



ORIGINAL ARTICLE

Scientometric evaluation of endodontic publications by Gulf Cooperation Council region in 21st century



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Abstract *Objectives:* The appraisal of research productivity is one of the key indicators to evaluate any area of knowledge. The current study aimed to analyze the Scopus-indexed publications on endodontics produced by Gulf Cooperation Council (GCC) region from 2000 to 2020.

Methodology: The dataset was extracted in May 2021 from Elsevier's Scopus database. Two keywords ("endodontic" and "endodontics") were entered into the basic search with the Boolean operator of OR for a period of 20 years from 2000 to 2020.

Results: Overall, the GCC region contributed 2.82% of the global endodontic research. This share has shown a remarkable increase between 2001 and 2020 from 0.82% to 7.20%. About 60% of documents' volumes were produced during the 2016–2020 period. Around 80% of research was produced by Saudi Arabia, while research articles produced by Kuwait gained the highest citation impact. Out of the ten productive institutions, nine belonged to Saudi Arabia and one was from Kuwait. The majority of research collaboration was conducted with the United States, but research articles produced in collaboration with Japan yielded the highest citation impact.

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Conclusion: The study highlighted various scientometric attributes of endodontic publications produced by GCC affiliated researchers. The ongoing growth of endodontic literature by GCC countries along with the increasing international collaboration is considered aspiring.

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1. Introduction

The Gulf Cooperation Council (GCC), founded in May 1981, consists of six Arab States of the Gulf, including the Kingdom of Saudi Arabia, United Arab Emirates (UAE), Kingdom of Bahrain, State of Kuwait, State of Qatar, and Sultanate of Oman. This region is blessed with natural resources of petroleum and falls in the category of high-income countries. These countries are spending an ample amount of resources in achieving excellence in education for their citizens and patronizing research activities (Meo et al., 2015). Authorities continue to monitor and evaluate the outcome of such efforts for strategic management and policy-making purposes (Butt, et al., 2020).

The scientometric technique is frequently used to quantify and evaluate knowledge growth and research progress. This term was introduced by Nalimov and Mulchenko in 1969, to study the evolution of science through the assessment of published information such as books and research articles. Proper utilization of scientometric measures is crucial to our understanding of publication growth and research trends (Hood and Wilson, 2001). This method is used to measure the characteristics of research progress from a single author, institution, country, region to the global level as well as a distinct area of knowledge (Sengupta, 1992).

The contribution of the GCC region in different areas of biomedical research has been discussed in various studies (Meo et al., 2015; Butt et al., 2020; Meo et al., 2016; Al-Busaidi et al., 2018; Lammers and Tahir, 1996; Al-Maawali et al., 2012). Dentistry is an important subdivision of biomedical sciences and its research is thoroughly connected with the living standards and quality of life. (Haq et al., 2019). The excellence of dental care is directly linked with the competencies of dental professionals. Quality dental education qualifies students to lead and meet the ever-increasing challenges, required by the community and the profession as well. The dental practice has been categorically improved by quality research (Baldwin and Sohal, 2003; Mascarenhas and Atchison, 2015).

Previous studies analyzed the publication pattern of the 100 top-cited articles in Dentistry (Feijoo et al. 2014; Asiri et al., 2021). The first bibliometric study on endodontics examined the attributes of the 100 top-cited articles (Fardi et al., 2011). The United States, Loma Linda University of California, and M. Torabinejad were found to be the most productive country, institution, and author, respectively. Tzanetakias, et al. (2015) analyzed the publications output of the International Endodontic Journal (IEJ) and Journal of Endodontics (JOE) in two different phases (1999–2003; 2009–2013). About 62% of the documents were published in the second phase. The collaborative research has increased from 93.2% in the first phase to 98.9% in the second phase. “Endodontic materials” was found to be the preferred research subject, while the United States has emerged as the most prolific country in terms of the number of publications.

