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Research Performance in the Category of “Dentistry, Oral Surgery & Medicine” by Saudi Arabia from 2014 to 2023: A Bibliometric Analysis

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ABSTRACT

Aim: The aim of this study was to evaluate bibliometric indicators of the dental research contributed by Saudi Arabia during the past ten years from January 2014 to December 2023.

Research Methodology: The dataset was retrieved from the Web of Science (WoS) database. The filter of country, publication years, document types and category were applied. The bibliographic details of articles and review articles indexed in the WoS category of “Dentistry, Oral Surgery & Medicine” (DOSM) under the affiliated address of Saudi Arabia were published in the targeted period (2014-2023) were later downloaded. The bibliometric indicators of periodic growth, citation impact, top journals, collaborative countries, contributing organizations, authorship patterns, top authors and keywords were analyzed.

Findings: The retrieved dataset demonstrated significant performance over the years, with an average annual growth rate of 14.33%. About half of the research was produced by the authors of three Saudi universities, while the majority of research collaborations were performed with United States, Egypt and India. Saudi Medical Journal (SDJ) was found to be the main publication channel followed by BMC Oral Health.

Conclusion: The upward trend in dental publications is indicative of excellence in dental education and an increase in research and development efforts, which have been made feasible during the last decade by adequate financial allocation and upgradation of dental research facilities in the country.

Keywords: Dental Research; Bibliometric; Saudi Arabia; Research productivity

INTRODUCTION

Research is a fundamental component of biomedical sciences, and it helps healthcare organizations to enhance their standard of patient care. The research produced by biomedical specialties has the potential to substantially improve the overall evidence-based healthcare system.[1,2] Dentistry is one of the most rapidly growing fields in modern biomedical sciences. Over the past few decades, there has been an exponential development in dental research, and advancement in materials and technology, which has resulted in substantial improvements in dentistry.[3,4] The swift and broad expansion in knowledge has brought about an evolution in dental education and practice, which in turn has enhanced oral healthcare services and overall quality of life. An extensive growth of scholarly literature supporting evidence-based oral health practice has been produced, worldwide.[5-7]

The evaluation of research publications, both qualitative and quantitative, has gained importance in correlation with the growth in the quantity of research publications. The bibliometric technique, i.e. application of mathematics and statistics on published material like books, articles have frequently been utilized.[8,9] Bibliometric studies investigate scholarly publications to determine the scientific outputs of authors, institutions, regions, or countries. These types of studies present

valuable and impartial statistics regarding the state of research in any science sector. Scientific activity can be evaluated on a country or organization's research progress, the research profile of one scientist and any area of knowledge using two indicators: publications and citation data.[10]

Dental education, practice and research have grown significantly in the Saudi Arabia in the last few decades, which has lead the way in dental research endeavors of Arab countries. [6] In order to emphasize and advance the importance of scientific research, the Saudi government has been setting up research facilities at hospitals and universities. One of the vital goals is to raise the standard of the country while moving forward to generate a steady stream of quality research.[11]

Various bibliometric studies highlighted that Saudi Arabia contributed substantial research in dentistry as one study on periodontics research revealed that Saudi Arabia produced 3.43% of periodontics literature globally and stood in 11th rank. [12] Haq et al., pointed out that more than one-third (38%) of the dental research produced by Arab countries shared by Saudi Arabia from 1998 to 2017. [6] Anas et al., examined 1,337 PubMed indexed articles on dentistry contributed by the Arab universities from 2010 to 2020 and revealed 39.19% (n=524) of articles produced by Saudi Arabia followed by Egypt (n=172; 12.86%). [13] Awawdeh et al., carried out the bibliometric analysis of orthodontic research in Arab League Nations from 2002 to 2021 and found that Arab countries contributed 5.03% of the global orthodontic research. Saudi Arabia emerged as the most productive country with 41% of the research followed by Egypt (17%) and United Arab Emirates (9%).[14]

Khayat and Rajeh assessed the contemporary trends in dental research in Saudi Arabia from 2010 to 2020. The study selected 1,899 papers extracted from the PubMed and WoS databases & more than half (51%) of the papers used the cross-sectional study design, while dental public health was found in most research areas (19%) followed by restorative and esthetic dentistry (13%). The study recommended more collaboration at international level on novel areas of dental research.[3] Alotaiby and Almutairi reviewed the 1,089 PubMed indexed articles on dentistry produced by Saudi Arabia from 2014 to 2021. The highest number of articles were written on oral pathology (22%), followed by periodontics (15%) and restorative dentistry (13%). Literature review (35%) was a common study design then systematic review (29.2%) and case report (15.6%).[4]

