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# Gender Variation, subject dispersion and citation impact in dental research: A bibliometric analysis of publications from 2009–2021

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## ABSTRACT

**Aim:** This study probed into the gender variation, subject dispersion and citation impact of dental research with an objective to highlight the increasing influence of female authors in the field of dentistry.

**Methodology:** The research employed bibliometric techniques to highlight gender variation in dental research as demonstrated in the Saudi Dental Journal (SDJ), over a period of thirteen years, 2009–2021. The examination comprised SDJ publications indexed in PubMed, with citation data extracted from Google Scholar on July 2023. The analysis encompassed the progressive growth of papers, authors, and citations, the gender distribution of authors, the co-authorship structure, subject dispersion, and collaboration patterns based on affiliation, both national and international.

**Results:** 625 SDJ publications were identified in the PubMed database from 2009 to 2021. There was a notable rise in the volume of papers and the number of authors per year. The citation impact analysis revealed that these 625 papers achieved an average of 26 citations each. Remarkably, the representation of female authors increased from 0.47 to 2.23 authors per paper during the study period. The authorship pattern largely showed single-authorship, closely followed by a three-author pattern. Almost half the papers (48%) were a collaboration between male and female authors, with female authors solely producing about 15% of papers.

The topological classification of papers revealed that the most considerable number of papers were on Periodontics, with the least number focusing on Oral and Maxillofacial Surgery. Female authors prominently contributed to Pediatric Dentistry and Periodontics papers.

**Conclusion:** The study illustrates an encouraging trend of heightened female authorship in dental research over the years. Their increasing engagement not only enriches the academic diversity but also impacts the progressive evolution of dental science, contributing to a more inclusive and balanced society.

## 1. Introduction

Evaluating research necessitates assessing both the quantity and quality of scholarly publications across reputable journals and communication platforms (Khan et al., 2021). This entails considering factors like publication count and their respective influence within academic circles. Such rigorous assessments validate research's credibility and underscore its significance in shaping global knowledge and societal

progress. Notably, there has been a marked surge in research advancements in recent decades (Meo et al., 2013; Khayat and Rajeh, 2022). Dentistry has seen a remarkable increase in research, driven by advancements in education, materials, and technology, as well as a vibrant global research culture. Pursuing excellence in oral healthcare through cutting-edge research elevates overall health and well-being (Haq et al., 2019). In addition, the dissemination of knowledge through such research not only paves the way for future breakthroughs (Celeste et al.,

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2016) but also sets benchmarks for global dental studies (Yu et al., 2022).

The evaluation and measurement of research growth can be a complex process. Bibliometric methods analyze the scope and impact of published research, offering insights into growth patterns, citations, and collaborations (Shehata and Mahmood, 2016). These studies evaluate publication outputs across authors, institutions, and regions and are pivotal for policy and grant decisions. Ranking agencies rely on bibliometric indices from reputable databases such as Web of Science and Scopus to gauge research productivity, influencing evaluations across the academic landscape (Adnan et al., 2022; Alfadley et al., 2021; Aqil et al., 2022). Bibliometric studies have illuminated dental research trends across different specialties (Shamszadeh et al., 2019; Mavropoulos and Kiliaridis, 2003; Basnet et al., 2018; Geminiani et al., 2014; Susarla et al., 2017). Remarkably, Saudi Arabia, representing over a third of the Arab World's dental literature, stood ninth globally in dental research contributions in 2019 (Ul Haq et al., 2020; Haq et al., 2019; Alfadley et al., 2021). A study focusing on Endodontics research in the Gulf Cooperation Council revealed Saudi Arabia's regional dominance, contributing 80 % of Endodontics research (Alfadley et al., 2022).

Scientific journals are integral in scholarly communication (Kevin et al., 2009). The Saudi Dental Journal (SDJ), established in 1989 as the Saudi Dental Society's official publication, has grown into a widely recognized and influential dental journal. Published by King Saud University in collaboration with Elsevier, the SDJ transitioned to open access in 2009 and was later included in PubMed, enhancing its reach. In Scopus, it stands in the 2nd quartile with a 3.5 CiteScore, ranking 44th out of 115 General Dentistry journals. Recently, it obtained its first impact factor of 1.8 in the Web of Science database.

