



Review:

Regenerative Endodontic Treatment: A Bibliometric Analysis of Global Indian Author's Research Contribution from 2000 to 2023

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Abstract

Aim: Regenerative endodontic (RE) treatment is a new paradigm shift in the management of non-vital or necrotic immature young permanent teeth and has been substantiated by numerous research publications in the endodontic literature.

Methods: A bibliographic database search was performed using PUBMED and Google Scholar for the published articles from 2000 to March 2024. All articles published in the English language only in this period were selected constituting only Indian authors who are working within India, their affiliations, working specialty, Indian institutions//College/University, gender, state of origin of the published article, and journal name with its impactor factor. The obtained data was tabulated and analysed for the estimation of bibliometric details. **Results:** The estimated Indian author's contribution towards RE on a global level was 3.34% with maximum original studies (N=11). Saveetha Dental College was found with highest publication (N=4). International Journal of Clinical Pediatric Dentistry (N=4) conquered the first place with maximum publications followed by Cureus (N=3). Karnataka state (N=7) and south zone (N=20) were found with maximum research output. Conservative Dentistry (N=17) and Pediatric and Preventive Dentistry specialty (N=11) were crowned with the highest research publications towards RE. **Conclusion:** The present bibliometric analysis showed that although there is growing interest and trend among Indian researchers/authors in the utilisation of RE, however, there are insufficient evidence-based results on this domain.

Keywords: Bibliometric analysis, Global analysis, Indian authors, Research contribution, Regenerative endodontic treatment

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Introduction

Children present with frequent injuries to their anterior teeth resulting in pulpal damage and necrosis which requires serious attention as anterior teeth play a major role in speech, esthetics, and function. The young permanent anterior teeth exhibit wide open blunder buss apex and thin lateral dentinal walls requiring a modifying treatment approach.^[1] Although various conventional and recent restorative materials have shown successful outcomes in the management of these teeth, each one is associated with its own drawbacks. As a result, a revolutionary biologic technique has touched the doors of the endodontic field and resulted in a tremendous paradigm shift.^[2] This novel modality includes “regenerative endodontic procedures” and was developed with the concept of stimulation of stem cells present in the apical region of the tooth to release growth factors which in turn combined with an appropriate physical scaffold will lead to regeneration of pulp tissue inside the root.^[3] Various research studies have been undertaken across the globe within this context to show the efficacy of various scaffolds such as blood clots, collagen, platelet-rich plasma, and plate-rich fibrin in pulp regeneration.^[1-10] India, being part of Asia represents the second most highly populated country in the world and hence it is essential to evaluate the available research evidence related to dental health science.

Krishnan et al.^[11] analysed the research contribution of Indian authors on regenerative endodontic procedures by evaluating all publications published during the period from 2008 to 2019. With there was sudden onset of the COVID pandemic, there was tremendous changes happened in research activities in many parts of the world including India.^[11] Therefore, it is highly essential to study the scenario of the Indian authors/researcher’s contribution after the post-COVID period towards dental health science including regenerative endodontic treatment. Hence the present retrospective observational study was carried out to answer the research question of the present bibliometric analysis “What is the overall Indian authors’ contribution towards regenerative endodontic treatment at the global level?” so that using the results of obtained evidence, further therapeutic guidelines or recommendations can be put forward Infront of the scientific society.

Materials and methods

A retrieval of publications from the period 2000 to March 2024 about only Indian-based articles was

performed using two electronic databases PubMed and Google Scholar.

Inclusion criteria: All types of publications that are in the English language including original studies, case series, systematic reviews and meta-analyses, narrative literature reviews, and case reports were considered for this bibliometric analysis. Among these publications, articles belonging to only the first author of Indian origin and affiliated or working in Indian institutions/organizations/ colleges were included.

Exclusion criteria: Articles consisting of Indian authors but their affiliation related to outside of India, and articles showing only abstracts and repeated publications in multiple journals were excluded from this analysis.

Study protocol: An electronic database search using PubMed and Google Scholar was carried out for a period of one month for the selection of articles published from 2000 to March 2024. Different medical MeSH search keywords like regenerative endodontic procedures, treatment of immature or necrotic permanent teeth, management of young permanent teeth, traumatized immature teeth treatment, biological scaffolds, blood clot, platelet-rich-plasma, and plate-rich-fibrin or stem cells were used in different combinations for selection of particular articles. All varieties of articles published in various journals irrespective of dental specialty were considered. Based on inclusion criteria selected articles were read in detail to obtain the required data. The selected articles were tabulated encompassing important details like the name of the first author along with gender, year of publication, journal name in which the article is published, its impact factor, type of the article, college/university/institution/research center to which author is attached, specialty and the state of the nation where article published. States were categorized according to the different zones of the nation like West, East, North, and South zones.