Alfadley et al., reviewed the endodontics research produced by the Gulf Cooperation Countries Region and reported that Saudi Arabian authors contributed about 80% of the research from 2001 to 2020. [15] Alrubaig et al., measured the endodontic research at global level from 2010 to 2022 and testified that 17,879 documents were found in WoS database and Saudi Arabian authors ranked 8th at with 3.29% (n=590) of the documents. These documents (n=590) gained 4,481 citations with an average of 7.59 citations per document. Most of the articles were published in Journal of Endodontics (n=54) followed by Saudi Dental Journal (SDJ) (n=29). United States, India and Egypt were found most collaborative countries.[16] Another study also assessed the Saudi Arabian contribution to 70 endodontic articles indexed in PubMed database from 2014 to 2021. These articles were cited 386 times with an average of 5.5 citations per article and two-author pattern was found most common. The analysis of types of research showed that case reports and literature reviews were most frequent.[17] Another article evaluated 280 articles published in Saudi Endodontics Journal from 2011 to 2020. These articles received an average of 3.8 citations per

article. Approximately 40% of the articles were submitted by Saudi Arabia, with the other articles being contributed by authors from 35 different nations worldwide.[18]

Hussam and Haq examined 1,929 articles published from 1987 to 2022 and cited with an average of 13.39 cites/article. The articles with international research collaboration gained higher citation impact (15.44 cites/article) as compared to non-international collaboration (9.35 cites/article). About 41% of the research was produced by King Saud University followed by King Abdulaziz University (13%). Journal of Contemporary Dental Practice was found most frequent channel for publications followed by SDJ, United States and India were found at the top of international collaboration.¹² Ababneh et al., (2022) revealed that the United States contributed the highest number of research on periodontics followed by India and Brazil from 2012 to 2021.[19]

Rajeh and Khayat examined the Level of Evidence (LoE) in the dental research conducted in Saudi Arabia between 2000 to 2020. The study selected 1,557 articles, only 10% of studies corresponded to the highest LoE (LoE-I), while maximum number of articles (78%) were found on LoE-IV & more than one-third articles (35%) had international collaboration.[20] Another study analysis based on LoE, found that 522 articles were published in SDJ from 2012 to 2021, while articles related to LoE-IV (40.61%) were found on the highest ratio followed by LoE-V (37.55%) and lastly, only 2.3% of articles were published on LoE-I.[21]

Alonaizan et al examined 5,689 articles on dentistry that have research collaboration; the study excluded articles that were written by a single author. About two-thirds (63.4%) of the articles had international collaboration and national collaboration was found in 16.4% of articles, while 20.1% of the articles had collaboration written within the institution.[22]

The WoS database was selected for this bibliometric research because of its extensive coverage and trustworthy indexing of scientific literature. It has progressively emerged as the most popular source of bibliographic data, usually used for bibliometric studies, research appraisal, journal selection, and other purposes. This database, in contrast to other databases, has records going all the way back to 1945 and offers a large selection of credible, peer-reviewed scientific publications from different parts of the world.[23]

This bibliometric analysis aimed to investigate dental research from the Saudi scientific community indexed in the subject category of “Dentistry, Oral & Surgery Medicine” within the WoS database from the year 2014–2023 and further determine the direction of dental research and their areas of interest, countries of collaboration, institutions, journals, and the citation impact.

RESEARCH METHOD

A bibliometric research method was applied to the dataset extracted from the Clarivate Analytics Web of Science (WoS) Core Collection database. In the first search box, using the drop-down button the “Address” option was clicked & “Saudi Arabia” had been typed in the subsequent search box. WoS identified all the documents (n=450,076) under the affiliated country name of Saudi Arabia from 1971 to the date of data extraction. Later from the filter of publication year, we selected the period of ten years from 2014 to 2023 (n=311,477), and from the filter of document types, only “Article” and “Review Article” were selected, and all other types of documents were

excluded (n=295,840). Lastly, the filter of WoS Categories and selected the category of “Dentistry, Oral Surgery & Medicine” (DOSM) were chosen. A total of 4,375 articles were found and the bibliographic details of these articles were downloaded for bibliometric analysis. The bibliometric indicators of periodic growth, types of articles, accessibility modes, frequently used sources of publications, top collaborative countries, most contributing research organizations, most prolific authors, author-used keywords and subject dispersion, were presented in tabular and graphical formats. Microsoft Excel (v16), and VOSviewer software (version 1.6.10 by van Eck and Waltman) were used.[24]

