1639-47.	3	2	3.00
115	Bohrer TC, Fontana PE, Lenzi TL, Soares FZ, Rocha RO. Can endodontic irrigating solutions influence the bond strength of adhesives to coronal dental substrates? A systematic review and meta-analysis of <i>in vitro</i> studies. <i>J Adhes Dent</i> 2018;20:481-94.	3	3	1.00
116	Ferreira I, Braga AC, Pina-Vaz I. Effect of Gutta-percha solvents on the bond strength of sealers to intraradicular dentin: A systematic review. <i>Iran Endod J</i> 2021;16:17-25.	3	/	0.00
117	Peralta-Mamani M, Rios D, Duarte MA, Santiago JF, Honorio HM. Manual vs. rotary instrumentation in endodontic treatment of permanent teeth: A systematic review and meta-analysis. <i>Am J Dent</i> 2019;32:311-24.	3	4	1.50
118	Wolf TG, Kim P, Campus G, Stiebritz M, Siegrist M, Briseño-Marroquín B. 3-dimensional analysis and systematic review of root canal morphology and physiological foramen geometry of 109 mandibular first premolars by micro-computed tomography in a mixed Swiss-German population. <i>J Endod</i> 2020;46:801-9.	2	2	2.00
119	Glynis A, Foschi F, Kefalou I, Koletsi D, Tzanetakis GN. Regenerative endodontic procedures for the treatment of necrotic mature teeth with apical periodontitis: A systematic review and meta-analysis of randomized controlled trials. <i>J Endod</i> 2021;47:873-82.	2	2	0.00
120	Shamszadeh S, Shirvani A, Asgary S. Does occlusal reduction reduce post-endodontic pain? A systematic review and meta-analysis. <i>J Oral Rehabil</i> 2020;47:528-35.	2	3	2.00
121	Moreira RN, Pinto EB, Galo R, Falcí SG, Mesquita AT. Passive ultrasonic irrigation in root canal: Systematic review and meta-analysis. <i>Acta Odontol Scand</i> 2019;77:55-60.	2	0	1.00
122	Amin J, Lines J, Milosevic MP, Park A, Sholapurkar A. Comparison of accuracy and reliability of working length determination using cone beam computed tomography and electronic apex locator: A systematic review. <i>J Contemp Dent Pract</i> 2019;20:1118-23.	2	/	1.00
123	Sadaf D, Ahmad MZ, Onakpoya IJ. Effectiveness of intracanal cryotherapy in root canal therapy: A systematic review and meta-analysis of randomized clinical trials. <i>J Endod</i> 2020;46:1811-23.e1.	1	1	1.00
124	Bedran NR, Nadelman P, Magno MB, de Almeida Neves A, Ferreira DM, Pintor AV, et al. Does calcium hydroxide reduce endotoxins in infected root canals? Systematic review and meta-analysis. <i>J Endod</i> 2020;46:1545-58.	1	0	1.00
125	de Deus JL, Wambier LM, Boing TF, Loguercio AD, Reis A. Effects of ibuprofen compared to other premedication drugs on the risk and intensity of postendodontic pain: A systematic review. <i>Eur Endod J</i> 2018;3:123-33.	1	/	0.33
126	Parikh M, Kishan K, Solanki N, Parikh M, Savaliya K, Bindu V, et al. Efficacy of removal of calcium hydroxide medicament from root canals by endoactivator and endovac irrigation techniques: A Systematic review of <i>in vitro</i> studies. <i>Contemp Clin Dent</i> 2019;10:135-42.	1	/	0.50
127	Jamali S, Jabbari G, Mousavi E, Ahmadi-zadeh H, Khorram M, Jamee A. The comparison of different irrigation systems to remove calcium hydroxide from the root canal: A systematic review and meta-analysis. <i>Pesqui Bras Odontopediatria Clin Integr</i> 2019;20:e5404.	1	/	0.50
128	Wong YJ. Does oral Nonsteroidal Anti-inflammatory Drugs (NSAIDs) premedication in patients with irreversible pulpitis increase the success rate of inferior alveolar nerve block? <i>Evid Based Dent</i> 2019;20:20-1.	1	/	0.50
129	Martins JN, Marques D, Silva EJ, Caramês J, Mata A, Versiani MA. Second root and second root canal prevalence in maxillary first and second premolars assessed by cone beam computed tomography – A systematic review and meta-analysis. <i>Rev Port Estomatol Med Dent Cir Maxilofac</i> 2019;60:37-50.	1	/	0.50

