

Analysis and Visualization of Research Trends in Indian Surgery: A Bibliometric Analysis

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ABSTRACT

Indian surgery has significantly impacted global surgery; many notable scholars from India have contributed to developing the cultural basis of surgery. The study aimed to present a summary of the research productivity and trends on Indian surgery in Indian research publications during the years 2010–2021 with a bibliometric analysis. Examine highlights of the most well-cited successful works, current journals, organizations, and writers; find global partnerships; and discuss keyword analysis and popular research subjects. The researcher used a replicable bibliometric methodology to analyze data; all the data was acquired from the Web of Science.

Keywords: Bibliometric analysis, Indian surgery, Research trends.

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INTRODUCTION

India has a mixed health care system in which both the public and private sectors provide health care. Globally, 5 billion people lack timely access to safe and affordable surgical care, with over a fifth of them living in India. Solving India's surgical access issues can have high returns on investment.¹ For every 1,00,000 people in low- and middle-income countries, 5,000 procedures are required, according to the Lancet Commission on Global Surgery.² The 4,642 procedures for a population of 88,273 were performed every year. Cataracts (22.8%), caesareans (3.8%), fracture surgeries (3.27%), and hernias (2.86%) were the most common surgical procedures. Essential operations made up 44.2% of all procedures. For every 100,000 Indians, 3,646 surgeries are predicted to be required annually. The Indian population aged 30–49 will require one-third of these procedures.³

The World Health Organization (WHO) and the Indian Council of Medical Research (ICMR) have significantly contributed to the nation by supporting several high-quality research initiatives. India has made significant contributions to the field of surgery across the globe. A nation's standards for scientific research are reflected in the quantity and caliber of its scientific publications. Indian surgery has been impacted by world surgery since it provides a worldwide framework for contributions from Indian surgery and institutions and encourages the creation of joint research products. The research output of Indian surgery in India is thought to vary considerably. India is currently ranked ninth in the world based on its relative fraction of global publications, according to the Department of Science and Technology (DST), India-2012 report.^{4–9} It is unknown, therefore, how much Indian surgery has contributed to international publications. Many academics and clinical scientists from India have contributed to developing the surgical profession's cultural foundation.

Review of Literature

It is critical to map a field's research output in order to lead policymakers, researchers, and funding organizations toward areas where research activity should be restricted or increased. Several studies have been conducted under the umbrella of bibliometrics

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in acknowledgment of its relevance. Using three databases, including Index Medicus, Excerpta Medica, and Tropical Disease Bulletin, between 1990–1994, Satyanarayana looked at the Indian contribution to biomedical research. The study estimates that 3,605 and 3,241 articles submitted from India were indexed in the databases in 1990–1994, respectively, while 379,939 and 551,885 papers were covered by the databases globally. India's percentage decreased from 0.949 percent in the database in 1990–0.587 percent in 1994.⁷ According to Holmgren and Schnitzer, The quantity of scientific publications any nation adds to the global output is one of the most significant indicators of the quality of that nation's research. Most scientific articles published worldwide are produced in developed nations like the United States and the European Union.⁵ In 2010, Bala and Gupta mapped the study assessments of the neuroscience research output in India from 1999 to 2008. According to the Scopus Citation database, India had a 0.99% global publishing share in neurosciences during the research period (with 4,503 papers), placing it 21st out of the top 26 nations in this field. According to researchers, there is a pressing need for India to enhance its neuroscience research activity significantly.⁹

Based on the total production of publications, their growth rate, the caliber of the papers released, and India's position in the global context, Gupta and Adarsh analyzed the research efforts of India in the field of medicine from 1999 to 2008. According to a survey, India is the 12th most productive nation for medical research, producing 65,745 papers with a global publication share of 1.59% and a growth rate of 76.68% from 1999 to 2003 to 2004 to 2008. The study's findings indicate that high-quality research is grossly underfunded in India and calls for strategic planning, financial investment, and resource assistance.⁶ Based on an analysis of the global publication output, Ram examined the work of Indian physicians over a 40-year span in the field of Guillain-Barre Syndrome (GBS). He found that 10,633 publications from international medical research covering the different facets of GBS were available. The country with the most number of publications was the United States, followed by India, which is ranked 10th overall on GBS and has 2.92% of the global output. In order to find a better way to treat the ailment in Indian situations, researchers contend that the research concentrating on this condition is highly prominent and requires serious medical attention through research capacity building.⁸ In order to investigate the publications of Indian spine surgeons, Kanna et al. reviewed the trends in scientific publications of Indian spine surgeons during a 14-year period from 2000 to 2013. A literature search of spine surgeons from India's publications was done using medline. According to the study's findings, 507 articles were examined after 4,459 publications had been excluded.