Following were the objectives of the study:-

1. To review the progress of articles, citations, cumulative growth and annual growth by year.
2. To assess the type of documents and modes of accessibility with citation impact.
3. To examine the top 10 frequently used journals.
4. To highlight the top 20 collaborative countries and their co-authorship network.
5. To analyze the top 20 most contributing research organizations
6. To scrutinize the authorship patterns and the most productive authors
7. To investigate the top-20 most occurred author-used keywords and their co-occurrence network.

RESULTS

The study selected the period of the 10 years from 2014 to 2023 in WoS database and further selected articles and review articles from the document type filter. The Saudi Arabian affiliated authors produced around 295,840 articles, further in the WoS Categories, “Dentistry Oral Surgery Medicine” (DOSM) were selected and excluded other categories.

A total of 4,375 (1.47%) articles were identified and Table-1 shows that about one-third (n=1,373; 31.38%) of the articles were published in the first five-year interval, while the rest of the articles (n=3002; 68.62%) were published in the last five years from 2019 to 2023. The highest number of articles (n=667) were published in the year 2021, overall, a growing trend was observed except last two years. These articles (n=4,375) were cited 46,220 times with a mean ratio of 10.56 citations per article. The proportion of self-citation was counted as 7.45% (n=3,440) & more citations were received by older articles than by newer ones. The average annual growth of the articles was recorded at 14.33% and the highest annual increase of about 45% was observed in 2019. Table 1 shows distribution of articles with different variables & figure 1 shows a frequency polygon for article distribution & citation. Table 2 shows articles types and access modes.

Table-1, Distribution of articles, citations, cumulative growth and annual growth by year

Year	Total Articles	Total Citations	Citation Impact	Cumulative Growth	Annual Growth
2014	184	4,243	23.06	184	
2015	243	5,388	22.17	427	32.07
2016	279	5,820	20.86	706	14.81
2017	299	5,467	18.28	1005	7.17

2018	368	5,331	14.49	1373	23.08
2019	533	6,391	11.99	1906	44.84
2020	608	5,463	8.99	2514	14.07
2021	667	4,410	6.61	3181	9.70
2022	635	2,626	4.14	3816	-4.80
2023	559	1,081	1.93	4375	-11.97
Total	4375	46,220	10.56*		14.33**

