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ORIGINAL ARTICLE

Research Productivity in Surgery from Pakistan: A Bibliometric Analysis (2001-2022)

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ABSTRACT

Aim: To evaluate the main bibliometric indicators and analyze the development of surgery-related research in Pakistan.
Methods: This was a descriptive bibliometric analysis. The Web of Science (WoS) database was used to extract data. The study analyzed all English-language articleson surgery research from Pakistan from 2001 to 2021. To analyze the data, R-Bibliometrics software was utilized.
Results: There were 748 articles, with 163 sources,11973 authors, and 39.97% international co-authorship. Annual growth rate was 9.91%. International Journal of Surgery, International Journal of Surgery Case Reports, World Journal of Surgery, and World Neurosurgery were the most leading sources, with >40 publications each. Overall, an increasing trend was observed during last 10 years, including 72.9% of all publications. Zafar H, Haider AH, Khan S, Zafar SN, &Enam SA published >20 articles. Enam SA had highest TC (1796), followed by Elkelany A, and Hanrahan M, 845 each. Aga Khan University Hospital and Aga Khan University displayed >200 affiliations. Karachi had 50% top ten most affiliated institutes. Mostly, funding agencies were international, except HEC which was leading from Pakistan. The articles published by Agha RA had highest citations.
Conclusions: Policymakers need to redesign research policies to increase faculty members' research productivity. Support is required in funding sources, professional development, and collaboration to produce high impact research. The findings could be useful for surgeons and researchers who want to study surgery-related research trends in the region including Pakistan. Certain practical implications can be deducted from this research. Influential authors and institutions can be identified which can help in decision-making regarding potential opportunities and collaborations. Identifying emerging trends and gaps would be helpful for researchers in the field.
Keywords: Surgery, Research, Pakistan, Bibliometrics, Web of Science

INTRODUCTION

Surgery is an important field, with many branches in health care profession. The standards of moral and compassionate practice have been established over centuries by the surgical profession. In the fields of research, clinical care, and education, surgeons have made outstanding achievements. Their groundbreaking contributions to surgical science and advances in operating technique revolutionized surgical treatment, saved many lives, and vastly increased the lifespan and quality of life[1]. Globally, an estimated 266 million operations were performed in 2015[2], more over number of procedures, technology, and research are expanding over time.

The goal of surgery research is to raise the standard of surgical care offered to patients in the nation. In Pakistan, there are a number of research institutions, universities and hospitals engaged in surgery research. Their investigations span a wide range of subjects, including surgical methods, patient outcomes, and healthcare regulations. Many examples are evident from literature. For instance, some published studies show experiences of laparoscopic cholecystectomies over the period of time from different institutes[3-5]. A study displays outcomes of surgical management of colorectal cancer[6]. Publications are evident on experiences and challenges in different specialties, e.g., pediatric surgery,[7] breast surgery[8], orthopedics[9], operating department practitioners,[10] and many others.

With some advancements in surgery-related research, Pakistan is facing unique issues of high population load and limited resources. Though there are studies analyzing overall research productivity from Pakistan[11,12] but research productivity in surgery is not analyzed separately.

This study's objective was to offer a bibliometric analysis of surgical research produced in Pakistan. The study's specific intents were to determine the trends and performance in surgery publications, the contributions of authors and institutions, the level of national and international collaboration, the main areas of research focus, and the most cited research from Pakistan.

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METHODS

A descriptive bibliometric analysis was conducted. Given that the data did not contain protected health information and were therefore available to the public, institutional review board approval was not necessary. The study analyzed all the published articles of surgery research from Pakistan that has been published between 2001 and 2022. The King Abdul-Aziz University (KAU) electronic library portal was used to access the database. The principal investigator (MI) conducted a search and collected papers. Surgery was chosen from among the Web of Science Categories since it only contained documents relevant to the topic of our investigation. The search protocol was followed as detailed in a previous study[13]. The search strategy used was: WC = (Surgery NOT Dentistry, Oral Surgery & Medicine) and CU= (PAKISTAN). All English language articles were included. On April 2, 2023, an online search of the Web of Science (WoS) (www.webofknowledge.com) database was carried out by the principal investigator (MI). The Web of Science Core Collection (WoSCC) database served as the foundation for all data, which included the number of publications, citations, and other factors, and R-Bibliometric package was used. Book reviews and chapters, news items, discussions, and corrections were excluded. The documents related to Dentistry, Oral Surgery & Medicine were also excluded. Documents of all other languages except English were excluded.