Results

PubMed and Google Scholar database search resulted in a total of 3580 articles. From these articles, based on inclusion and exclusion criteria the irrelevant and duplicate articles were removed. Finally, only 33 articles were selected for evaluation to obtain bibliometric details which included original studies, case series, systematic reviews and meta-analysis, narrative reviews, and case reports. These articles were arranged in descending order from new to old according to the custom-made table format constituting all details (Table 1).



Author/Gender	Year	Journal Name	Impact factor	Type of Research	Dental specialty	State
Kumar et al/M	2023	BMC Oral Health	2.9	Case report	Public Health Dentistry	Tamil Nadu
Nagaveni & Ashwini/F	2023	Global Journal of Research in Dental Sciences	5.67	Web-based survey	Pediatric and Preventive Dentistry	Karnataka
Jena et al/M	2023	Journal of Pharmacy and Bio allied Sciences	0.8	Original Study	Conservative Dentistry and Endodontics	Odisha
Lalitha Priya et al/F	2023	Cureus	1.2	Systematic Review	Conservative Dentistry and Endodontics	Tamil Nadu
Shruti Thakkar et a l/F	2023	Saudi Dental Journal	1.92	Original Study	Pediatric and Preventive dentistry	Karnataka
Khan et al/M	2023	Journal of the Scientific Society	0.3	Review	Pediatric and Preventive Dentistry	Uttar Pradesh
Arathi et al/F	2023	International Journal of Clinical Pediatric Dentistry	0.46	Retrospective Study	Pediatric and Preventive Dentistry	Kerala
Saraswathi et al/F	2023	Saudi Dental Journal	1.92	Survey	Pedodontics and Preventive Dentistry	Karnataka
Swati et al/F	2022	Restorative Dentistry & Endodontics	1.5	Original article	Conservative Dentistry and Endodontics,	West Bengal
Nivedita et al/F	2022	International Journal of Clinical Pediatric Dentistry	0.46	Systematic Review & Meta Analysis	Pedodontics and Preventive Dentistry	Karnataka
Tulika et al/F	2022	International Journal of Clinical Pediatric Dentistry	0.46	Original Study	Department of Dentistry	Uttarakhand N
Pratima panda et al/ F	2022	Journal of Clinical Medicine	3.9	Systematic review & Meta analysis	Conservative Dentistry and Endodontics	Odisha
Maru et al/M	2022	Cureus	1.2	Original study	Pedodontics and Preventive Dentistry	Maharashtra W
Maheshwaran et al/ M	2022	Journal of Pharmaceutical Negative Results	0.3.9	Survey	Conservative dentistry and endodontics	Tamil Nadu
Subramaniam et al /M	2022	Cureus	1.2	Review	Conservative dentistry and endodontics	Tamil Nadu
Mayya et al/M	2021	Journal of International Society of Preventive and Community Dentistry	1.34	Original study	Department of dental sciences	Karnataka
Shetty et al/M	2021	Scientific Reports	4.6	Original Study	Conservative Dentistry and Endodontics	Maharashtra
Joseph et al /M	2021	Dental Research Journal	1.23	Case report	Pedodontics and Preventive Dentistry	Karnataka
Veena Jayadevan et al/F	2021	Journal of Clinical and Experimental Dentistry	1.6	Original Study	Conservative Dentistry and Endodontics	Karnataka
Tyagi et al/M	2021	Acta Scientific Dental Sciences	1.27	Case report	Pedodontics and Preventive Dentistry	Delhi
Justin et al/M	2021	IP Indian Journal of Conservative and Endodontics	0.84	Review	Conservative Dentistry and Endodontics	Maharashtra,
Chakravarthy et al/M	2021	Journal of Scientific Dentistry	0	Survey	Conservative Dentistry and Endodontics	Tamil Nadu
Harveen Singh et al/M	2021	Contemporary Clinical Dentistry	1.2	Case report	Periodontics	Punjab
Kritika et al/F F	2021	Scientific Reports	4.6	Original Study	Conservative Dentistry and Endodontics	Tamil Nadu
Divya et al/F	2021	Journal of Conservative Dentistry	0.98	Original Study	Pedodontics and Preventive Dentistry	Karnataka
Nagaveni et al/F	2020	International Journal of Clinical Pediatric Dentistry	0.46	Case report	Pedodontics and Preventive Dentistry	Karnataka
Rosarian et al/M	2020	Journal of Pharmacy and Bio allied Sciences	0.8	Systematic review	Oral and Maxillofacial Pathology and Oral Microbiology	Tamil Nadu
Nivedhitha et al/F	2020	Journal of Operative Dentistry and Endodontics	0	Review	Conservative Dentistry and Endodontics	Tamil Nadu
Arora et al/M	2020	Journal of Conservative Dentistry	0.98	Case series	Conservative Dentistry and Endodontics	Gujarat
Nivedhitha et al/F	2020	Case Reports in Dentistry	0.74	Case reports	Conservative Dentistry and Endodontics	Tamil Nadu
Farwan Ariwala et al/M	2020	Indian Journal of Public Health Research & Development	6.4	Survey	Conservative Dentistry and Endodontics	Karnataka
Shivani Mallishery et al/F	2020	Journal of Advances in Medicine and Medical Research	0	Review	Conservative Dentistry and endodontics	Maharashtra
Jain et al/M	2020	Journal of Pharmacy and Bio allied Sciences	0.8	Original Study	Conservative Dentistry and Endodontics	Uttar Pradesh