* Average citations per article, ** Average annual growth rate

Figure-1, Distribution of Articles and Citations by Years

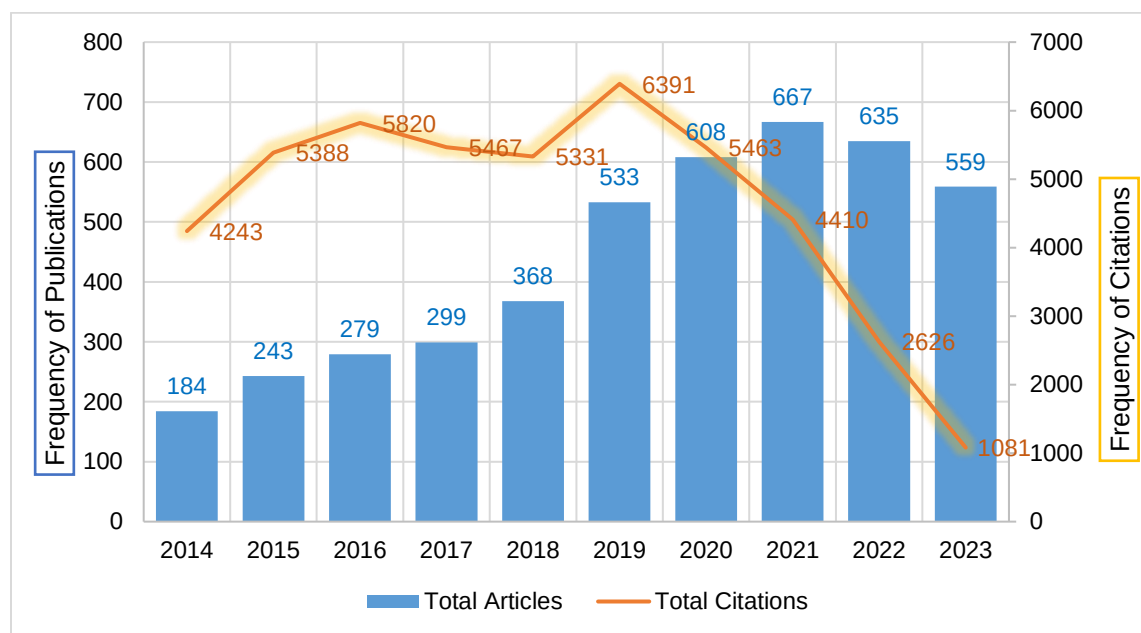


Table-2 elaborates that although the ratio of original research articles was more than review articles, review articles gained a higher citation impact. Similarly, the proportion of subscription-based articles was found lower than open access articles, but subscription-based articles gained higher citation impact.

Table-2, Distribution of articles by types and accessibility modes

Variables	Description	Total Articles	Total Citations	Citation Impact
Type of Documents	Articles	3700	35,610	9.62
	Review Articles	675	10,610	15.72
Accessibility Mode	Open Access Articles	2357	21,367	9.07
	Subscription-Based Articles	2018	24,853	12.32

Saudi Arabian authors published their research on DOSM in 164 journals and more than one-third of the articles (n=1,670; 38.17%) were published in top-10 journals as shown in Table-3. About

nine percent (n=393) of the articles were published in SDJ, followed BMC Oral Health and Journal of International Society of Preventive and Community Dentistry with 218 and 181 articles, respectively. Among the top-10 journals, Journal of Prosthetic Dentistry gained the highest citation impact (16.65 cites/article) and secured the maximum impact factor (4.3 as per Journal Citation report of 2023), while International Journal of Medical Dentistry got the lowest citation impact as well as the lowest impact factor.

Table-3, Top-10 Frequently Used Journals

Serial No.	Name of Journal	Impact Factor	Total Articles	Total Citations	Citation Impact
1	Saudi Dental Journal (SDJ)	1.7	393	3,230	8.22
2	BMC Oral Health	2.6	218	2,061	9.45
3	Journal of International Society of Preventive and Community Dentistry	1.4	181	1,693	9.35
4	Annals of Dental Specialty	0.3	151	97	0.64
5	Open Dentistry Journal	0.5	141	523	3.71
6	International Journal of Dentistry	1.9	139	1,286	9.25
7	Journal of Prosthodontics Implant Esthetic and Reconstructive Dentistry	3.4	128	1,891	14.77
8	International Journal of Medical Dentistry	0.2	113	39	0.35
9	Journal of Prosthetic Dentistry	4.3	112	1,865	16.65
10	Clinical Cosmetic and Investigational Dentistry	1.5	94	645	6.86

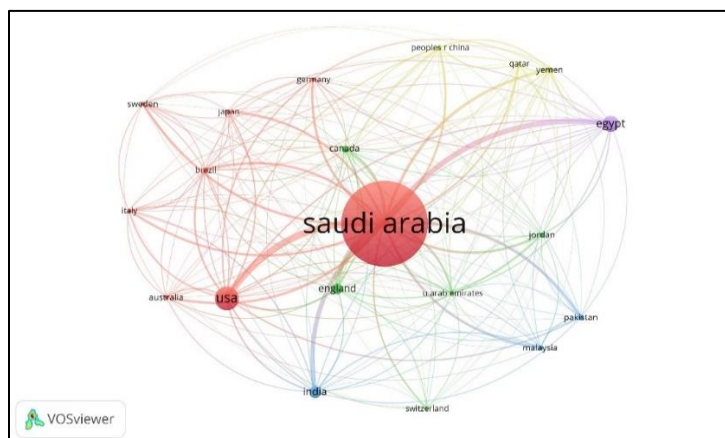
Saudi Arabia authors collaborated with authors from 97 countries and the highest number of research collaborations was performed with the United States (n=849; 19.40%), followed by Egypt, India and England with 524, 361 and 314 articles, respectively. Among the top-20 countries mentioned in Table-4, the maximum citation impact (28.87 cites/article) was gained by the research collaboration with Germany, followed by Japan and Brazil. Figure-2 denotes the authorship network of top-20 countries with Saudi Arabia. The network consisted of five clusters, eight countries (Australia, Brazil, Germany, Italy, Japan, Saudi Arabia, Sweden, & United States) comprised in top-one cluster represented in red knobs, and then the second cluster of green knobs embodied five countries (Canada, England, Jordan, Switzerland, United Arab Emirates).