RESULTS

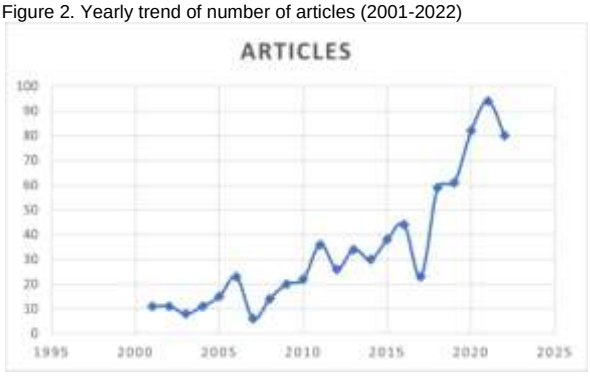
Total number of documents indexed in WoS with surgery (excluding Dentistry & Oral Surgery) as web of science category from 2001 to 2022 were 1,163,230 from 553 sources and 206 countries with USA, England, Japan, German and China around collectively contributing around 61%: 34.7%, 7.9%, 6.9%, 6.3% & 5.3% respectively while top 10 countries collectively contributed for more than 2/3rd (around 78.5%). Documents were found to be related to 60 WoS categories (other than surgery) led by Transplantation (13.3%), Clinical Neurology (11.6%), Cardiac Cardiovascular Systems (9.1%) and Orthopedics (8.4%). Articles (57.5%) were found to be the leading document type (n= 668,582)

followed by meeting abstracts (17.2%) and Editorial Materials (11.1%). Reviews articles were around 5%. The total number of authors' appearances was > 100,000 while around 1.3% of documents (n= 10,137) showed any group authors. Around 297,709 (25.6%) documents were in the open access category and 14.1 % showed any funding source. When explored for this study scope, contribution from Pakistan was ranked 51st with 1,376 documents representing around 0.12% of the global productivity. Among neighboring countries India and Iran were in top 30 ranked at 14th and 27th respectively. India showed 2.13% (n= 24,801) while Iran contributed around 0.55% (n= 6,365) of global productivity. The research strategy showed a total of 748 articles from 1376 documents on the topic of surgery (excluding Dentistry & Oral Surgery), from Pakistan, as shown in figure 1. An annual growth rate of 9.91% was observed. The total number of authors was 11973, while most articles were multi-authored. International co-authorship was 39.97%. Regarding the type of publications being indexed from Pakistan, the most common publication type in the field of surgery was articles representing around 54.4% (748) followed by meeting abstracts (16.3%), letters (12%) and review papers (9%).

Figure 1. Summary figure (time span 2001-2022)

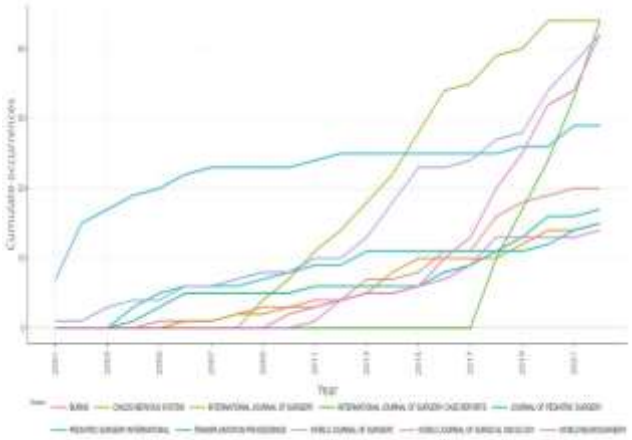
Yearly trend of number of articles is given in figure 2. An increasing trend in annual scientific production was observed over years, especially from 2017 onward. Top ten most relevant sources were explored. International Journal of Surgery, International Journal of Surgery Case Reports, World Journal of Surgery, and World Neurosurgery were the most relevant sources, with >40 publications per journal, followed by Transplantation Proceedings and Burns, with 20 or more publications. While, Journal of Pediatric Surgery, Child's Nervous System, Pediatric Surgery International, and World Journal of Surgical Oncology made the third tier with >10 publications.