The number of endodontic publications produced by GCC-affiliated researchers has increased in recent years. This study was conducted to thoroughly investigate the scientometric indicators of endodontic research in the GCC region in the 21st Century from 2001 to 2020.

2. Methodology

A scientometric study was performed on endodontic research produced by authors affiliated with the GCC region. The dataset was extracted in the third week of May 2021 from Elsevier’s Scopus database. Two keywords (“endodontic” and “endodontics”) were written in the basic search with the Boolean operator of OR for a period of 20 years from 2000 to 2020.

A global picture of endodontic research was presented by Scopus, and the summary of the data was downloaded in Comma Separated Value (CSV) file, further from the country index, the dataset of six countries of the GCC region were filtered and downloaded. The database provided the bibliographic records of 686 documents on endodontics with at least one author affiliated with any country of the GCC region. All types of documents were downloaded including original research articles, reviews, books, book chapters, editorials, notes, etc. Upon verification of documents, no duplication was found.

This study was limited to the publications indexed in the Scopus database. Since the data was extracted from an online database, which is publicly available, application for ethical approval to conduct the study was deemed unnecessary. Microsoft Excel-16 and VOSviewer Software were used to present the data in tabular format.

3. Results

3.1. Global research productivity on endodontics

A total of 24,313 papers on endodontics were identified in the Scopus database. This reflects the overall global production for twenty years between 2001 and 2020. The majority of research (62%) was produced in the second decade, and most papers (n = 3271; 13.45%) were published in JOE. The University of São Paulo, Brazil (n = 984; 4%) and the United States (n = 4212; 13.45%) emerged as the most contributing institution, and country, respectively. José F. Siqueira Jr, a Brazilian researcher, was found to be the most prolific author with 208 publications. One-third (n = 8052; 33.11%) of the worldwide research on endodontics was produced by two countries; the United States and Brazil.

3.2. Share of GCC in the research productivity on endodontics

Scholars affiliated with the GCC region produced 686 papers on endodontics which constitutes 2.82% of the global share during the study period, with an average of 34.3 papers per year. The share of the GCC region among the globe was less than 2% during the first decade. The research share of the GCC region crossed the limit of 2% annually in 2011 and gradually increased to 4.42% in 2016, and 7.20% in 2020 (Table 1). Remarkable progress was attained from 0.82% to 7.20% of the global share in twenty years. Although there was a variation in the number of documents published each year, an overall growing trend was noted with an average annual growth rate of 33.6%. Published papers received 7,401 citations with an average of 10.78 cites/doc. Documents published in 2007 received the highest number of citations (n = 47).

3.3. Periodic growth of endodontic research by GCC

The analysis of periodic growth segregated into four intervals of five years each demonstrates that about 61% of the endodontic research by GCC was produced during the last interval (2016–2020). Most citations (43.79%) were gained by the 177 papers published between 2011 and 2015, while the greatest citation impact was obtained by the 59 papers published during the period between 2006 and 2010 with an average of 33.30 cites/doc.

3.4. Distribution of endodontic research by country

A total of 57 countries collaborated with the six GCC countries. Table 2 shows that about 80% (n = 551) of the total

endodontic research in GCC was contributed by Saudi Arabia, followed by United Arab Emirates (n = 73; 10.64%) and Kuwait (n = 52; 7.58%). Low research productivity was observed in Qatar, Bahrain, and Oman. In terms of citation analysis, Kuwait demonstrated the highest citation impact with an average of 37.88 cites/doc, followed by Bahrain (15.45 cites/doc) and Saudi Arabia (9.09 cites/doc). In the analysis of indigenous research, the highest share of nationally collaborated papers belongs to Saudi Arabia (46.64%), followed by Kuwait (36.53%) and United Arab Emirates (35.61%). Oman produced five papers on Endodontics, all with the support of international collaboration.