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Rank	Article	Citations (scopus)	Citations (WOS)	CD
130	Mohamed A, Steier L. Uncertain decision-making in primary root canal treatment. J Evid Based Dent Pract 2017;17:205-15.	0	0	0.00
131	dos Reis-Prado AH, Abreu LG, Tavares WL, Peixoto IF, Viana AC, de Oliveira EM, et al. Comparison between immediate and delayed post space preparations: A systematic review and meta-analysis. Clin Oral Invest 2021;25:417-40.	0	1	0.00
132	Wolf TG, Anderegg AL, Wierichs RJ, Campus G. Root canal morphology of the mandibular second premolar: A systematic review and meta-analysis. BMC Oral Health 2021;21:306.	0	0	0.00
133	Zhou J, Liu T, Guo L. Effectiveness of XP-Endo Finisher and passive ultrasonic irrigation on intracanal medicament removal from root canals: A systematic review and meta-analysis. BMC Oral Health 2021;21:294.	0	0	0.00
134	Sarao SK, Berlin-Broner Y, Levin L. Occurrence and risk factors of dental root perforations: A systematic review. Int Dent J 2021;71:96-105.	0	/	0.00
135	Bronzato JD, Bomfim RA, Hayasida GZ, Cúri M, Estrela C, Paster BJ, et al. Analysis of microorganisms in periapical lesions: A systematic review and meta-analysis. Arch Oral Biol 2021;124: 105055.	0	0	0.00
136	Junior EC, de Andrade Vieira W, Normando AG, Pereira JV, Ferraz CC, Almeida JF, et al. Calcium silicate-based sealers do not reduce the risk and intensity of postoperative pain after root canal treatment when compared with epoxy resin-based sealers: A systematic review and meta-analysis. Eur J Dent 2021;15:347-59.	0	/	0.00
137	Aung NM, Myint KK. Diagnostic accuracy of CBCT for detection of second canal of permanent teeth: A systematic review and meta-analysis. Int J Dent 2021;2021:1107471.	0	/	0.00
138	Magnucki G, Mietling SV. Four-rooted maxillary first molars: A systematic review and meta-analysis. Int J Dent 2021;2021:8845442.	0	/	0.00
139	Aminoshariae A, Kulild JC. Size of master apical file and optimal irrigation of the apical zone: A systematic review. Iran Endod J 2018;13:424-37.	0	/	0.00
140	Pereira TM, Piva E, De Oliveira Da Rosa WL, Da Silva Nobreza AM, Pivatto K, Aranha AM, et al. Physicomechanical properties of tertiary monoblock in endodontics: A systematic review and meta-analysis. Iran Endod J 2021;16: 139-49.	0	/	0.00
141	Almuthhin M, Afify M, Alshammari Y, Alkatheeri N, Altuwaijri SM, Alhussain B, et al. The safety and efficacy of pre-and post-medication for postoperative endodontic pain: A systematic review and network meta-analysis. Open Dent J 2020;14:563-99.	0	/	0.00
142	Feghali M, Khajanka E, Nardo DD, Bhandi S, Kassabian P, Seracchiani M, et al. Incidence of different types of intracanal fracture of nickel-titanium rotary instruments: A systematic review. J Contemp Dent Pract 2021;22:427-34.	0	/	0.00
143	Rahbani Nobar B, Dianat O, Rahbani Nobar B, Shirvani A, Zargar N, Kazem M, et al. Effect of rotary and reciprocating instrumentation motions on postoperative pain incidence in non-surgical endodontic treatments: A systematic review and meta-analysis. Eur Endod J 2021;6:3-14.	0	/	0.00
144	Rosso CB, Pereira KF, Boretti VH, Arashiro FN, Guerisoli DM, Yoshinari GH. Postoperative pain in infected teeth after single - Versus multiple-visit endodontic treatment - A systematic review. Pesqui Bras Odontopediatria Clin Integr 2012;12: 143-8.	0	/	0.00
145	Jamali S, Farhang R, Nasrabadi N, Ahmadizadeh H, Mousavi E, Kaviani M. Comparison of microscopic endodontic techniques: A systematic review and meta-analysis. Pesqui Bras Odontopediatria Clin Integr 2021;21:e5414.	0	/	0.00
146	Jamali S, Darvish M, Nasrabadi N, Jafarizadeh S. Evaluation of the effect of the intensity and occurrence of postoperative pain of resin-based and bioceramic root canal sealers: A systematic review and meta-analysis of randomized controlled trial studies. Pesqui Bras Odontopediatria Clin Integr 2021;21:e0219.	0	/	0.00
147	Nasrabadi N, Jamali S, Vojoodi MG, Jamali M. The impact of distinctive root canal instrumentation systems on endotoxin lessening from the root canal: A systematic review and meta-analysis. Pesqui Bras Odontopediatria Clin Integr 2020;21:1-7.	0	/	0.00
148	Parolia A, Nikolopoulou D, Lim BS, Kanagasalingam S. Comparison of antibacterial effectiveness between Sealapex and AH-plus sealer against <i>Enterococcus faecalis</i> : A systematic review of <i>in vitro</i> studies. G Ital Endod 2020;34: 119-34.	0	/	0.00
149	De-Geus JL, Wambier LM, Loguercio AD, Reis A. Influence of ProTaper/ProTaper Next, compared to other rotatory/reciprocating systems, on the risk and intensity of postoperative pain after endodontic instrumentation in adult patients: A systematic review and meta-analysis. Dent Press Endod 2020;10:48-59.	0	/	0.00