Figure 2. Yearly trend of number of articles (2001-2022)



The ten most productive sources are shown in figure 3. Transplantation Proceedings had more or less consistent publications over time. World Journal of Surgery had gradual rise, with maximum production (n=42) in the year 2022. Publications started in World Neurosurgery in 2010, and gradually increased over time, with maximum production (n=42) in 2022. In Burns, production started in 2004, and gradually increased over time. In International Journal of Surgery Case Reports, research production started in 2018, and a peak was observed afterwards. International Journal of Surgery started producing research articles from Pakistan in 2009, and then increase in production was observed. Journal of Pediatric Surgery, Child's Nervous System, Pediatric Surgery International, and World Journal of Surgical Oncology had, more or less, consistent publications during the last 10 years.

Figure 3: Year-wise growth of 10 most productive sources (2001-2022)



Top 20 most productive authors and their impact are summarized in table1.Zafar H, Haider AH, Khan S, and Zafar SN were prominent with >20 articles, followed by Enam SA, Shamim MS, Ahmed A, Sharif S, Ahmed E, And Rizvi A with >15 articles. Six authors, among top 20, had h-index >10, and 5 authors had g-index ≥20. Enam SA had highest total citations (TC), n=1796, followed by Elkelany A, and Hanrahan M with >800 TC, and Pata F, Tabiri S, Arango MCM, and Hassan A with >700 TC.

Table1. Top 20 most productive authors and their impact (2001-2022)

Author	NP	h-index	g-index	TC	PY start
Zafar H	28	13	23	537	2002
Zafar SN	24	13	23	542	2011
Enam SA	20	11	20	1796	2006
Haider AH	27	11	21	453	2012
Pata F	13	11	13	758	2016
Tabiri S	13	11	13	758	2016
Khan S	25	10	21	457	2009
Rizvi SAH	16	10	16	489	2002
Soreide K	12	10	12	683	2016
Ahmed E	16	9	16	302	2001
Akhtar F	13	9	13	217	2001
Arango MCM	9	9	9	762	2016
Elkelany A	9	9	9	845	2016
Hanrahan M	9	9	9	845	2016
Hassan A	9	9	9	708	2016
Nazir Z	14	9	13	192	2004
Rayne S	9	9	9	679	2016
Spence R	9	9	9	679	2016
Zafar MN	15	9	15	383	2001
Ademuyiwa AO	11	8	11	600	2016

NP=number of publications, TC=total citation, PY=publication year

Top ten most frequent affiliations and funding sources are shown in table 2. Aga Khan University Hospital and Aga Khan University had shown highest affiliations (>200), followed byDow University of Health Sciences (>50). National Institutes of Health (NIH), USA

and United States Department of Health Human Services (UK) were the most frequent funding sources – 17 articles each. Other frequent funding agencies were also from the United States and United Kingdom, except one from Pakistan - Higher Education Commission of Pakistan.

Table 2. Top 10 most frequent affiliations and funding sources

Top 10 Most Frequent Affiliations	Articles	Top 10 most frequent funding sources	Articles
Aga Khan Univ Hosp	222	National Institutes Of Health (NIH) USA	17
Aga Khan Univ	204	United States Department of Health Human Services	17
Dow Univ Hlth Sci	58	National Institute for Health Research (NIHR) UK	8
King Edward Med Univ	37	Higher Education Commission of Pakistan	6
Shifa Int Hosp	37	NIH National Institute Of General Medical Sciences NIGMS USA	6
Sindh Inst Urol and Transplantat	35	NIH Fogarty International Center (FIC) USA	5
Harvard Med Sch	31	American College Of Surgeons	3
Liaquat Natl Hosp And Med Coll	27	Association of Coloproctology of Great Britain And Ireland	3
Shaukat Khanum Mem Canc Hosp and Res Ctr	26	Association of Upper Gastrointestinal Surgeons	3
Icahn Sch Med Mt Sinai	23	British Association for Surgical Oncology	3

Aga Khan University Hospital (AKUH) and Aga Khan University (AKU) had substantial increase in affiliation from 2009 onward. Dow University of Health Sciences (DUHS), King Edward Medical University (KEMU), and Shifa International Hospital (SIH) also showed an increasing trend over time.

Top 10 corresponding author's countries with number of articles, single or intra-country publications (SCP), and multiple or inter-country publications (MCP) are shown in table 3. Pakistan was leading followed by USA and UK. The articles, in which the corresponding author's country was Pakistan, were published mostly (85.29%) as SCP, with MCP ratio 0.1. On the other hand, the articles with corresponding authors from other countries mostly published as MCP, with MCP ratio from 0.7-1 for different countries.