3.5. Types of documents with accessibility model and citation impact

Out of the 686 documents, 46.64% (n = 320) of the papers were open-access and these documents gained a total of 2,016 citations with a mean of 6.3 cites/doc, while the toll-based documents (n = 366; 53.36%) received 5,386 citations with an average of 14.71 cites/doc. The majority of documents (n = 591; 86.15%) were original articles which gained a total of 6,352 citations with an average of 10.72 citations per article. The toll-based articles and reviews received higher citation impact compared to open-accessed articles and reviews, respectively.

3.6. Most productive authors and institutions

A total of 1864 authors have contributed to the 686 documents. The list of most productive and influential authors in endodontics during the study period is presented in Table 3. As the majority of the papers involved international collabora-

Table 1 Distribution of global research productivity with the share of GCC on endodontic publications, with annual growth rate, total citations, and average citations per paper by years.

Year	Global Productivity	Share of GCC (%)	Annual Growth Rate	Total Citations	Citation Impact
2001	610	5 (0.82%)		157	31.40
2002	723	9 (1.24%)	80.00%	142	15.78
2003	776	7 (0.90%)	-22.22%	253	36.14
2004	861	3 (0.35%)	-57.14%	70	23.33
2005	835	7 (0.84%)	133.33%	141	20.14
2006	854	14 (1.64%)	100.00%	464	33.14
2007	1034	16 (1.55%)	14.29%	736	46.00
2008	1196	11 (0.92%)	-31.25%	338	30.73
2009	1175	5 (0.43%)	-54.55%	91	18.20
2010	1257	13 (1.03%)	160.00%	336	25.85
2011	1374	28 (2.04%)	115.38%	690	24.64
2012	1437	28 (1.95%)	0.00%	899	32.11
2013	1604	31 (1.93%)	10.71%	499	16.10
2014	1637	47 (2.87%)	51.61%	613	13.04
2015	1401	43 (3.07%)	-8.51%	540	12.56
2016	1494	66 (4.42%)	53.49%	512	7.76
2017	1430	61 (4.27%)	-7.58%	317	5.20
2018	1372	82 (5.98%)	34.43%	283	3.45
2019	1466	82 (5.59%)	0.00%	185	2.26
2020	1777	128 (7.20%)	56.10%	135	1.05
Total	24,313	686 (100%)	33.6%*	7401	10.78**

* Average Annual Growth Rate.

** Average Citation per paper.

Table 2 Distribution of endodontic research by GCC.

Country	Total Papers (%)	Citable Papers (%)	Total Citations	Citation Impact	National Collaboration	Active period
Saudi Arabia	551 (80.32%)	427 (77.50%)	5010	9.09	257 (46.64%)	2001–2020
United Arab Emirates	73 (10.64%)	47 (64.38%)	353	4.84	26 (35.61%)	2003–2020
Kuwait	52 (7.58%)	49 (94.23%)	1970	37.88	19 (36.53%)	2001–2019
Qatar	13 (1.90%)	8 (61.54%)	36	2.77	3 (23.07%)	2002–2020
Bahrain	11 (1.60%)	11 (100%)	170	15.45	2 (18.18%)	2006–2018
Oman	5 (0.73%)	4 (80%)	24	4.8	0	2010–2020

tion, two Italian researchers, G. Gambarini and L. Testarelli (Sapienza University of Rome of Italy) were found as the most productive authors with 18 and 16 papers, respectively. A. A. Madarati of Taibah University ranked first among GCC affiliated authors with 14 papers, followed by K. Al-Hezaimi (King Saud University), M. S. Zafar (Taibah University), and A. Jamleh (King Saud bin Abdulaziz University for Health Sciences) with 11 papers each. Among the top ten authors, three belonged to Taibah University and King Saud University. D. Al-Sudani was found as the most influential author, as her 10 papers gained 324 citations with an average of 32.4 citations per paper.