Multiple bibliometric studies analyzed dental journal literature. Jamjoom et al. (2023) reviewed 522 articles from the Scientific Journal Database (SJD) between 2012 and 2021, with a majority at Level of Evidence (LOE) IV and V, and an average of 21.19 citations. Khan et al. (2021) and Moraes et al. (2020) studied author collaborations in International Endodontic Journals and the Brazilian Dental Journal. Mayta-Tovalino et al. (2023) reported an 11.4 citation average from the International Dental Journal, emphasizing the high impact of international collaborations. Alfadley et al. (2021) observed a trend of three-author collaborations in the Saudi Endodontic Journal, averaging 3.8 citations. Khayat and Rajeh (2022) noted King Saud University's dominance in Saudi dental literature and rising collaboration rates. Adnan et al. (2022) evaluated the Journal of College of Physicians and Surgeons Pakistan, identifying prevalent research topics and male-led authorship.

The current study aimed to analyze bibliometric characteristics of SDJ papers from 2009 to 2021. This encompassed annual numbers of papers, authors, and citations, co-authorship dynamics, gender distribution with a spotlight on female authorship, categorization by dental specialties, and a comparison of Saudi versus international affiliations.

## 2. Material and methods

In this bibliometric study, gender variations in the SDJ's dental research from 2009 to 2021 were assessed. Bibliographic data was sourced from PubMed and citations from Google Scholar, with datasets retrieved in July 2023. Two researchers categorized the papers and determined Arabic authors' gender and affiliations. Gender identification for other authors involved collaboration with Indian and Canadian faculty. The team then analyzed publication growth, author and citation counts, gender distribution, authorship and collaboration patterns, and subject categorization. The data was tabulated and graphically presented using Microsoft Excel.

## 3. Results

### 3.1. Distribution of papers, authors and citations by year

Table 1 illustrates an annual breakdown of 625 papers from SDJ published between 2009 and 2021, as indexed in PubMed. From 2009 to 2017, there was an average output of about 30 papers annually, but this escalated to nearly 89 papers yearly from 2018 to 2021, making up 57 % of all publications. Of the 2,240 contributing authors, the average authorship per paper increased from approximately 2 in 2009 to approximately 5 in 2021. In total, the papers received 16,361 citations, averaging 26 per paper, with 2014's publications achieving the highest average at 54 citations per paper.

### 3.2. Distribution of authors productivity by gender

Table 2 shows the distribution of authorship by gender, revealing an overall greater ratio of male authors (61 %) in comparison to their female counterparts (39 %). In the initial five-year span of the study (2009–2013), female authorship accounted for 32 % of the total, however, it witnessed an increase, reaching 41 % in the subsequent eight years (2014–2021). In 2009, the average ratio of authors per paper was higher for males at 1.20 versus females at 0.47. Interestingly, by 2021, there was an escalation in the average authors per paper for both genders, with males contributing 2.47 authors per paper and females coming in close at 2.23 authors per paper.

### 3.3. Patterns of co-authorship by gender

Fig. 1 details authorship patterns in papers. Single-authored papers lead with 141 articles, followed by three-author (n = 109), four-author (n = 91), and two-author papers (n = 82). Over three-fourths (n = 484; 77 %) involved collaborative authorship, with solo-authored papers achieving the highest citation rate at 39 per paper, compared to 23 for multi-authored works. Further examination of authorship configurations uncovers that, outside of the single-authorship category, the papers with the highest citations are papers authored by a trio of male and female collaborators. While male authors contributed to 37 % (n = 231) of papers, surpassing females at 15 % (n = 92), collaborations between both genders represented the majority (n = 301; 48 %). In terms of citation impact, male-only papers ranked highest, followed by female-only and mixed-gender collaborations.

### 3.4. Distribution of papers by subject-category of dentistry and gender

The study evaluated 625 articles, categorizing them into twelve distinct fields of dentistry, including a miscellaneous category (Fig. 2). Periodontics dominated the publications, while oral and maxillofacial radiology had the fewest. The 'miscellaneous' category achieved the highest citation impact, with dental public health and restorative dentistry papers following closely. Periodontics and endodontics averaged over four authors per paper, whereas oral medicine had the fewest, averaging fewer than three. Male authors dominated across all disciplines, but pediatric dentistry, periodontics and restorative dentistry showed the highest proportion of female authorship.