Table 3: Top 10 corresponding author's countries with articles and collaboration

Country	Articles	SCP	MCP	MCP Ratio
Pakistan	517	441	76	0.1
USA	93	0	93	1
United Kingdom	43	3	40	0.9
China	11	0	11	1
Canada	10	0	10	1
Germany	9	0	9	1
Saudi Arabia	9	1	8	0.8
Sweden	7	2	5	0.7
Australia	6	0	6	1
Afghanistan	4	0	4	1

SCP: Single or Intra-country publication, MCP: Multiple or Inter-country publications

Pakistan, USA, and United Kingdom were revealed as the most cited countries with 4764, 4609, and 3564 total citations, and 9.20, 49.60, 82.90 average article citations respectively.

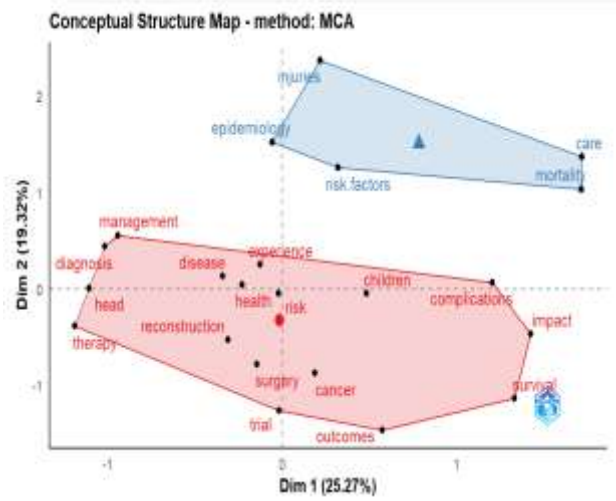
Table 4 shows ten most cited documents. The article, on consensus-based surgical case report guidelines (SCARE guideline), published by Agha RA was at the top, with >20 local citations and >3000 global citations. Other two articles, by the same author and same topic, were cited >1000 times globally.

Table 4: Top ten most cited documents (2001-2022)

*Document &DOI (type)	LC	GC	LC/GC Ratio (%)	NLC	NGC
AGHA RA, 2018, INT J SURG 10.1016/j.ijsu.2018.10.028 (Guideline)	22	3232	0.68	39.33	47.67
AGHA RA, 2016, INT J SURG 10.1016/j.ijsu.2016.08.014 (Guideline)	9	1296	0.69	16.50	32.18
SHAH AA, 2015, INJURY 10.1016/j.injury.2014.08.029 (Retrospective review)	6	14	42.86	7.86	0.95
Rizvi Sah, 2005, Transplantation 10.1097/01.TP.0000161666.05236.97 (Observational)	5	56	8.93	9.38	1.91
NOORDIN S, 2011, INT J SURG 10.1016/j.ijsu.2010.09.009 (Cohort)	5	8	62.50	9.00	0.58
DAR FS, 2015, LIVER TRANSPLANT 10.1002/lt.24151 (Observational)	5	29	17.24	6.55	1.96
BHANGU A, 2016, BRIT J SURG 10.1002/bjs.10151 (Cohort)	5	143	3.50	9.17	3.55
AGHA RA, 2020, INT J SURG-a 10.1016/j.ijsu.2020.10.034 (Guideline)	5	1240	0.40	29.29	48.17
RAJA IA, 2001, WORLD J SURG 10.1007/s00268-001-0087-3 (Observational)	4	50	8.00	4.89	4.62
KHAN A, 2010, INT J SURG 10.1016/j.ijsu.2009.10.012 (Observational)	4	27	14.81	12.57	1.61

*Author, year of publication, journal, LC=local citation, GC=Global citation, NLC=NormalizedLocal Citations, NGC=Normalized Global Citations

Figure 4. Conceptual structure word map of key word plus with multiple correspondence analysis



Among top ten most frequent keywords (KW), Pakistan was the most frequent (n=29). Trauma, case report, outcome, surgery, neurosurgery, survival, burns, and mortality were used ≥ 10 times. Two possible clusters were identified for the top twenty keyword plus (KP) by using the multiple correspondence analysis (MCA), as shown in figure 4. Lower cluster (red) identified a combination of fifteen KP related to different fields of surgery and distinctive categories. Upper cluster (blue), a combination of 5 KP, mostly classified areas of epidemiological significance.