The list of the top ten most productive institutions is shown in Table 3. Out of the ten, nine institutions belonged to Saudi Arabia while one was from Kuwait. Authors affiliated with King Saud University contributed to more than one-quarter of the documents ($n = 175$; 25.51%) and emerged as the most productive of endodontic research in the GCC region. King Abdulaziz University, Taibah University, and King Khalid University ranked 2nd, 3rd, and 4th with 79, 50, and 35 documents, respectively. Although Kuwait University falls on the 5th rank in terms of the number of documents, it stood first on citation impact with its 32 documents achieving 1,127 citations with an average of 35.21 citations per paper.

Table 3 Top ten productive authors and institutions with the total number of documents (TD), total citations (TC), and average citations per document (ACPD).

Serial No.	Productive Researchers	Affiliation	TD	TC	ACPD	Serial No.	Productive Institutions	TD	TC	ACPD
1.	Gambarini, G.	Sapienza University of Rome, Italy	18	446	24.77	1.	King Saud University	175	2247	12.84
2.	Testarelli, L.	Sapienza University of Rome, Italy	16	371	23.18	2.	King Abdulaziz University	79	902	11.41
3.	Madarati, A.A.	Taibah University	14	91	6.5	3.	Taibah University	50	369	7.38
4.	Al-Hezaimi, K.	King Saud University	11	147	13.6	4.	King Khalid University	35	108	3.08
5.	Zafar, M.S.	Taibah University	11	148	13.45	5.	Kuwait University	32	1127	35.21
6.	Jamleh, A.	King Saud bin Abdulaziz University for Health Sciences, Saudi Arabia	11	71	6.45	6.	Imam Abdulrahman Bin Faisal university	30	232	7.73
7.	Al-Sudani, D.	King Saud University	10	324	32.4	7.	Ministry of Health Saudi Arabia	28	89	3.17
8.	Alrahabi, M.	Taibah University	10	132	13.2	8.	Alfarabi Colleges	28	217	7.75
9.	Salameh, Z.	Lebanese University, Beirut, Lebanon.	10	288	28.8	9.	King Saud bin Abdulaziz University for Health Sciences	27	195	7.22
10.	Al-Madi, E.M.	King Saud University,	9	42	4.66	10.	Jazan University	24	52	2.16

Table 4 International Research Collaboration with GCC.

County	Total Documents	Total Citations	Citations Impact
United States	114	2308	20.24
Egypt	59	475	8.05
India	56	166	2.96
United Kingdom	43	768	17.86
Italy	34	727	21.38
Pakistan	18	107	5.94
Syrian Arab Republic	16	173	10.81
Jordan	15	226	15.06
Germany	13	141	10.84
Malaysia	13	12	0.92
Japan	12	492	41.00
Brazil	10	180	18.00
Switzerland	10	380	38.00

3.7. International research collaboration with GCC in endodontic research

A total of 63 countries were identified by VOSviewers including the six countries of GCC. The majority of research collaboration was performed in collaboration with the United States

Table 5 Top ten cited papers in endodontics by GCC from 2001 to 2020.