### 3.5. Pattern of research collaboration and its citation impact

Table 3 shows that Saudi Arabian authors solely contributed to 44 % (n = 275) of the total research papers, a body of work termed as indigenous research. International authors, in comparison, contributed 263 papers. Combined efforts from both international and Saudi Arabian authors resulted in 87 collaborative papers. The indigenous research purely conducted by Saudi Arabian authors outperformed others in terms of citation impact. International-authored papers displayed a slightly elevated percentage of female contributors compared to those

**Table 1**  
Distribution of papers, authors and citations by year.

Year	Total number of papers	Percentage	Total number of authors	Average number of authors per paper	Total citations	Average citations per paper
2009	15	2.40	25	1.67	322	21.47
2010	34	5.44	74	2.18	1,256	36.94
2011	36	5.76	89	2.47	1,336	37.11
2012	28	4.48	73	2.61	1,081	38.61
2013	27	4.32	65	2.41	1,347	49.89
2014	29	4.64	82	2.83	1,573	54.24
2015	38	6.08	114	3.00	1,298	34.16
2016	32	5.12	80	2.50	1,157	36.16
2017	29	4.64	105	3.62	1,327	45.76
2018	57	9.12	216	3.79	1,713	30.05
2019	76	12.16	289	3.80	1,619	21.30
2020	57	9.12	242	4.25	1,331	23.35
2021	167	26.72	786	4.71	1,001	5.99
Total	625	100	2240	3.06*	16,361	26.18*

Average\*.

**Table 2**  
Distribution of authors productivity by gender.

Year	Total number of papers	Total number of authors	Male authors	Average number of male authors per paper	Female Authors	Average number of female authors per paper
2009	15	25	18	1.20	7	0.47
2010	34	74	48	1.41	26	0.76
2011	36	89	69	1.92	20	0.56
2012	28	73	43	1.54	30	1.07
2013	27	65	44	1.63	21	0.78
2014	29	82	57	1.97	25	0.86
2015	38	114	78	2.05	36	0.95
2016	32	80	55	1.72	25	0.78
2017	29	105	74	2.55	31	1.07
2018	57	216	132	2.32	84	1.47
2019	76	289	180	2.37	109	1.43
2020	57	242	147	2.58	95	1.67
2021	167	786	413	2.47	373	2.23
Total	625	2240	1358	2.17*	882	1.41*

Average\*.

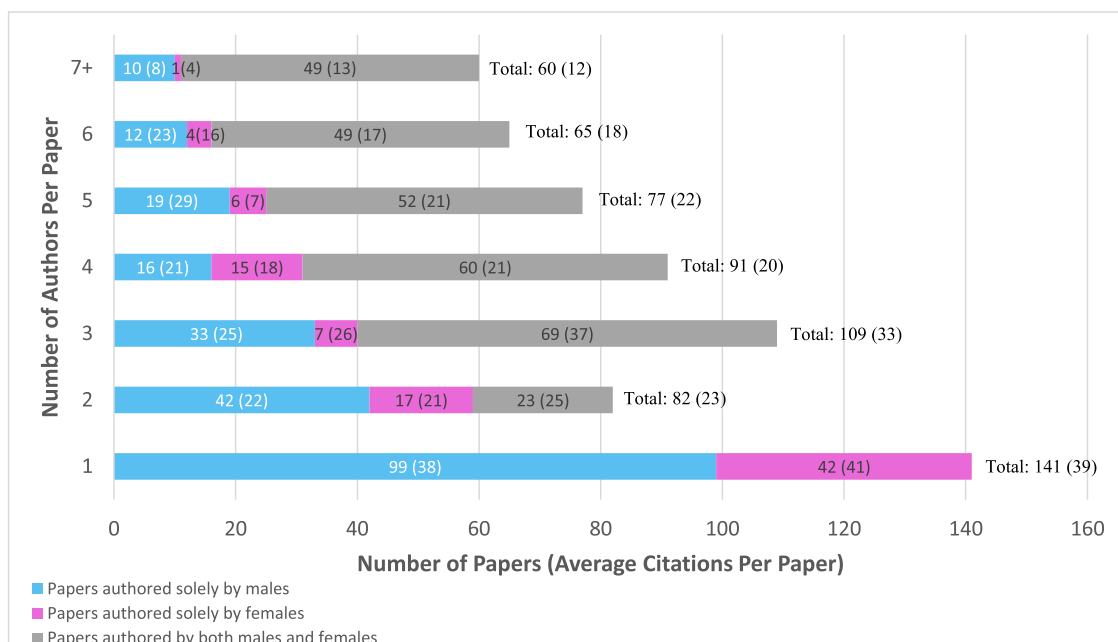
from Saudi Arabia. This female contribution, however, dropped even further in the works co-authored by Saudi Arabian and international authors.

#### 4. Discussion

The study offers a detailed bibliometric analysis of the SDJ, a leading dentistry journal in Saudi Arabia and the Gulf region, spanning 2009–2021. Utilizing metadata from open-access platforms such as PubMed and Google Scholar, it highlights significant trends and contributor demographics in dental research locally and internationally (Jamjoom et al., 2023).