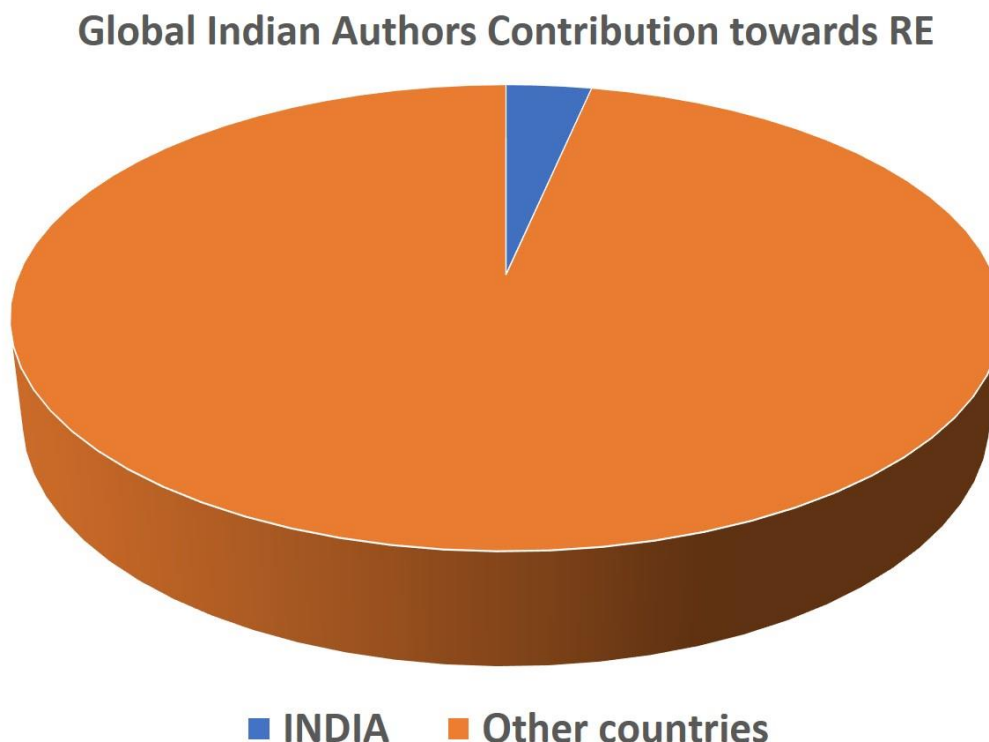
Bibliometric analysis

Indian author's global contribution

The estimated Indian author's research output (contribution) pertaining to the domain RE among

global PubMed indexed and Google scholar cited publications during the period 2000 to March 2024 was about 3.34% (33 publications) (Figure 1).