/: Data not available, CD: Citation density, WOS: Web of Science

distinct clusters, with Nagendrababu V representing the biggest node.

The overall number of citations and the number of articles by year of publication is illustrated in Figure 4. The highest number of publications was noted in the year 2020 with 26 articles published, followed by 2018 and 2019, each with twenty articles. On the other hand, the least number of publications were found in the years 2001,

2005 and 2009, each with one article published. The year 2007 had the largest number of total citations ($n = 600$), followed by 2008 ($n = 527$) and 2010 ($n = 425$). When comparing the first decade (years 2001–2010) to the second decade (years 2011–2021), the number of publications increased dramatically ($P < 0.05$), but the total number of citations decreased substantially ($P < 0.05$). Furthermore, the overall citations count displayed an inconsistent pattern over the years, with a sharp decline beginning in 2017.

Journals ranking, impact factor scores, Journal Citation Reports scores

Table 2: Authors with at least four articles published on systematic review and meta-analysis related to endodontics

Number of Authors	Count
1	1
2	11
3	26
4	23
5	31
6	33
7	10
8	7
9	4
10	0
11	2
12	0
13	1

Science and Scopus databases, respectively. Table 3 presents the list of journals that published at least five articles, with the Journal of Endodontics publishing the most with 46 publications (29.5%), followed by the International Endodontic Journal with 26 articles (17.4%), and Clinical Oral Investigation with six articles (4.0%). Out of the 149 articles chosen, 87 were published in journals related to endodontics [Figure 5a]. The Journal of Endodontics published the greatest number of articles with a total of 46 (52.9%) publications. Following that, the International Endodontic Journal contributed 26 articles (29.9%), the Australian Endodontic Journal and the Iranian Endodontic Journal each contributed five articles (5.7%), the European Endodontic Journal contributed three articles (3.4%), and the Dental Press Endodontics and the Giornale Italiano di Endodonzia each contributed one article (1.2%).