Between 2009 and 2021, 625 papers were published in SDJ, averaging 48 papers annually. The first nine years had an average of 30 papers yearly, which escalated to 89 in the latter four years, with a peak of 167 papers in 2021. Initially, only two issues in 2009 were indexed in PubMed. The SDJ published quarterly until 2019, but from 2020, it released eight issues a year, adding a supplementary issue in 2019.

The recent surge in publication growth can be attributed to increased investments in Saudi Arabian higher education and the establishment of new academic institutions. Universities have emphasized research, evident in hiring and promotion criteria, and enhanced their research



**Fig. 1.** Patterns of co-authorship by gender.

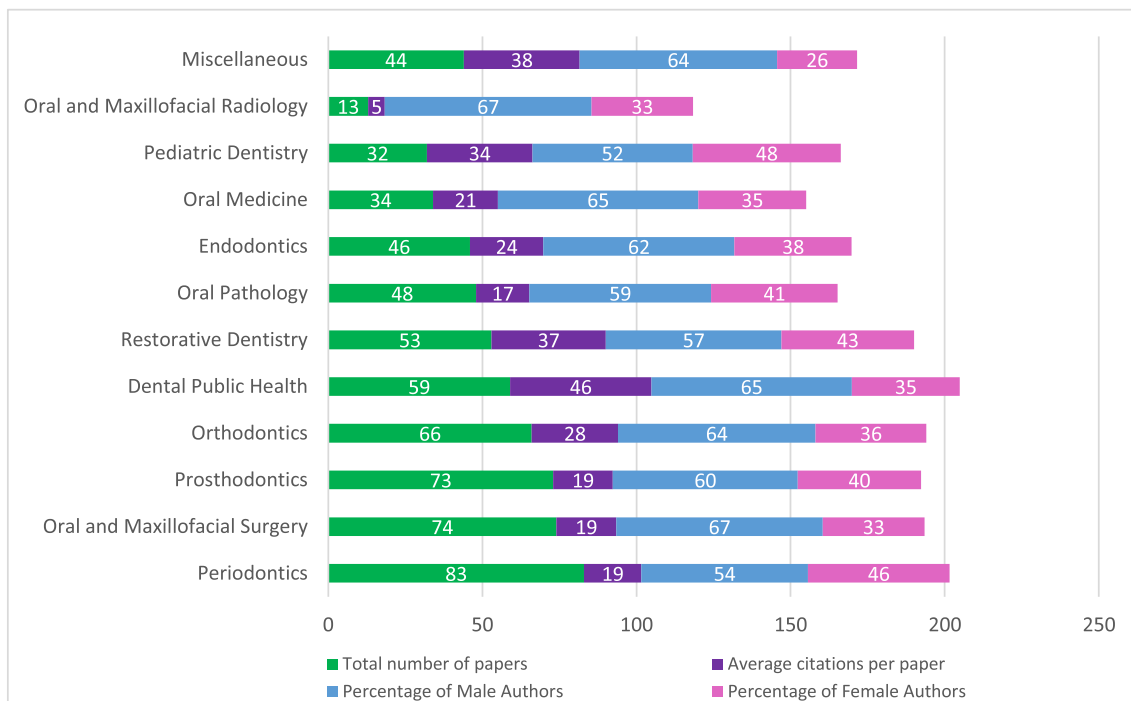


Fig. 2. Distribution of papers by subject-category of dentistry and gender.

Table 3

Pattern of national (Saudi Arabian), international and research collaboration between national and international authors with citation impact.

Affiliation of Authors	Total number of papers	Average citations per paper	Average number of authors per paper	Percentage of male authors	Percentage of female authors
National (Saudi Arabian authors only)	275	29.87	3.17	60.62 %	39.38 %
International Authors only	263	24.45	3.73	58.92 %	41.08 %
Collaboration between Saudi and International authors	87	19.70	4.46	64.95 %	35.05 %

units. Updated research policies, encouragement of both national and international collaborations, and incentivizing research production have amplified this trend. Research output has become vital for institutions aiming for sustainability and competitiveness (Aqil et al., 2022; Zaher et al., 2018; Shehatta and Mahmood, 2016).

A bibliometric analysis of the Saudi Medical Journal from 1979 to 2019 demonstrated a rise from 20 to 205 papers. Half were from Saudi Arabia, with the rest from 80 other countries. Notably, a quarter came from three main Saudi institutions: King Saud University, King Abdulaziz University, and King Faisal Specialized Hospital and Research Center (Tanveer et al., 2020).

Using Google Scholar, it was found that the SDJ papers received 16,361 citations, averaging 26 per paper. A study on LOE found an average of 21 citations for each of 522 articles from the SDJ between 2012 and 2021 (Jamjoom et al., 2023).