DISCUSSION

Research productivity in surgery (excluding Dentistry & Oral Surgery) from Pakistan, evident from this research, is negligible (0.12%) while comparing with global output, though an increasing trend is observed during last few years.Other significant findings of this analysis show that major type of publications was articles, and annual growth rate of 9.91% was observed, with 19.08% average citations per document. A previous study shows Pakistan's overall research productivity for the year 2018 was 0.52% of global productivity.[11]Our findings show that >2/3rd of surgery-related research is contributed by 10 countries. The United States is leading, the finding that is evident in literature[14]. Another issue of

concern is that Pakistan is laggingbehind the neighboring countries, such as India and Iran. Even if this can be argued that India is a bigger country, with population of >1.4 billion, the magnitude of research is significantly higher in India. In one study, it is found that India was included in one of the most contributing developing countries in the field of bariatric surgery.[15]Moreover, Iran, with significantly lesser population than Pakistan, shows quite significantly higher surgery-related research production. Our findings are consistent with a previous study, which shows higher contribution of Iran in research production[11]. A recent study supports this evidence. Iran was one of the leading countries in COVID-19-related research publications in the Eastern Mediterranean Region. The number of publications was higher as compared to Pakistan[16].

The ten most relevant sources are world renowned journals, which are famous for publishing good surgery-related articles. Similarly, an interesting trend can be observed in the ten most productive sources over time. A particular increase in production is observed in World Journal of Surgery, World Neurosurgery, International Journal of Surgery Case Reports, and International Journal of Surgery during last few years. The findings are consistent with increasing trend in production of research articles from Pakistan from 2017 onward (Figure 2). A study shows that 42% of overall research production from Pakistan was from 2017-19[12]. The findings are motivating that research productivity is moving in positive direction. However, no Pakistani journal is included in the top ten most productive or relevant sources. This point should also be considered by all stakeholders and leaders in health profession.

While analyzing most productive authors, it is observed that 4 authors have published >20 articles, and 6 authors contributes >15 articles. Six authors have h-index>10, 5 authors have g-index ≥20, and, mostly, both indexes are showing consistency. Both, h- and g-index can be used as metrics for the appraisal of academic productivity, and both indexes show strong correlation as well.[17]Only one author, Enam SA, have TC>1000. Interestingly, Arango MCM, Elkelany A, Hanrahan M, and Hassan A, who have started publication year from 2016, displays >700 citations with 9 articles each. The findings could be of interest to the researchers in the relevant fields. Citations, h- and g-index are used as bibliometric parameters among others[18].

While exploring the top ten most affiliated institutes, some interesting phenomena are observed. Aga Khan University Hospital and its affiliated university, Aga Khan University, private sector institutes being managed by the same organization, have shown highest affiliations - >400 combined; other institutes are far behind. Dow University of Health Scienceshas the second highest affiliations (n=58). Increasing trend in affiliation in institutes, such as, AKUH, AKU, KEMC, DUHS, and SIH, is encouraging. Fifty percent of the top ten affiliated institutes, from Pakistan, are from private sector, another interesting finding for stakeholders. Two international institutes, both from the United States, come under top ten most frequent affiliated institutes. The findings make correlation with MCP. Another interesting phenomenon is the inclusion of 50% of top 10 most affiliated sources form a single city – Karachi. This finding is consistent with other parameters, such as most cited articles and most productive authors. These outcomes could be due to better collaboration at local and international level from the researchers and organizations from Karachi. This phenomenon could be used by researchers from other cities to expand their research horizon.

Nine out of ten most frequent funding agencies are international. Two countries are dominating, USA and UK. This finding points out that Pakistani researchers might have better access to the funding agencies in these countries. Maximum research grants are approved by NIH and its sister agencies. NIH is leading in research grants in biomedical research.[19]The alarming issue is that only one agency from Pakistan, HEC, comes in top ten most frequent funding organizations. It has been discussed that, in Pakistan, expenditure on research is not a priority, though it is directly linked to research output[20].