Article types, thematic categories, source of articles, keywords, source of fundings

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meta-analysis [Table 4]. As for the thematic category, the clinical or radiographic outcome theme contributed the highest number of articles ($n = 30$), followed by mechanical preparation and instrumentation ($n = 19$), chemical preparation ($n = 16$), and epidemiological studies ($n = 14$). However, working length determination, restoration, and pulp biology or pathology are among the themes with the least amount of publication, with each contributing two articles. Furthermore, the department

of endodontics was the most prolific, with 46 articles, followed by 17 articles from the department of restorative dentistry and seven articles from the department of oral medicine and oral pathology. Only three articles were labeled as “non-academic” from all the articles included. The sources of finding are listed accordingly with the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES Foundation) Brazil contributed the most [Appendix 3]. When the minimum number of co-occurrences of keywords was set to eight, 884 keywords were discovered. There were 58 that met the standards, with the top four keywords being “human,” “meta-analysis,” “systematic review,” and “endodontics” [Figure 6].

DISCUSSION

The current study is the first of its kind to analyze and compare the trends and bibliometric indices of systematic reviews and meta-analyses in endodontics over the last two decades. Even though systematic reviews and meta-analyses have long been thought to represent the highest level of evidence, the top-cited article earned 184 citations,^[9] and fewer than 20% of the review articles received 50 or more

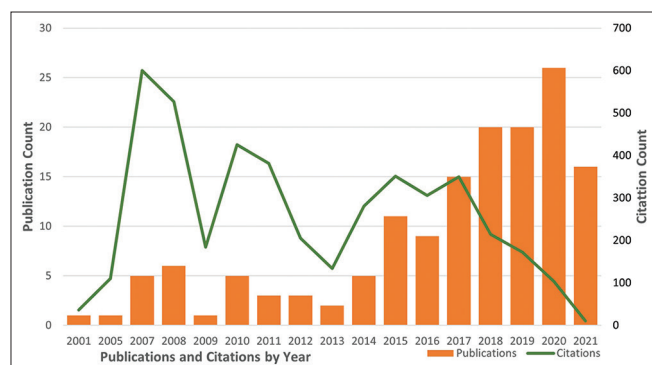


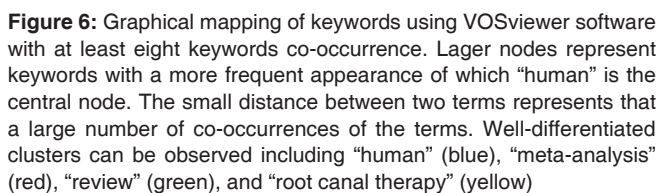
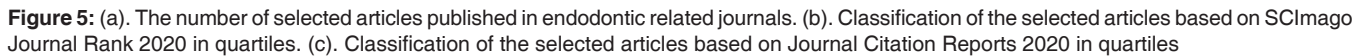
Figure 4: Number of publications and total citation counts with regards to the year of publication

Table 3: Institutions, countries, and journals with at least five articles published on systematic reviews and meta-analyses in endodontics

Institution	Number	Country	Number	Journal	Number
International Medical University	8	Brazil	40	Journal of Endodontics	46
The University of Hong Kong	8	United States	34	International Endodontic Journal	26
Rio de Janeiro State University	6	China	15	Clinical Oral Investigations	6
University of Milan	6	Malaysia	13	Australian Endodontic Journal	5
Instituto de Implantologia	5	Australia	12	Iranian Endodontic Journal	5
University of São Paulo	5	United Kingdom	11	Pesquisa Brasileira em	5
The University of Adelaide	5	Iran	10	Odontopediatria e Clinica	
Federal University of Pelotas	5	Italy	10	Integrada	
Shahid Beheshti University of Medical Sciences	5	Hong Kong	8		
The University of California, Los Angeles	5	Saudi Arabia	7		
University of Melbourne	5	India	6		
University of Malaya	5	Portugal	6		
University of Campinas	5	Spain	6		
The University of Lisbon	5	Canada	5		
Loma Linda University	5	Germany	5		
		Switzerland	5		