Figure 1: Global Indian author's research contribution towards RE



Bibliometric Indian Authors analysis

Analysis of Indian authors who contributed to global scientific literature towards RE consisted total of 154 researchers, of which 32 authors were contributed as first authors. The maximum number of authors noted in some publications was 10. Maximum publications of more than one and in first author place were contributed by authors like Nagaveni NB (two publications). Authors with more than one publication either in second, third, fourth, or fifth place contributed by authors like Saraswathi Naik (4 publications), Attiguppe Prabhakar (2 publications), and Arathi

Prakash (2 publications). The remaining authors contributed single publications. Publications contributed by only two authors were seen in three articles. Articles consisting of only single-author contributions were not seen in this bibliometric analysis (Table 2). When gender contribution was analyzed concerning the first author, it was noticed that the maximum contribution was noted in male researchers (N=18) compared to female authors (N=15).

Table 2: Author contribution towards Regenerative Endodontics

Authors/Researchers	Number of publications contributed
Saraswathi Naik	4
Nagaveni NB	2
Attiguppe Prabhakar	2
Arathi Prakash	2

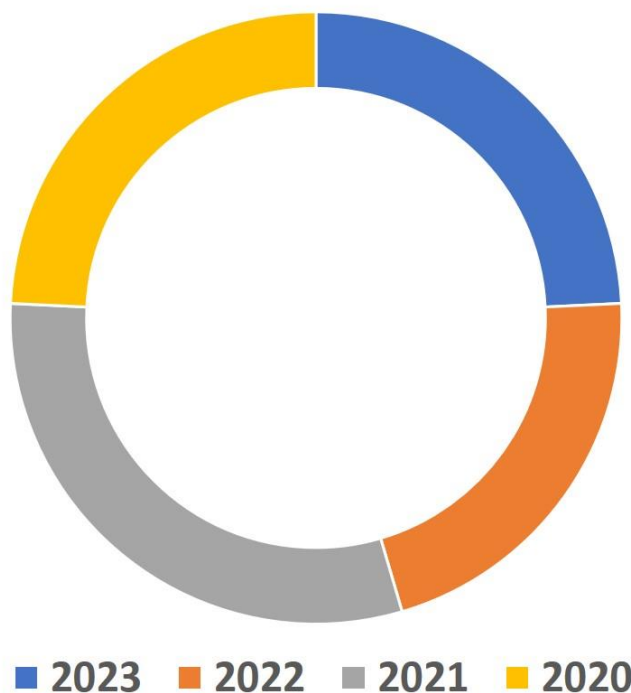
Publication year analysis

When publication year metrics were analysed, it was found that maximum publications were noticed in 2021

(N=10) followed by 8 publications in the year 2020 (N=8) and 2023 and in 2022 with 7 publications (N=7) (Figure 2).

Figure 2: Bibliometric Indian publication year analysis

Bibliometric Publication Year Analysis



Bibliometric Journal analysis

Bibliometric evaluation of scientific journals showed the contribution of maximum publications in the

International Journal of Clinical Pediatric Dentistry (N=4) with impact factor of 0.46 followed by the Journal of Pharmacy and Bioallied Sciences (N=3), Cureus (N=3), Saudi Dental Journal and Journal of Conservative Dentistry (N=2). The remaining journals contributed single publications each (Table 3).

Table 3: Bibliometric Journal Analysis

S No.	Journal name	Number of articles published
1	International Journal of Clinical Pediatric Dentistry	4
2	Cureus	3
3	Journal of Pharmacy & Bio Allied Science	3
4	Saudi Dental Journal	2
5	Journal of Conservative Dentistry	2
6	Scientific Reports	1
7	Indian Journal of Public Health Research & Development	1
8	Case Reports in Dentistry	1
9	Journal of Operative Dentistry and Endodontics	1
10	Journal of Advances in Medicine and Medical Research	1
11	Contemporary Clinical Dentistry	1
12	Journal of Scientific Dentistry	1
13	IP Indian Journal of Conservative and Endodontics	1
14	Acta Scientific Dental Sciences	1
15	Journal of Clinical and Experimental Dentistry	1
16	Dental Research Journal	1
17	Journal of International Society of Preventive and Community Dentistry	1
18	Journal of Pharmaceutical Negative Results	1
19	Journal of Clinical Medicine	1
20	Restorative Dentistry & Endodontics	1