Serial No.	Bibliographic Description of documents	Type	Citations Scopus	Citations Google Scholar
1.	Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, DiAngelis AJ, Kenny DJ, Sigurdsson A, Bourguignon C, Flores MT, Hicks ML. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. <i>Dental Traumatology</i> . 2012 Apr;28(2):88–96.	Article	359	753
2.	Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, Bourguignon C, DiAngelis A, Hicks L, Sigurdsson A, Trope M. Guidelines for the management of traumatic dental injuries. II. Avulsion of permanent teeth. <i>Dental traumatology</i> . 2007 Jun;23(3):130–6.	Article	292	629
3.	Darvell BW, Wu RC. “MTA”- an hydraulic silicate cement: review update and setting reaction. <i>Dental Materials</i> . 2011 May 1;27(5):407–22.	Review	126	253
4.	Al-Omiri MK, Mahmoud AA, Rayyan MR, Abu-Hammad O. Fracture resistance of teeth restored with post-retained restorations: an overview. <i>Journal of Endodontics</i> . 2010 Sep 1;36(9):1439–49.	Review	101	190
5.	Barrieshi-Nusair KM, Qudeimat MA. A prospective clinical study of mineral trioxide aggregate for partial pulpotomy in cariously exposed permanent teeth. <i>Journal of Endodontics</i> . 2006 Aug 1;32(8):731–5.	Article	101	205
6.	Mously HA, Finkelman M, Zandparsa R, Hirayama H. Marginal and internal adaptation of ceramic crown restorations fabricated with CAD/CAM technology and the heat-press technique. <i>The Journal of Prosthetic dentistry</i> . 2014 Aug 1;112(2):249–56.	Article	96	188
7.	Qudeimat MA, Barrieshi-Nusair KM, Owais AI. Calcium hydroxide vs. mineral trioxide aggregates for partial pulpotomy of permanent molars with deep caries. <i>European Archives of Paediatric Dentistry</i> . 2007 Jun;8(2):99–104.	Article	89	172
8.	Saad AY, Al-Hadlaq SM, Al-Katheeri NH. Efficacy of two rotary NiTi instruments in the removal of gutta-percha during root canal retreatment. <i>Journal of Endodontics</i> . 2007 Jan 1;33(1):38–41.	Article	89	227
9.	Farsi N, Alamoudi N, Balto K, Mushayt A. Success of mineral trioxide aggregate in pulpotomized primary molars. <i>Journal of Clinical Pediatric Dentistry</i> . 2005 Jul 1;29(4):307–11.	Article	87	206
10.	Kahler B, Mistry S, Moule A, Ringsmuth AK, Case P, Thomson A, Holcombe T. Revascularization outcomes: a prospective analysis of 16 consecutive cases. <i>Journal of Endodontics</i> . 2014 Mar 1;40(3):333–8.	Article	85	153

Table 6 Top 30 keywords.

Serial No.	Keywords	Occurrence	Serial No.	Keywords	Occurrence
1	Human	407	16	Tooth pulp	65
2	Endodontics	386	17	Procedures	64
3	Female	127	18	Dental surgery	61
4.	Male	127	19	Molar tooth	59
5	Root canal filling material(s)	110	20	Tooth crown	57
6	Adult	109	21	Case report	57
7	Comparative study	97	22	Saudi Arabia	56
8.	Controlled study	96	23	Tooth root	53
9	Endodontic procedure	92	24	Tooth pulp disease	53
10	Root canal therapy	95	25	Root canal obturation	51
11	Tooth root canal	83	26	Materials testing	51
12	Root canal preparation	72	27	Dentin	50
13	Dental pulp cavity	72	28	Child	48
14	Methodology	67	29	biomedical and dental materials	48
15	Chemistry	65	30	Premolar tooth	47

(n = 114; 16.61%), followed by Egypt, India, and the United Kingdom with 59, 56, and 43 documents, respectively (Table 4). Research produced in collaboration with Japan produced the highest citation impact with an average of 41 cites/doc, followed by Switzerland (38 cites/doc).

3.8. Characteristics of ten top-cited papers and occurrence of keywords

As shown in Table 5, about one-fifth (n = 1,425; 19.25%) of the total citations were gained by the ten top-cited papers with an average of 142.5 citations per paper. In Google Scholar,

these papers received 2976 citations with an average of 297.6 citations per paper. Authors from two countries contributed to the ten papers; six papers were authored by Kuwait while four were produced by Saudi Arabia. In terms of article type, eight papers were original articles and two papers were review articles.

Table 6 shows the top 30 keywords along with the number of their occurrences. A total of 3,945 keywords were used in the 686 documents. The most common terms used in the keyword section revealed common and expected words such as “Human”, “Endodontics”, “Root canal filling materials”, and “Root canal preparation”.