Table-4, Top 20 Collaborative Countries

Rank	Country	Total Articles	Total Citations	Citation Impact
1.	United States	849	12,167	14.33
2.	Egypt	524	5,983	11.42
3.	India	361	3,077	8.52
4.	England	314	5,639	17.96

5.	Canada	177	2,720	15.37
6.	Yemen	147	1,370	9.32
7.	Pakistan	142	2,272	16.00
8.	Jordan	112	1,406	12.55
9.	Malaysia	111	1,001	9.02
10.	Sweden	106	1,063	10.03
11.	Australia	101	1,582	15.66
12.	Brazil	95	2,184	22.99
13.	Germany	93	2,685	28.87
14.	China	89	1,218	13.69
15.	United Arab Emirates	89	655	7.36
16.	Italy	88	1,211	13.76
17.	Japan	79	1,856	23.49
18.	Qatar	56	370	6.61
19.	Switzerland	48	739	15.40
20.	Syria	46	608	13.21

Figure-2, Co-authorship network of top-20 countries



The authors belonged to 2,410 organizations that contributed in 4,375 articles and 63.31% (n=1,526) organizations had contributed one article. The details of 20 top research producing

organizations are presented in Table-5. More than one-fourth (n=1,126; 25.73%) of research on DOSM produced by the authors of King Saud University, then, King Abdulaziz University (n=673; 15.38%), Imam Abdulrahman Bin Faisal University (n=338; 7.72%) and Jazan University (n=251; 5.73%). Top-14 organizations belonged to Saudi Arabia while the rest belonged to Egypt, United States and United Kingdom. The research collaboration done with the authors of University of Rochester, United States got the highest citation impact (23.15 cites/article) and among the national level research organizations, the research produced by the Taibah University gained the maximum citation impact (14.59 cites/article), followed by King Saud University (13.18 cites/article).

Table-5, Top-20 Most Contributing Research Organizations

Rank	Organization's Name	Total Articles	Total Citations	Citations Impact
1.	King Saud University	1,126	1,4836	13.18
2.	King Abdulaziz University	673	7,795	11.58
3.	Imam Abdulrahman Bin Faisal University	338	3,178	9.40
4.	Jazan University	251	2,532	10.09
5.	Ministry of Health,	222	1,859	8.37
6.	King Saud bin Abdulaziz University for Health Sciences	218	2,153	9.88
7.	Taibah University	214	3,122	14.59
8.	Riyadh Elm University	193	926	4.80
9.	King Khalid University	187	1,024	5.48
10.	Umm Al Qura University	183	1,306	7.14
11.	Qassim University	164	1,016	6.20
12.	Princess Nourah Bint Abdulrahman University	153	1,769	11.56
13.	Jouf University	143	715	5.00
14.	Prince Sattam Bin Abdulaziz University	132	936	7.09
15.	Cairo University, Egypt	126	2,121	16.83
16.	Alexandria University, Egypt	108	957	8.86
17.	Al Azhar University, Egypt	105	897	8.54
18.	University of Rochester, United States	88	2,037	23.15
19.	Tufts University, United States	78	1,431	18.35
20.	Kings College London	78	1,162	14.90

The examination of the authors denotes that 21,415 authors including multiple counts contributed to 4,375 articles with an average of 4.89 authors per article. The ratio of average authors per article was recorded at 4.42 during the first five years (2014-2018), while the ratio of authors per article increased to 5.11 in the next five years (2019-2023).

The exploration of authorship pattern reveals that about 10% (n=416; 9.51%) of the articles were written by a single author pattern and these articles gained an average of 8.80 citations per article, while 90.49% (n=3,959) articles were written by multi-author pattern and these article gained

higher ratio of citations (10.75 cites/article). The six-author pattern was found a most frequent (n=730; 16.68%) followed by five-author (n=686; 15.68%) and four-authors (n=665; 15.02%).

As a distinct name, 12,722 authors were identified by VOSviewer software and more than three-fourths (n=9801; 77%) of the authors had published one article. The details of top-20 Saudi Arabian affiliated authors are shown in Table-6. Mohammad Khursheed Alam of AlJouf University emerged as the most prolific author with 92 articles, followed by Fahim Vohra of King Saud University and Mohammed Mustafa Gad of Imam Abdulrahman Bin Faisal University with 69 and 57 articles, respectively. Zohaib Khurshid of King Faisal University emerged as the most influential author based on citation impact (36.25 cites/article) followed by Zuhair S. Natto of King Abdulaziz University (30.32 cites/articles) and Abdulaziz A. Al-Kheraif of King Saud University (24.06 cite/article). Among the top-20 authors, seven authors belonged to Imam Abdulrahman Bin Faisal University, followed by five authors from King Saud University, three authors from AlJouf University, two authors from Jazan University and one each from King Abdulaziz University, King Faisal University and King Saud bin Abdulaziz University for Health Sciences.