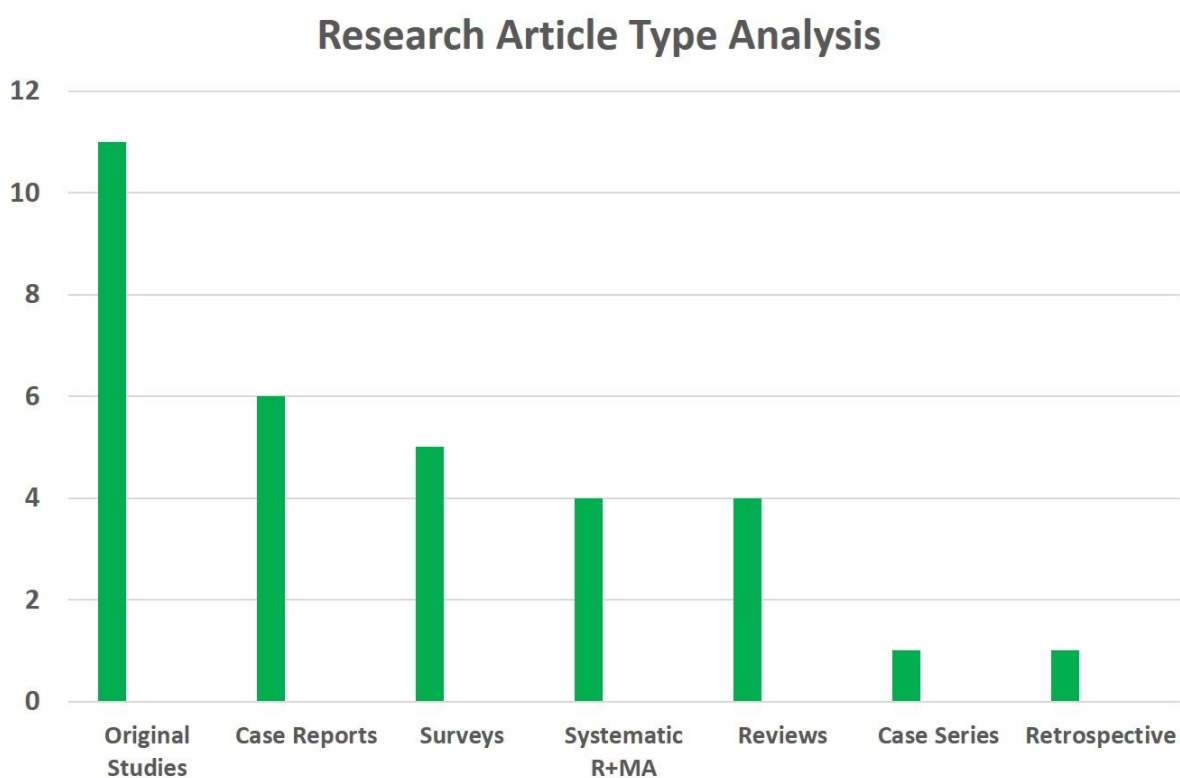
21	Journal of the Scientific Society	1
22	Global Journal of Research in Dental Sciences	1
23	BMC Oral Health	1

Research Article type analysis

Estimation of bibliometric published research article type analysis revealed a maximum of original research

articles (N=11), followed by Case reports (N=6), review articles (N=5), questionnaire surveys (N=5), and systematic reviews and meta-analysis (N=4). Other types of articles observed in this analysis were case series articles (N=1) and retrospective studies (N=1) (Figure 3).