It is evident, in this study, that the majority articles, with corresponding author from Pakistan, were published as SCP, while MCP is prominent in other countries. Studies have revealed that collaboration in research increases productivity, furthermore, collaboration with international researchers provides higher chances of publication in internationally well-reputed journals[21,22]. More efforts are desirable by the researchers, affiliated institutes and funding bodies to enhance international collaboration. From the most cited countries, average article citations were quite high from USA and UK as compared to Pakistan. This may reflect better quality papers produced by those countries.

Three articles, which were on the top of citations, are published by the same author - Agha RA. These articles are consensus-based surgical case report guidelines, with updated versions. Other articles, in the top 10 most cited, are mostly observational studies in different fields. It is observed that no metanalysis and systematic analysis or randomized controlled trials (RCT) are included in the top ten cited articles. Iqbal MP[23] discussed the issues of research in Pakistan many years back. He argues that research is not a priority for the government of Pakistan and emphasizes the importance of different institutions to develop research culture. Perhaps, with some improvements, situation is more or less the same. Rahman MM et al[24] have discussed the paucity of biomedical research in developing countries. They have given suggestions how developing countries, with insignificant contribution in indexed journals, can improve. These suggestions can be used in our local context to get high quality research articles.

If we analyze top ten keywords, a few specific areas can be identified, e.g., trauma, neurosurgery, and burns. Trauma, including road traffic accident, is a major cause of mortality and morbidity in Pakistan[25,26]. So, it is not surprising to find trauma in top ten keywords. Neurosurgery and burns are also associated with it. There is an association of top keywords with published articles and most productive authors. When analyzing 20 most frequent KP, two clusters are emerged. The one (blue) with 5 KP is reflecting different determinants of surgery diseases. This pattern signifies that public health issues have been studied, and different articles associated with risk factors, mortality, and other associated factors can be identified. This positive trend may help to identify preventive measures. Thind A et al.,[27] about a decade ago, have discussed the importance of surgical epidemiology. The other pattern (red), comprising 15 KP, shows generalized words. No theme of specialties can be identified. It can be noted that certain KW and KP, e.g., colorectal, breast, obesity, bariatric surgery, laparoscopy, robotic surgery, hepatobiliary, liver, urology, thoracic, and many others, are not included in the top ten KW and KP. Though the burden of diseases, associated with the above-mentioned words, is quite high in Pakistan. For instance, obesity is a major challenge in Pakistan ,[28] and though we can find research papers on bariatric surgery from Pakistan, the trend is not observed in ten top cited articles, or top ten KW and KP. In some countries, emerging trend can be observed. In a recent scientometric analysis, a clear increase in obesity and bariatric surgery articles can be acknowledged from Arab countries.[29]Similarly, in an analysis, it is observed that, though, there are research papers on breast cancer from Pakistan, with global collaboration, but improvement is warranted.[30] Regarding colorectal cancer, the contribution for the top ten RCTs and top ten institutes are from developed nations[31]. These examples, and many others in literature, show the paucity of high-quality research from Pakistan, indicating the need of a big paradigm shift in research policies at all levels.

Our study has limitations. Single database, 'WoS' was used for data extraction which mightaffect the generalizability, as other databases, e.g.,PubMed, Scopus, PubMed, or Google Scholar could produce a different list of publication records. The inclusion of solely English-language publications was another restriction that

might have an impact on the overall research output. Another limitation was the lack of similar study on this issue. Many journals from Pakistan are not indexed in web of science core collection, so some data might be missing.

CONCLUSIONS

This study aimed to explore research productivity in surgery from Pakistan. The study found thatPakistan's contribution is negligible in overall global production, though an increasing trend toward publications was observed, especially during last few years.Karachi was a prominent city with 50% top ten most affiliated institutes.Private sector was dominating. Mostly, funding agencies were international. SCP was prominent in articles published by corresponding authors from Pakistan. The findings suggested that policy changes are warranted byall stakeholders, including HEC, university administrators, and policymakers,to redesignresearch policies to increase faculty members' research productivity.Support is required in funding sources, professional development, and collaboration to produce high impact research. The findings, in this study, could be useful for surgeons and researchers who want to study research trends in surgery-related research in Pakistan. Certain practical implications can be deducted from this research. Influential authors and institutions can be identified which can help in decision-making regarding potential opportunities and collaborations. Identifying emerging trends and gaps would be helpful for researchers in the field.

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Contribution: Conceptualization, data curation, investigation, methodology, project administration, validation, writing draft.

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