Table 4: Article types, thematic categories, and the source of articles

Article type	Number	Theme	Number	Source	Number
Systematic review only	56	Clinical or Radiographic Outcomes	30	Endodontics	46
Systematic review with meta-analysis	93	Mechanical Preparation and Instrumentation	19	Restorative dentistry	17
		Chemical Preparation	16	Oral medicine and oral pathology	7
		Epidemiological Studies	14	Conservative dentistry	4
		Microbiology	9	Oral surgery	4
		Endodontic Materials	7	Dental materials	3
		Endodontic Surgery	6	Oral health	3
		Obturation	5	Paediatric dentistry	3
		Root Canal Morphology	3	Prosthodontics	2
		Working Length Determination	2	Oral biology	2
		Restoration	2	Periodontics	1
		Pulp Biology or Pathology	2	Cariology	1
		Others	34	Others	56



of citations, notably beginning in 2018. Furthermore, high-quality endodontic systematic reviews may opt to be published in non-dental journals, such as the BioMed Research International journal,^[18] which have higher IFs than other dentistry journals. Notwithstanding, since the dental field is typically smaller than the medicine and health sciences, it is questionable to directly compare IFs of journals in various areas. Although systematic reviews offer a higher level of evidence, these publications primarily summarize the current literature.^[19] As a result, the authors speculated that when a new research paper intends to describe its findings and draws a comparison to existing literature, the original article is frequently cited. In addition to the chance of a review article being cited, editors of journals also tend to take into account the review's readership, hence leading to lower citation count.^[20]

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a result of demands to publish those researchers and policymakers are oblivious to.^[22] Nonetheless, the average number of authors per paper reflected a multidisciplinary approach and a growing interest among researchers from diverse institutes and nations.^[23] On the other hand, the co-authorship network map indicated a dearth of shared edges between neighboring nodes or clusters, highlighting more future collaboration opportunities as separate research groups with various cluster colors do not collaborate. Collaboration within research networks is essential because it allows researchers to share their expertise and discoveries, making them more efficient, productive, and less repetitious in their work.^[24]

The current findings show a dramatic surge of publication in the second decade (years 2011–2021). Such a rise could be due to endodontic advancements in recent years, which have allowed for more well-designed research and systematic reviews. A vast number of systematic reviews were published in the year 2020 which may be attributed to an increase in the quantity and quality of conservative and endodontics researchers, a better understanding of systematic review protocol, and widespread interest among researchers in collaborative work.^[7,8] One interesting finding of this study is that the year 2007 had the highest amount of citation counts. It is indeed predictable that papers published in 2021 earn no citations, but it's unclear if citations will increase over time and peak in the coming years. This could be one of the shortcomings of the present analysis as it included articles published in recent years. Moreover, some key articles may not be readily recognized as citation classics despite their publication history since their scientific topic has become so well-known that it is no longer acknowledged.

The Journal of Endodontics published the most articles, which is consistent with other endodontic-related bibliometric analyses.^[17,24] Future readers and researchers interested in systematic reviews and meta-analyses pertaining to endodontics will be able to focus their efforts on this key journal. Only three journals (7.5%) published more than five articles, whereas 19 journals (47.5%) published only one review article. This indicates that while many journals contributed to the publication of systematic reviews in endodontics, only a few journals insisted on publishing relevant research.^[25] The two most prolific endodontic journals were the Journal of Endodontics and the International Endodontic Journals, with overall SJR and IF scores ranging from 1.850–1.988 to 4.171–5.264, respectively, suggesting that high-impact endodontic journals publish systematic reviews and meta-analyses more frequently. The journal's high IF also shows its relevance

as a source of knowledge for endodontic researchers interested in systematic reviews and meta-analyses.^[26] Surprisingly, the Clinical Oral Investigation was placed third in the number of review articles published, indicating that not all endodontic articles are published in endodontic journals. The journal's aim and scope, which favors studies with a high level of evidence, its high IF and SJR scores, rapid review status, higher acceptance rates compared to other journals, and more social media dissemination are all possible explanations for this occurrence. Therefore, these increase the likelihood of the Clinical Oral Investigation journal in drawing attention.