Figure 3: Analysis of Indian research article type

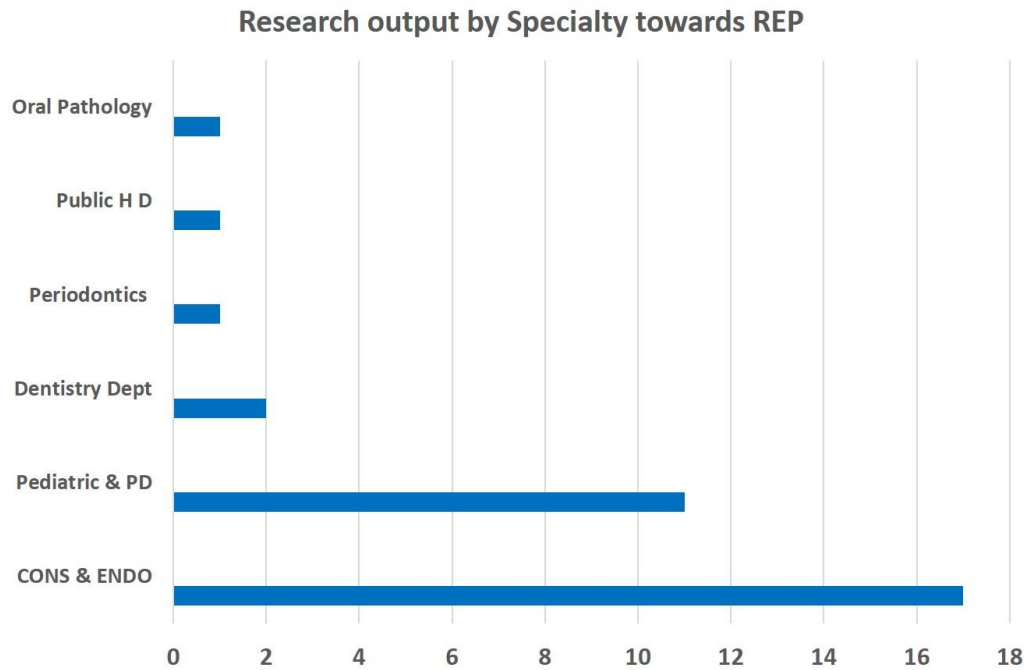


Analysis of research output by Specialty/Department

Maximum research output contribution credit towards regenerative endodontic procedures was achieved by

the Conservative Dentistry and Endodontics (N=17) department, followed by Pediatric and Preventive Dentistry (N=11). Other speciality like Periodontics, Public Health Dentistry, and Oral and Maxillofacial pathology contributed single research article (Figure 4).

Figure 4: Total research output by Indian dental specialty about RE

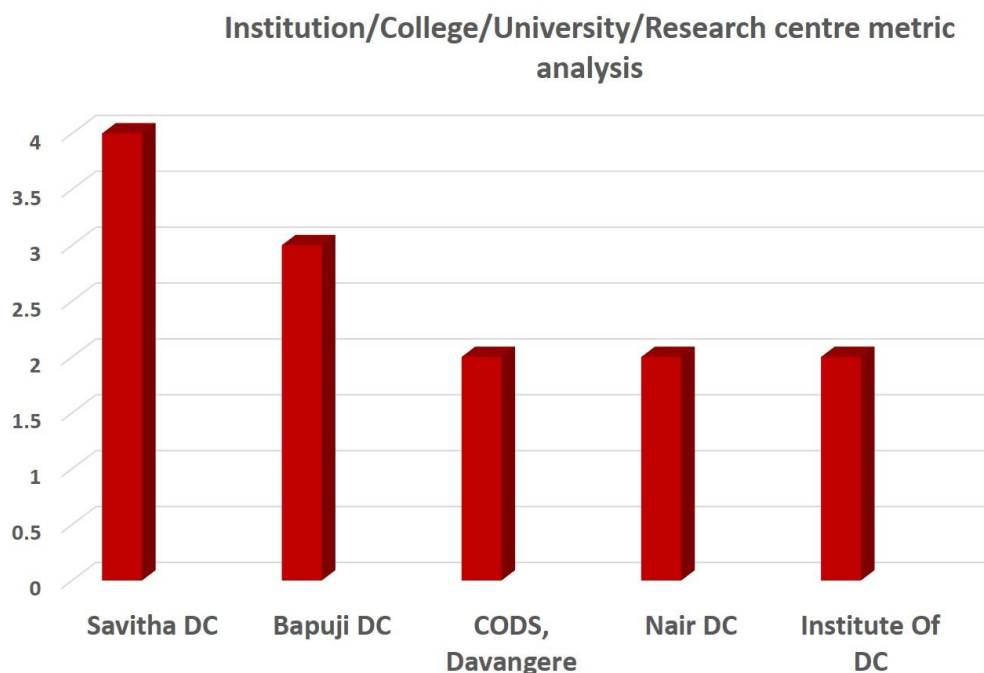


Institution/Research Centre/College analysis

Institution analysis found a total of 24 colleges across India which contributed towards research on RE.

Among these institutions, Savitha Dental College and Hospital bagged first place in maximum contribution (N=4) followed by Bapuji Dental College and Hospital (N=3), College of Dental Sciences (N=2), Nair Dental College and Hospital (N=2) and Institute of Dental Sciences (N=2) (Figure 5).