Table-6, Top-20 Most Productive Saudi Arabian Affiliated Authors

Rank	Authors' Name	Affiliation	Total Articles	Total Citations	Citation Impact
1.	Mohammad Khursheed Alam	AlJouf University	92	818	8.89
2.	Fahim Vohra	King Saud University	69	1,442	20.9
3.	Mohammed Mustafa Gad	Imam Abdulrahman Bin Faisal University	57	844	14.81
4.	Tariq Abduljabbar	King Saud University	51	935	18.33
5.	Esam Halboub,	Jazan University	49	665	13.57
6.	Abdulaziz A. Al-Kheraif	King Saud University	47	1,131	24.06
7.	Maged Sultan Alhamadi	Jazan University	39	286	7.33
8.	Ahmad M. Al-Thobity	Imam Abdulrahman Bin Faisal University	39	618	15.85
9.	Santosh R. Patil	AlJouf University	31	301	9.71
10.	Abdulaziz Alhelal	King Saud University	30	417	13.90
11.	Mohammad D. Al Amri	King Saud University	30	614	20.47
12.	Zuhair S. Natto	King Abdulaziz University	28	849	30.32
13.	Ahmed Jamleh	King Saud bin Abdulaziz University for Health Sciences	27	355	13.55
14.	Sultan Akhtar	Imam Abdulrahman Bin Faisal University	26	494	19.00
15.	Soban Q. Khan	Imam Abdulrahman Bin Faisal University	26	380	14.92
16.	Zohaib Khurshid	King Faisal University	24	870	36.25

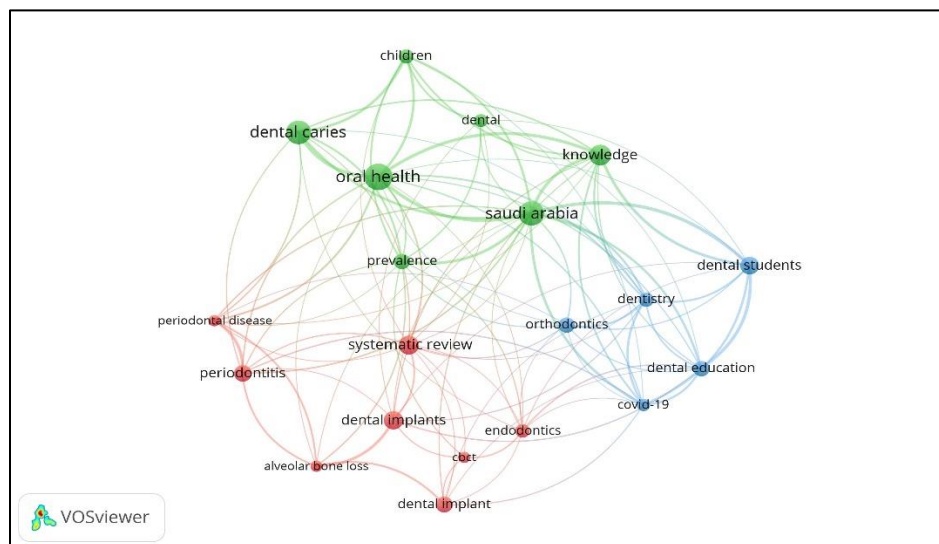
17.	Fahad A. Al-Harbi	Imam Abdulrahman Bin Faisal University	24	512	21.33
18.	Muhammad Ashraf Nazir	Imam Abdulrahman Bin Faisal University	24	113	4.71
19.	Kiran Kumar Ganji	AlJouf University	23	85	3.7
20.	Reem Abualsaud	Imam Abdulrahman Bin Faisal University	24	457	19.04

The scrutiny of author-used keywords revealed that 8,689 keywords were identified and 72.51% (n=6,301) keywords have occurred once. The keywords of Oral Health, Saudi Arabia, Dental Caries and Knowledge occurred more than 100 times. The details of other keywords are mentioned in Table-7. The co-occurrence network of top-20 author-used keywords produced by VOSviewers software is shown in Figure-3. These keywords are distributed into three clusters, first cluster consists of eight keywords (Alveolar Bone Loss, CBCT, Dental Implant, Dental Implants, Endodontics, Periodontal disease, Periodontitis, Systematic review), the second cluster is comprised of seven keywords (Children, Dental, Dental Caries, Knowledge, Oral Health, Prevalence, Saudi Arabia) and the third cluster consisted of five keywords (Covid-19, Dental education, Dental students, dentistry, orthodontics).