Citations are accepted as a credible metric of fair sharing of scientific communication, facilitating the growth of a knowledge-driven environment (Davis, 2011). A study on Saudi Arabian dental research from 2009 to 2018 analyzed 1,771 papers from the Web of Science, showing an average of 6 citations per paper. Hospital-based research had greater citation impact than university-based. While the U.S. was the predominant research collaboration partner, higher citation rates were seen with Italy, Germany, and Japan. Among the preferred publication sources, the SDJ ranked second, with 85 papers averaging 1.86 citations each. Google Scholar’s broader scope, as opposed to the Web of Science, may explain our study’s higher citation impact (Yang and Meho, 2006).

In examining 625 articles from the SDJ, the current study found an average of 3 co-authors per paper, with a trend towards increased

collaboration from 2009 to 2021. Initially, papers averaged 2 authors, but this grew to 4 by 2021. In contrast, Batcha’s (2018) study of 11,350 dental papers found an average of 4 authors, with four-author collaborations appearing in 19 % of articles. Thus, the SDJ’s authorship ratio is relatively lower than global trends.

The study highlights the growing role of women in academia, with their presence in dental research notably increasing. Their active participation strengthens societal fabric and enhances the academic sphere. Despite historical limitations in representation within the healthcare sector, and particularly within dentistry (Ioannidou et al., 2019), about 39 % of SDJ authors were female. This figure grew from 32 % in 2009–2013 to 41 % in 2014–2021, reflecting women’s significant impact on dental research.

Pinho-Gomes et al., (2020) found that only 34 % of authors in 1,370 COVID-19-related studies were female. Similarly, a study from 2011 to 2018 in a library and information science journal showed women comprised 29 % of the total authors in a total of 464 papers with an average of 2 authors per paper (Patel and Verma, 2019).

Upon investigation of authorship by gender, it was found that males, both solo and collaborating, contributed to 37 % of papers, while female authors represented 15 %. Collaborative authorship between both genders constituted 48 %. Periodontics dominated thematic classifications with 83 papers, averaging four authors each. This field also ranked second with a notable 46 % female authorship. Pediatric dentistry has the highest female author ratio, followed by periodontics and restorative dentistry. This may be attributed to a greater representation of females in these dental specialties relative to others. Additionally, dental public health papers received the most citations, and oral medicine

demonstrated the smallest authorship team sizes compared to other dental disciplines.

Saudi-affiliated authors contributed to 58 % of the papers, with 44 % solely by Saudi nationals, while international authors composed 42 %. Collaborations between Saudi and international authors occurred in 14 % of papers. Female representation was higher in internationally contributed papers than those contributed by Saudi authors. Female involvement in Saudi-international collaborations was even lower (Table 3). This is consistent with the challenges identified by Rajeh et al., (2017), that may deter professional development of female dentists in Saudi Arabia, these being; family responsibilities, sociocultural factors, workplace challenges, and transportation concerns.

The present study could serve as an eye-opener for dental researchers, driving a deeper understanding of the prominence and involvement of female authors across the spectrum of the SDJ. This endeavor could not only assist as a stepping stone for future investigations assessing the role of female authors in diverse fields of knowledge but also motivate more contributions from female authors, thereby expanding the horizons of knowledge. In the Islamic world, and notably in Saudi Arabia, women are increasingly being granted equal opportunities. This allows them to demonstrate their talents and make significant contributions towards the nation's development.

The scope of this study focused on the SDJ's PubMed-indexed papers, with citation data from Google Scholar. Future investigations might consider data from Web of Science and Scopus, exploring the most prolific authors, top contributing institutions and countries, characteristics of highly cited papers, and classification of papers according to research design. Additionally, assessing self-citations and comparing the SDJ with other dental journals would offer deeper insights.

## 5. Conclusion

This study explores co-authorship trends, gender dynamics, and citation impact in the SDJ over a chosen timeframe. A noticeable growth in literature was observed, especially in recent years, with an increase in female author contributions. Papers contributed by Saudi Arabian authors gained more citations as compared to international contributions. Interestingly, the study found that the quality of the research paper was predominantly determined by the nature of the study rather than the number of contributors. While single-author papers had the highest citation impact, research with international collaboration, despite more authors, had lesser impact. Periodontics was the preferred research domain, with oral and maxillofacial radiology less chosen. The findings aim to guide future dental research trends and policies. Anticipating the outcomes of this study, it is hoped that these insights, besides supporting dental researchers and policy-makers in understanding the current growth and trends, will importantly inform and shape the course of future research in the field.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sdentj.2023.10.007>.

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