Figure 5: Institution/College/University/Research centre metric analysis





Analysis of State Contribution

A total of 9 states from India showed research contributions about RE on a global level. In these nine states, the credit for maximum research output goes to Karnataka state (N=10) having numerous high-quality

Table 4: Bibliometric State analysis

Sl. No.	Name of the State	No. of Publications
1	Karnataka	10
2	Tamil Nadu	9
3	Maharashtra	4
4	Odisha	2
5	Uttar Pradesh	2
6	Delhi	1
7	Punjab	1
8	Kerala	1
9	Uttarakhand	1
10	West Bengal	1
11	Gujarat	1

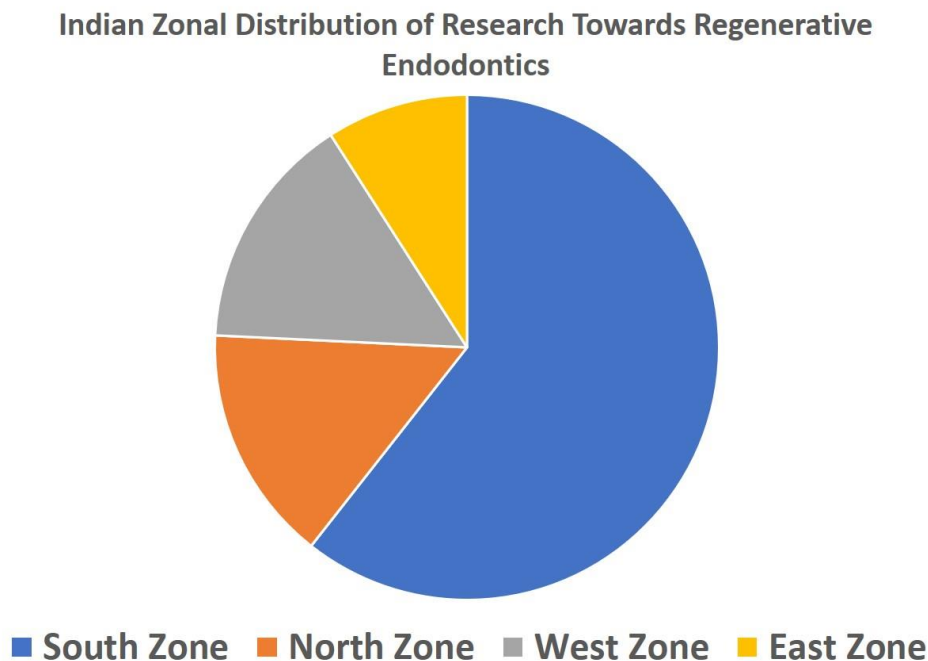
institutions and is active in research publications. The second place was captured by Tamil Nadu (N=9) followed by Maharashtra (N=4). Other states like Odisha and Uttar Pradesh contributed two publications each (N=2). The remaining states Kerala, Uttara Khand, West Bengal, Gujarat, Punjab, and Delhi contributed single publications each (Table 4).

Indian Zonal distribution of research publications

Evaluation of zonal distribution of research articles across five zones of India reflected higher contribution from South zone (N=20). Other zones like North zone

contributed 5 publications (N=5), West zone five publications (N=5) and East zone contributed 3 publications (N= 5) (Figure 6).

Figure 6: Indian zonal distribution of research towards RE



Discussion

Regenerative endodontic treatment is quite a challenging technique in the management of necrotic immature young permanent teeth in children. Various

research studies including histological and animal studies have been performed by different investigators across the globe.^[12-34] Moreover, it is joyful matter that the American association of endodontists has started funding to research activities to encourage, enlighten and support more research in the arena of Regenerative Endodontics.^[11] The present bibliometric analysis and observational study was carried out by evaluating the retrospective electronic data pertaining to regenerative endodontic treatment for the management of non-vital permanent teeth with open apex. The birth of bibliometric analysis resulted in estimation of nation-based evidence in different health related domains across the globe.^[11]

The results obtained from the previous bibliometric analysis revealed 7.6% of Indian contribution among the total PubMed indexed global publications on RE and the clinical trials reported from the nation constituted a substantial 22% of the total global output.^[11] This bibliometric analysis was estimated to evaluate the research contribution found during the period from 2008 to 2019. In the present bibliometric analysis, which calculated during the total research output during the period from 2020 to March 2024 and revealed 3.34% of Indian authors contribution on the global level (total PubMed and google scholar indexed research output) towards RE. Such national level assessment of total research output regarding any particular health related domain is highly warranted to compare with other nation to assess the current status of the nation's research. Maximum publication output was noticed in the year 2021 followed by 2022 and 2023. Author metric analysis revealed maximum contribution in first author position by Nagaveni NB from College of Dental Sciences, Davangere, Karnataka.^[3,14] With respect to second or third order position, maximum publication was seen with Saraswathi Naik from Bapuji Dental College, Davangere, Karnataka followed by Attiguppe Prabhakar and Arathi Prakash from the same institution.^[13,17,33,34] In previous analysis performed by Krishnan et al,^[11] Nagaveni NB and her institution (College of Dental Sciences) stood in the second place. But Saraswathi et al, Prabhakar and Arathi were not in the list of previous analysis. This shows existence of increased awareness, interest in learning and practice of utilising the RE procedures among budding clinicians.