Between 2009–2013, when 60.15 percent of the articles were published, a 440% increase in the number of publications was seen. Clinical studies ($n = 492$; 97.04%) are the most prevalent type of article, followed by experimental studies and other types. According to the study's findings, although it has been fewer recently, publications in the field of spine surgery have been rising.^{4,10,11} A global bibliometric analysis from 2011 to 2020 concentrated on the overall trends of scholarly publications about Calotropis. 6,584 research articles found utilizing the Scopus database engine served as the basis for the analysis. Utilizing bibliometric tools such as Biblioshiny and VOS viewer, data matrices for co-citation, coupling, scientific collaboration analysis, and co-word analysis have been constructed. The study's findings show that there is an increase in publications, particularly from countries like China and India.¹² Grover, Gupta, and Dhawan used a variety of bibliometric markers to analyze schizophrenia-related publications published in India between 1990–2019. Analysis of the papers revealed that with a global share of 2.04 and a 14.21% annual growth rate, India is currently ranked 13th in the world for publications on schizophrenia, with 22.8% of them including international collaboration. Citation impact per paper (CPP) for Indian publications published between 1990–2019 was 13.3. Researchers also noted that India provides just a very small percentage of the global production of schizophrenia research, and they suggested that the quality of this research has to be improved.¹⁰

The Need and Purpose of the Study

The researcher aimed to analyze the contribution of Indian surgery research and academic publications toward global publications. Despite the fact that various bibliometric studies in general surgery and other disciplines of medicine have been published, there are few studies mapping the Indian research output in the field of surgery. The researcher aimed to offer an overview of the Indian research articles on surgery between the years 2010–2021, which

called for this examination. The study also attempts to reveal the most cited effective publications, active journals, institutions, and authors; identify international collaborations; and discuss keyword analysis and trending research topics in order to ascertain the evolution of publications over time and the factors affecting the productivity of publications with correlation and regression analysis.

Objectives of the Study

This study's primary goal is to examine India's research performance in Indian surgery in relation to other countries and National and International contexts, as evidenced by the publications it produced between 2010–2021. Specifically, the research focuses on the following goals:

- To determine the volume and growth of surgical research conducted in India.
- To analyze the research trends and productivity, citations, and h-index in Indian surgery.
- To identify the distribution of Indian surgery journal publications.
- To determine the traits of the most prolific authors and papers.
- To determine the productivity and influence of top Indian institutions in publishing.
- Research communication trends in the most fruitful journals.

Research Design and Methodology

The current study examines research trends in the area of surgery by the Indian contribution using replicable bibliometric methodologies from 2010 to 2021. The Web of Science database was used to collect the data for this Indian Surgery Research. Using the search keywords "surgery" (Web of Science Categories) and "India" (Address), the data was downloaded in June 2022. The Web of science is a widely recognized and frequently utilized database for assessing scientific papers. It provides complete publication data and has identified 14,956 items in total. Utilizing the search terms "Surgery" (Web of Science Categories) and "India" (Address) and "2010–2021" (Year Published) and Science Citation Index Expanded (SCI-EXPANDED) (Web of Science Index), an advanced search technique is also employed for data collection.

Data Analysis

Publications were categorized and scored methodically based on publication year, nation, journal, study field, authors, and connections with organizations. In addition, the frequency of keywords taken from the publications was evaluated and then used in a network analysis of the evolution of Indian surgery research. Biblioshiny, a well-liked tool for studying and visualizing relationships between authors, countries, co-citations, and article titles, incorporates all of this data. A higher association strength indicates more similarity between words and a greater number of publications in which two items co-occur, indicating that the keywords are more closely related. This mapping approach was used to compute similarity (affinity) based on association strength. The number of clusters may vary based on the similarity threshold between nodes (Table 1).