Brazil was ranked first among other nations in terms of the number of publications in endodontics which is in accordance with a previous study,^[27] with the United States coming in second. The United States' position was predicted, given it corresponded to the previous findings.^[7] Brazil, China, and Malaysia showed a significant scientific contribution in systematic reviews and meta-analyses, indicating that endodontics knowledge is growing fascinatingly in non-English speaking countries where language may not be a major obstacle.^[28] Furthermore, publications from funding organizations or partners in developed countries may be indexed as collaborative research, and therefore, developed countries' top researchers and research funding organizations may need to work more closely with developing countries to boost up their research output.^[29] Interestingly, International Medical University Malaysia and The University of Hong Kong contributed the most articles, with eight articles each. This highlights the potential of Asian countries to produce systematic reviews and meta-analyses related articles which corroborates with previous bibliometric analysis.^[8]

More than half of the selected reviews comprised meta-analysis, implying that researchers are becoming aware of the value of meta-analysis as a tool for validating or debunking disputed findings from numerous studies. In terms of thematic category, the bulk of the publications dealt with the clinical and radiographic outcome, followed by mechanical and instrumentation, and chemical preparation which contradicts previous bibliometric studies.^[7,8] This might be due to a need for clinicians to have a greater understanding on how endodontic therapy is improving, with more predictable outcomes and fewer postendodontic complications for patients. On the other hand, working length determination, restoration and pulp biology or pathology are among the least popular fields, which may be due to the restricted primary study available to conduct this sort of review. Hence, future systematic reviews should explore further into these contexts in order

to offer clinicians more trustworthy and credible evidence. Moreover, a large number of articles were categorized as “other” since they could not be classified in any of the 16 thematic categories relevant to the subject of research.

The discovery that a high number of review articles in the endodontic literature appeared to originate from endodontics-related departments of academic institutions, which contradicted a previous analysis,^[8] was of considerable interest. Academic institutions where the endodontic department is integrated within the “restorative,” or “preventive dentistry” department are more common in European countries.^[8] However, most papers in the current analysis originated from non-European nations, hence, it is reasonable to assume that the terms “endodontics” and “endodontology” are included in their department determination. Keywords generally reflected the studies’ themes of interest and techniques by using the VOS software to indicate the research trend line. The VOS software eliminated generic phrases unrelated to the specific topic and selected the most relevant keywords from the chosen articles to retain the focus on more useful terms.^[30] As a result, the keywords discovered in this study may properly represent how research in the field of minimally invasive access cavities has been conducted.

The highest level of evidence in the hierarchy of evidence is systematic reviews and meta-analyses, labeled as “level I.”^[31] The current study has the advantage of providing level I publications, which have the highest level of evidence-based knowledge in endodontics. Furthermore, endodontic articles were commonly published in general dental journals. The inclusion of such a diverse variety of journals allows the current bibliometric analysis to be relevant and credible. Several limitations in the current bibliometric analysis were also identified. First, only two databases (Scopus and Web of Science) were used, and the linguistic medium was confined to English. This means that publications that were not found in both databases, as well as those written in languages other than English, were excluded from the analysis. Second, since the institutional addresses used in the current study were limited to institutions and countries where the authors worked/were employed at the time the research was performed or the paper was written, only those institutions and countries received acknowledgment.

Third, the time frame chosen for the present analysis appears to be rather recent. As a result, the time factor would have a significant influence, as freshly published papers, regardless of their content or quality, obviously have

a disadvantage of inadequate time to accrue a significantly higher number of citations.^[32] Besides, a citation count as a valid tool to assess a scientific publication may not be adequate. However, several factors impact an article’s citation count, including the author’s reputation and the journal chosen for citation. These considerations indicate that citation count acts as an adversary in terms of being an unbiased mirror of a manuscript’s quality and impact.^[33] Moreover, the specific use of keywords in the current analysis may limit search results and future studies should explore different keywords during the primary search of articles.