Bibliometric analysis with respect to journal contribution depicted maximum publications published by international journal of Clinical Pediatric dentistry with an impact factor of 0.46 and is associated with an Indian based publishing agency.^[13,14,19] The second journal with maximum contribution was shared by Cureus^[22,27] which is an international journal with an impact factor of 1.2 and journal of Pharmacy and Bioallied Sciences (impact factor of 0.8). More than

one publication was contributed by Saudi Dental Journal (Impact factor 1.92) and Journal of Conservative Dentistry (Impact factor 0.98) (N=2).^[17, 33, 34] Remaining journals contributed single publications each. With regard to research article type metric analysis, maximum research was associated with original research studies (N=11) followed by case reports (N=6) and surveys (N=5). Four systematic reviews with meta-analysis were found within this short-stipulated time evaluation (from 2000 to 2023). Among original studies two classical outstanding studies were performed in 2021 by two institutions such as Bapuji dental College, Karnataka and Nair dental college and hospital, Mumbai.^[5,34] One study evaluated the 3-dimensional volume space of pulp following regenerative endodontic treatment.^[5] In another study for disinfection of the root canal space, an innovative disinfection method using laser was used.^[34] This indicates increased trend and interest in performing this novel treatment modality seen among young budding clinicians or researchers. Some case reports showed use of a novel scaffold materials like hydrogel and amniotic membrane which were not used so far.^[18,20] Therefore, further prospective studies with more sample size including newer scaffold materials in comparison with other scaffolds is essential to explore more regenerative potential of periapical stem cells.

Evaluation of specialty metric analysis showed maximum research work contributed by department of Conservative Dentistry and Endodontics followed by Pediatric and Preventive dentistry.^[3,14,33,34] The reason behind this scenario is associated with the type of patients indicated for or requiring regenerative endodontic treatment is dealt by these two specialties. Other specialties which contributed a single publication was found with periodontics, public health dentistry, oral and maxillofacial pathology departments. Although these specialties don't perform RE, but for publication purpose must have drafted the manuscript and published the article. Institution metric analysis revealed highest research contribution by Saveeha dental college and hospital situated in Chennai (Tamil Nadu) followed by Bapuji dental college and hospital, Davangere, College of Dental sciences, Davangere both are located in Karnataka state (south zone).^[3,14,33,34] Other colleges which showed some amount of research work was by Nair dental college and hospital, Mumbai and Institute of Dental Sciences, Bhubaneswar (Odisha state). Saveetha dental college and hospital is at the top of the pinnacle in research work ranked in No. 1 position in NIRF (National Institutional Ranking Framework) ranking. The other institution, College of Dental sciences, Davangere is ranked with A+ grade in NAAC (National Assessment and Accreditation Council) accreditation. Evaluation of state metric contribution exhibited maximum contribution by Karnataka state (N=10) followed by Tamil Nadu (N=9), Maharashtra (N=4), Uttar Pradesh

(N=2) and Odisha (N=2). Although institutional analysis showed Saveetha dental college credited with maximum research output, but as Karnataka state contains numerous institutions, the first place with highest publications was associated with Karnataka state.

Analysis of zonal contribution across India from Indian authors about RE was showed that, maximum contribution was performed from Southern zone (N=20). Whereas North zone and West zone contributed five publications. In southern part of India numerous quality institutions/colleges/universities/research centres are located with increased research-oriented aims and objectives. For instance, Saveetha dental college, college of dental science and Nair hospital, AB Shetty dental college and hospital and many more. Among these Savitha dental college is the top most institution almost equivalent to IIT engineering colleges in the research-oriented goals. In addition to this, in south zone availability of research resource, funding, research grants, international collaborative research work is tremendous in these institutions compared to north or other zones of India. The similar observation was found in the previous analysis too.

Conclusion

From this bibliometric analysis it was evident that identification of national level health resources, sectors, high quality research strategies are highly essential to further explore the domain of RE with ample clinical and laboratory-based research evidence for further contribution to the global scientific literature. Therefore, this observational study on bibliometric analysis shows new path for other researchers in the near future to develop more international collaborations and identification of some more active research groups within India.

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