Details on total bibliographical data show that 219 sources were retrieved from journals, books, etc., and 14,956 documents were retrieved on Indian Surgery. Average years from publications show 5.95, and average citations per document are 6.7. Also, a total of 11,327 references were available. Analysis towards the document

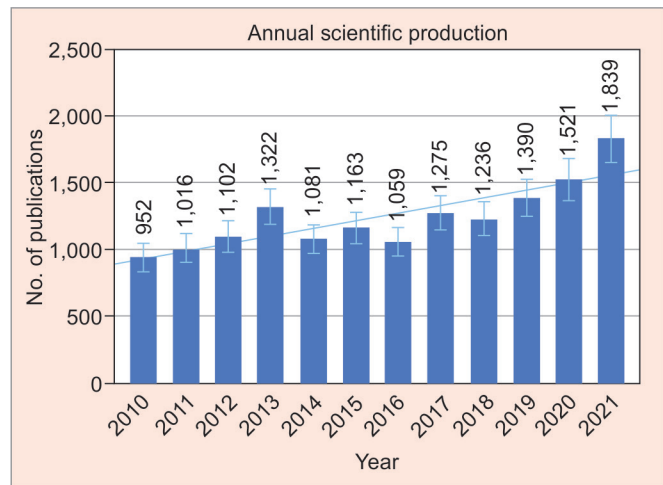
Table 1: Bibliographic Details from 2010 to 2021

Description	Results
Timespan	2010:2021
Sources (Journals, Books, etc.)	219
Documents	14,956
Average years from publication	5.95
Average citations per documents	6.7
Average citations per year per doc	0.9421
References	11,327
Document types	
Article	7,960
Article; proceedings paper	188
Biographical-item	13
Book review	2
Correction	50
Editorial material	1,319
Editorial retracted publication	1
Letter	2,201
Meeting abstract	2,266
Reprint	2
Retraction	3
Review	951
Document contents	
Keywords plus (ID)	13,676
Author's keywords (DE)	20,502
Authors	
Authors	34,538
Author appearances	83,110
Authors of single-authored documents	641
Authors of multi-authored documents	33,897
Authors collaboration	
Single-authored documents	1,348
Documents per author	0.433
Authors per document	2.31
Co-authors per documents	5.56
Collaboration index	2.49

type result shows that 7,960 articles were retrieved, followed by 2,266 meeting abstracts, 2,201 letters, and 1,319 editorial materials. Related to contents study found 13,676 keywords, and 20,502 are author keywords. Author distribution data reveals that about 34,538 authors have contributed to Indian surgery, and 83,110 author appearances are available (Fig. 1).

The number of articles related to surgery research has steadily increased over the past 12 years but with some fluctuations (Fig. 1). Out of 14,956 publications in the specific period, the maximum number of 1,839 (12.29%) papers are published in 2021 followed by 2020 ($n = 1,521$, 10.16%), 2019 ($n = 1,390$, 9.29%) 2013 ($n = 1,322$, 8.83%) and 2017 ($n = 1,275$, 8.52%) and the lowest numbers of articles were published in the year 2010 with 952 (0.60%) (Table 2).

India's annual research growth in surgery research during 2010–2021 shows that the first research paper on the surgery research was

**Fig. 1:** Annual scientific production over the past 12-years**Table 2:** Literature growth in Indian Surgery research during 2010–2021

Year	TP	Percentage				
		of 14,956	MeanTCperArt	TC	ACP	h-index
2010	952	6.36	12.06092	11,486	12.07	43
2011	1,016	6.79	10.25591	10,434	10.27	43
2012	1,102	7.36	8.934664	9,888	8.97	39
2013	1,322	8.83	9.127837	12,072	9.13	44
2014	1,081	7.22	8.770583	9,484	8.77	40
2015	1,163	7.77	8.380052	9,705	8.34	38
2016	1,059	7.08	7.915958	8,388	7.92	34
2017	1,275	8.52	6.516863	8,328	6.52	37
2018	1,236	8.26	7.244337	8,956	7.26	32
2019	1,390	9.29	4.066187	5,884	3.99	25
2020	1,521	10.16	2.980276	4,811	2.48	20
2021	1,839	12.29	0.727026	950	0.51	9

published in 2010 with (NP = 952) 11,486 total citations. After 2011 (NP = 1,016), Indian surgery research output gradually increased. The significant study involved 2012 (NP = 1,102) to 2021 (NP = 1,839), where 86.78 % of publications were published with 78,466 citations. The year 2021 was the highest producer of research (NP = 1,839) with 950 total citations. The year 2010 has received the maximum total citation (TC = 11,486) and H-index (43) for 952 publications (Table 3).