Table-7, Top-20 Most Occurred Keywords

Serial No.	Keyword	Occurrences	Serial No.	Keyword	Occurrences
1.	Oral Health	134	11.	Orthodontics	70
2.	Saudi Arabia	121	12.	Prevalence	70
3.	Dental Caries	116	13.	Children	65
4.	Knowledge	102	14.	Dentistry	64
5.	Systematic Review	92	15.	Endodontics	61
6.	Dental Implants	87	16.	Dental	58
7.	Dental Students	84	17.	Covid-19	56
8.	Periodontitis	77	18.	Alveolar Bone Loss	50
9.	Dental Implant	74	19.	Periodontal Disease	50
10.	Dental Education	71	20.	CBCT	49

Figure-3, Co-Occurrence Network of Top-20 Keywords



DISCUSSION

The core component of any organization or field of study is research and an assessment of research publications on a certain topic helps other professionals to understand the driving forces behind its development.[9] The research is crucial in assisting scholars in identifying knowledge gaps by critically evaluating the body of literature that is currently available. By going through a peer-review process, the publication procedure enables the researchers to have their work examined and value their contributions to the field.[25] One of the most widely used research techniques to evaluate the qualities and attributes of publications is the bibliometric study.[8]

This study's bibliometric analysis offers insightful information about the state of dental research in Saudi Arabia. The results show several significant trends and patterns that advance our understating of the evolution dental research in the country. The present study examines the dataset taken from WoS database to highlight the various bibliometric attributes of dental research produced by Saudi Arabia during the last decade (2014-2023). Our findings illustrate that Saudi Arabia has significantly improved in dental research from 184 articles in the year 2014 to 559 articles in the year 2023 with an average annual growth rate of 14.33%. The articles have grown exponentially in the first eight years and fluctuation has been seen in the last two years of study. Ababneh et al., assessed the periodontics research in Saudi Arabia from 2012 to 2021 and reported that a growing trend from 49 articles in 2012 to 281 articles in 2021.[19] Alfadley et al., reported the findings of Scimago Journal and Country Rank (SJR) portal that Saudi Arabia stood in ninth rank globally in dental research in 2019.[15] Other bibliometric studies focused on dental research revealed that more than one-third of the total dental research in the Arab world was produced by Saudi Arabia.[6,13] Another bibliometric study on orthodontic research in the Arab World also endorsed similar findings.[14]

Citation counts are a useful tool for evaluating the quality and excellence of academic literature.[26] It indicates the number of times other academics have cited the study dataset in their writings. The citations show that academic work has fairly shared and exchanged. The sharing of information contributes to the development of a knowledge-based society and significantly

supports the addition of valuable knowledge to the body of existing knowledge. [27] Our study stated that 4,375 articles gained an average of 10.56 citations per article and older articles gained more citations as the articles published in 2014 were cited with an average of 22.06 citations per article. In line with this finding, the study described that Saudi Arabian authors produced 1,771 papers on dentistry from 2009 to 2018 and these papers were cited with an average of 5.83 citations per paper. This study also endorsed the fact that review articles gained a higher ratio of average citations as compared to original research articles.[28] Our study also confirmed that review articles and subscription-based articles gained more citations as compared to original research articles and open-accessed articles.

Regarding the preferred publication channels, our study stated that more than one-third of the articles (38.17%) were published in the top-10 frequently used journals and the maximum number of articles (n=393) was published in SDJ, followed by BMC Oral Health and Journal of International Society of Preventive and Community Dentistry with 218 and 181 articles, respectively. Earlier studies pointed out that SDJ was the second most preferred source of publications for Saudi Dentists.[12,16] SDJ is a prestigious, open-access journal with having impact factor of 1.7 and recently SDJ enhanced its publication frequency from eight issues to 12 issues in a year. Jamjoom et al., revealed that out of 522 articles published in SDJ from 2012 to 2012, more than half (51.72%) of articles were contributed by Saudi Arabia, while the rest of the literature was submitted by authors from 40 countries. These articles were cited with an average of 21.19 citations per article as a Google Scholar citation metric.[21]