CONCLUSION

Within the limitations, this present bibliometric study offers valuable information regarding systematic reviews and meta-analyses in the field of endodontics. With 17 authors contributing at least four publications, 18.1% of the chosen review articles were designated citation classics. Over the last two decades, there has been a constant increase in research publications. The bulk of articles came from Brazil, and the Journal of Endodontics remains the most popular journal among researchers. Moreover, more than half of the selected systematic reviews comprised of meta-analyses, and the most prominent topic of interest was clinical or radiographic outcomes.

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Conflicts of interest

There are no conflicts of interest.

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Appendix 1: The authors' contribution

Authors	Number of articles	Authors	Number of articles	Authors	Number of articles
White, S.N.	8	Gomes, M.S.	2	Al-maweri, S.A.	1
Nagendrababu, V.	7	Gulabivala, K.	2	AlShwaimi, E.	1
Silva, E.J.N.L.	6	Gutmann, J.L.	2	Alamoudi, N.M.	1
Martins, J.N.R.	5	Haghdoost, A.A.	2	Alanazi, F.	1
Neelakantan, P.	5	Handysides, R.	2	Albajj, S.M.A.	1
Rossi-Fedele, G.	5	Hodges, J.S.	2	Alberto Caponio, V.C.	1
Torabinejad, M.	5	Hu, B.	2	Alhadainy, H.	1
Ahmed, H.M.A.	4	John, M.T.	2	Alhussain, B.	1
Caramês, J.	4	Karabucak, B.	2	Alkathheeri, N.	1
Gomes, B.P.F.A.	4	Kohli, M.R.	2	Almas, K.	1
Jamali, S.	4	Kulild, J.	2	Almeida, J.F.A.	1
Marques, D.	4	Küchler, E.C.	2	Almuthhin, M.	1
Mata, A.	4	Law, A.S.	2	Alqaderi, H.	1
Pak, J.G.	4	Leitune, V.C.B.	2	Alqutaibi, A.Y.	1
Pulikkotil, S.J.	4	Leong, D.J.X.	2	Alshammari, Y.	1
Sathorn, C.	4	Levin, L.	2	Alsheri, Y.	1
Versiani, M.A.	4	Lodi, G.	2	Altmann, A.S.P.	1
Aminoshariae, A.	3	Loguercio, A.D.	2	Altuwajiri, S.M.	1
Campus, G.	3	Lozada, J.	2	Aly Ahmed, H.M.	1
Cheung, G.S.P.	3	Maia, L.C.	2	Amin, J.	1
Decurcio, D.A.	3	Mann, V.	2	Anderegg, A.L.	1
Del Fabbro, M.	3	Martín-González, J.	2	Anderson, P.	1
Estrela, C.	3	McGuire, L.A.	2	Andrada, A.C.	1
Hamedy, R.	3	Messer, H.	2	Andrade Junior, C.V.	1
Moraes, R.R.	3	Messer, H.H.	2	Andrade, M.R.T.C.	1
Nasrabadi, N.	3	Moana-Filho, E.J.	2	Andric, M.	1
Parashos, P.	3	Mousavi, E.	2	Antunes, L.A.A.	1
Setzer, F.C.	3	Ng, Y.L.	2	Antunes, L.S.	1
Shirvani, A.	3	Nixdorf, D.R.	2	Aranha, A.M.F.	1
Taschieri, S.	3	Ogawa, R.S.	2	Arashiro, F.N.	1
Veettil, S.K.	3	Pagonis, T.C.	2	Arena, C.	1
Wolf, T.G.	3	Pappen, F.G.	2	Aung, N.M.	1
Abbott, P.V.	2	Pereira-Cenci, T.	2	Bader, J.	1
Ahmadizadeh, H.	2	Puterman, I.	2	Bahjri, K.	1
Asgary, S.	2	Reis, A.	2	Bansal, R.	1
Barbizam, J.V.	2	Rosen, E.	2	Barker, D.R.	1
Berlin-Broner, Y.	2	Sarkis-Onofre, R.	2	Bastos, J.V.	1
Bukiet, F.	2	Segura-Egea, J.J.	2	Batista, V.E.	1
Cabanillas-Balsera, D.	2	Shakiba, B.	2	Bedran, N.R.	1
Cenci, M.S.	2	Wong, A.W.Y.	2	Beljic-Ivanovic, K.	1
Chu, C.H.	2	Zhang, C.	2	Ben-lzhack, G.	1
Collares, F.M.	2	Abdulrab, S.	1	Benetti, F.	1
Corbella, S.	2	Abouqal, R.	1	Berenji, H.	1
De-Deus, G.	2	Abraham, D.	1	Bergeron, B.	1
Felippe, W.T.	2	Abreu, L.G.	1	Bertani, P.	1
Fidalgo, T.K.S.	2	Adl, A.	1	Bhakta, S.	1
Shamszadeh, S.	2	Afify, M.	1	Bhamra, G.	1
Song, J.	2	Afrashtehfar, K.I.	1	Bhandi, S.	1
Suresh, A.	2	Aggarwal, V.	1	Bhatia, S.	1
Tay, F.R.	2	Ahmad, M.Z.	1	Bier, C.A.	1
Tsesis, I.	2	Ajaj, R.	1	Bindu, V.	1
Wambier, L.M.	2	Al Tuwirqi, A.A.	1	Blazer, T.	1
Wierichs, R.J.	2	Al-Shahrani, S.	1	Bogari, D.	1