4. Discussion

In the current study, we examined the publication growth of endodontics from 2000 to 2020 in the GCC region as reflected in the Scopus database. Scopus is the largest abstract and citation database that provides comprehensive coverage of worldwide peer-reviewed literature (Alhibshi et al., 2020). A total of 686 documents were identified with an average annual growth rate of 33.6%. Published documents received a total of 7,401 citations with an average of 10.78 cites/doc. Promising growth in the number of publications was observed after 2010. Possible reasons for this growth might be attributed to the increasing number of dental institutions, enhanced collaboration with international researchers, an increase in research and development fund allocation, in addition to the fact that research culture has started to flourish in the GCC region.

Saudi Arabia is playing a leading role in research in the GCC region, but based on the number of its population, these figures should increase in the future. In this study, it was found that about 80% of endodontic research was contributed by authors affiliated with Saudi Arabia. Almost 47% of the Saudi Arabian research was the result of national collaboration and considered as indigenous research work. However, this ratio was lower in other GCC countries. Other studies focusing on the GCC region have also highlighted that Saudi Arabia has a leading position in research growth. A study on diabetic foot disease research revealed that Saudi Arabia produced 63% of the papers (Al-Busaidi et al., 2018). An analysis of road traffic injuries studies identified that Saudi Arabia contributed the highest number of papers, followed by UAE and Qatar. Meo (2015) examined the research output on medical education. A total of 503 publications were identified of which most papers (64.21%) were contributed by Saudi Arabia.

In the present study, the analysis of most productive authors showed that two Italian authors actively collaborated with GCC authors, A. A. Madarati and D. Al-Sudani also contributed significantly. In the most contributing institutions, nine belonged to Saudi Arabia while one was from Kuwait. The authors of GCC regions collaborated with the authors of 57 countries in their endodontic research journey. When assessing the preferred sources for publications, JOE came on top with 54 documents, followed by the Journal of Contemporary Dental Practice, Saudi Endodontic Journal (SEJ), and IEJ with 51, 50, and 25 documents, respectively. SEJ and Saudi Dental Journal (SDJ) started their publications in 2011 and 1989 but the coverage in the Scopus database was available from 2015 and 2010 onwards, respectively.

As far as global research productivity is concerned, the GCC region needs to enhance its research productivity. Overall, their contribution constitutes only 2.82% of the global literature in endodontics. However, there is an encouraging fact that this ratio was 0.82% in 2001 and has increased to 7.20% in 2020. Haq et al. (2019) assessed the research output on dentistry by the 22 Arab countries from 1998 to 2017 and found that the Arab world contributed 7.50% of the worldwide literature in dentistry while Saudi Arabia subsidized 38% of the total Arab share and 3.63% of the global dental research.

This study has its limitations. For instance, data collection was restricted to one database; Scopus. Future studies should consider the areas of subject dispersion and analysis of research methodology to highlight research trends. In light of the findings, there is a need to investigate the factors that might have led to the low scientific production of GCC countries in comparison to other developed countries around the world.

5. Conclusion

It is evident from the findings that Saudi Arabia outperformed the rest of the countries in the GCC region in endodontic research as demonstrated by its share of scientific production. Although UAE and Kuwait's contributions are a bit reasonable, endodontic research is still in a state of infancy in the remaining GCC countries. Hence, future directions should include the establishment of new academic and research institutions, enhancement of human resources, and increase of financial resources allocated for research and development.

6. Authorship declaration

All authors have contributed significantly, and all authors are in agreement with the present manuscript.

7. Disclosure statement

The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

CRedit authorship contribution statement

Abdulmohsen A. Alfadley: Conceptualization, Investigation, Formal analysis, Project administration, Writing – review & editing. **Ikram Ul Haq:** Conceptualization, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. **Hussam A. Alfawaz:** Investigation, Formal analysis, Validation, Writing – review & editing. **Ahmed O. Jamleh:** Conceptualization, Investigation, Formal analysis, Validation, Writing – review & editing.

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