The current era of research largely relies on international collaboration due to the effects of globalization and the continual growth of scientific communication. Therefore, there may be a gradual drop in the standard and significance of research at universities that fail to emphasize international collaboration. [29] The analysis of research collaboration in our study, exposed that Saudi Arabian dental researchers collaborated with authors from 97 countries about one-fifth of the articles (19.40%) were produced with the collaboration of the United States but the research performed with the German authors gained the highest number of citations (28.87 cites/article). Alrubaig et al., measured the endodontic research of Saudi Arabia and stated that the highest number of research collaborations was done with the United States, India and Egypt. [16] The findings of Ababneh's paper on periodontics research in Saudi Arabia from 2012 to 2021 and validated the findings that the highest number of research collaborations was performed with United States but research with Germany got the highest citation impact.[19]

Universities and research organizations have a big impact on the sustainable development of society and improving the quality of human life. They are essential to the advancement of the different technological, social, cultural, and economic segments of the community.[25] The gigantic research productivity comes from the universities. Our study reported that about half of the dental research (48.84%) in Saudi Arabia was produced by the three universities: King Saud University, King Abdulaziz University and Imam Abdulrahman bin Faisal University. Another study conducted by Alonaizan et al., who scanned the collaborative dental research in Saudi Arabia endorsed similar findings. This study stated that about two-thirds (63.4%) of the articles had international collaboration and the highest number of research was produced by King Saud University, followed by King Abdulaziz University and Imam Abdulrahman bin Faisal University. [22] These universities are well established, with exceptional faculty, state of the art research

facilities and a congenial research environment to carry out quality research, while other Saudi universities were very enthusiastic and increased their research productivity.

In our study, an average of 4.89 authors per article has been identified, this ratio of average authors per article was increased from 4.42 in the first five years (2014-2018), to 5.11 in the next five years (2019-2023). About 10% of the articles were written by a single author, while the majority of articles were produced by multi-author patterns. The six-author pattern was found the most frequent (16.68%) followed by five-author (15.68%). A study reviewed the dental research trends in Saudi Arabia from 2010 to 2020 stated that about 23% of the papers had been written by a single author followed by two-author pattern (16%). [3] Awawdeh et al., study on the bibliometric evaluation of orthodontic research in Arab League Nations reported that three-author pattern was found common (19.72%), and only 13% of articles written by a single-author pattern. [14] Another study focused on collaborative research in dentistry revealed that the ratio of average authors per article was found 5.27 in 5,089 articles and this study excluded 12% of single-author articles.[22]

The analysis of distinct names of authors in our study exposed that more than three-fourths (77%) of the authors had published one article. In line with this finding, a bibliometric study on regenerative periodontics surgery stated that 4,823 authors contributed to 1,794 documents, with 79.6% of the authors contributing to just one document. These results show that small number of researchers made the greatest number of scientific contributions.[30]

We found that the Jouf University came on 13th rank in contributing organization with 143 articles and Mohammad Khursheed Alam of this University emerged as the most prolific author in our study with 92 articles, followed by Fahim Vohra of King Saud University and Mohammed Mustafa Gad of Imam Abdulrahman Bin Faisal University with 69 and 57 articles, respectively. Among to top authors, mostly belonged to Imam Abdulrahman Bin Faisal University, and King Saud University.

There are a few limitations to this study , first was that only the WoS database was used to extract data, further, to broaden the study's findings, more data sources such as MEDLINE, Scopus, and others could be consulted. Lastly, only VoSviewer software had been used for co-authors network and co-occurrence clusters, therefore it is advised that; future scholars conduct bibliometric analysis using a variety of databases and visualization applications.

Conclusion

The study used bibliometric research methods to ascertain the publication trends in dentistry in Saudi Arabia over the past decade (2014 to 2023). A steady growth in publications of articles has been observed except in 2022 and 2023. An increase in dental research in the country has been strongly correlated with government investment in human resources. Dental research is mostly published in international journals but Saudi-based journal, SDJ was found most preferred. Publications of articles in international sources showing the diversification of dental literature. The analysis of co-authors has shown that the majority of authors (77%) had contributed in one article and about half of the research produced by three leading universities of Saudi Arabia. The analysis of the keywords might support the dental authors in their research endeavors and motivate them to conduct research on innovative topics. The results of this study could benefit academicians,

researchers, and practitioners interested in dental research as well as for decision makers to allocate funds and make research policies.

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