Appendix 2: Countries contribution

Country	Number of article	Country	Number of article
Brazil	40	Israel	2
United States	34	Russian	2
China	15	Singapore	2
Malaysia	13	Turkey	2
Australia	12	Albania	1
United Kingdom	11	Bahrain	1
Iran	10	Colombia	1
Italy	10	Denmark	1
Hong Kong	8	Fiji	1
Saudi Arabia	7	Guatemala	1
India	6	Hungary	1
Portugal	6	Ireland	1
Spain	6	Lebanon	1
Canada	5	Morocco	1
Germany	5	Myanmar	1
Switzerland	5	Netherlands	1
Egypt	3	Poland	1
Thailand	3	Serbia	1
France	2	Sweden	1
Greece	2	Yemen	1

Appendix 3: Funding sponsors

Funding body	Number of articles
Coordenação de Aperfeiçoamento de Pessoal de Nível Superior	6
Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro	4
Conselho Nacional de Desenvolvimento Científico e Tecnológico	3
Ministério da Ciência, Tecnologia e Inovação	3
National Institute of Dental and Craniofacial Research	3
Fundação de Amparo à Pesquisa do Estado de São Paulo	2
Kerman University of Medical Sciences	2
National Center for Research Resources	2
National Institutes of Health	2
National Natural Science Foundation of China	2
Universität Bern	2
ADA Foundation	1
American Association of Endodontists Foundation	1
Boston University	1
Changjiang Scholar Program of Chinese Ministry of Education	1
Companhia Energética de Minas Gerais	1
Conselho Nacional de Desenvolvimento Científico e Tecnológico	1
Coordenação de Aperfeiçoamento de Pessoal de Nível Superior	1
Department for BioMedical Research, Universität Bern	1
Fundação de Amparo à Pesquisa do Estado de Minas Gerais	1
Harvard University	1
Hungarian Scientific Research Fund	1
Itä-Suomen Yliopisto	1
Johannes Gutenberg-Universität Mainz	1
Kementerian Pendidikan Malaysia	1
Loma Linda University	1
Ministarstvo Prosvete, Nauke i Tehnološkog Razvoja	1
Ministry of Education of the People's Republic of China	1
Ministry of Science and Technology of the People's Republic of China	1
National Key Research and Development Program of China	1
National Research, Development and Innovation Office	1
Office of Vice Chancellor for Research and Technology, University of Isfahan	1
Program for Innovation Team Building at Institutions of Higher Education in Chongqing	1
Semmelweis Egyetem	1
Thailand Research Fund	1
U.S. Department of Health and Human Services	1
Universidade Federal de Minas Gerais	1
University of California	1
University of California, Los Angeles	1
University of Connecticut	1
University of Isfahan	1
University of Washington	1
Universität Bern	1