Data on top ten journals produce shows that 5,957 papers were published with, 23,784 total citations. Indian Journal of Surgery (JIF = 0.656, Quartile = 4, H-Index = 20) nominated as the leading source with 1,689 publications with 4,734 citations, followed by Obesity Surgery (JIF = 4.129, Quartile = 1, H-Index = 27) with 855 publications and 2,299 citations. Transplantation (JIF = 4.939, Quartile = 2, H-Index-2) with 789 papers and 1,376 citations and World Neurosurgery (JIF = 2.104, Q4) with a 727 publication and 2,520 citations are ranked 3rd and 4th respectively in the list. International Journal of Surgery (JIF = 6.071, Q1) with a 242 publication and 6,170 citations are ranked 10th in the list (Table 4).

The most prolific authors on Surgery research in India shown that, the prolific author Kumar A, affiliated with the All India Institute of Medical Sciences (AIIMS) New Delhi has 215 publications (1,588)

Table 3: Top ten most relevant journals

Sources	NP	TC	JIF	Quartile	h_index	g_index	m_index
Indian Journal of Surgery	1,689	4,734	0.656	Q4	20	26	
Obesity Surgery	855	2,299	4.129	Q1	27	42	2.07
Transplantation	789	1,376	4.939	Q2	20	34	1.53
World Neurosurgery	727	2,520	2.104	Q4	20	27	1.53
Journal of Minimal Access Surgery	403	1,884	1.407	Q4	18	27	1.50
Indian Journal of Otolaryngology and Head & Neck Surgery	386	2,156	0.054	Q4	17	22	1.30
Liver Transplantation	356	654	5.799	Q2	15	20	1.15
Journal of Craniofacial Surgery	261	1,004	1.046	Q4	15	21	1.15
Childs Nervous System	249	987	1.475	Q4	14	19	
International Journal of Surgery	242	6,170	6.071	Q1	23	77	1.76

Table 4: Prolific authors

Row labels	Sum of NP	Sum of TC	Sum of h_index	Sum of g_index	Sum of m_index
Kumar A	215	1,588	19	28	1.462
Kumar S	200	2,254	23	40	1.769
Agarwal A	155	2,526	25	42	1.923
Gupta A	139	1,667	18	35	1.385
Goel A	135	1,558	20	34	1.538
Gupta S	135	1,741	17	37	1.308
Sharma A	123	1,085	16	27	1.231
Singh S	117	1,079	17	28	1.308
Gupta R	100	1,129	16	28	1.231
Kumar R	99	819	15	21	1.154

citations, followed by Kumar S affiliated with (AIIMS) New Delhi has 200 publications (2,254 citations). Agarwal A, affiliated with Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, has 155 papers and 2,526 citations. Gupta A affiliated with (AIIMS) New Delhi, has 139 papers and 1,667 citations. Goel A, affiliated with King Edward (VII) Memorial Hospital and Seth Gordhandas Sunderdas Medical College Mumbai, has 135 papers and 1,558 citations. Gupta S and Sharma A have published 135 and 123 papers, each with 1,558 and 1,085 citations, respectively, and they identified as the least prolific authors in the list. Agarwal A received the maximum number of citations (TC = 2,526) for 155 publications, followed by Kumar S (TC = 2,254) for 200 publications, and Gupta S (TC = 174) for 1,741 research papers. Agarwal A has the highest H-index (42), followed by Kumar S (40) and Gupta S (37) (Fig. 2).

Pattern of Authorship

The authorship pattern in Indian surgery research shows that for 14,596 publications, there are 1–10 types of authorship patterns identified for the Indian Surgery Research' research. Three authored publications (NP = 11,731) have the maximum number of research papers, followed by four authorship patterns that have a number of publications (NP = 8,704), five authorships (NP = 5,932), six authorships (NP = 3,936), seven authorships (NP = 2,531) and more than 10 authorships is list of 646 (Table 5).

All India Institute of Medical Sciences New Delhi (NP = 1,477, TC = 12,689) found to be the leading organization in surgery research in India, followed by PGIMER Chandigarh (NP = 888, TC = 4,872)

(Table 4). Tata Memorial Centre TMC, Mumbai has (NP = 467, TC = 11,537), followed by Sanjay Gandhi Postgraduate Institute of Medical Sciences (NP = 409, TC = 2,344), The two lowest ranked institutions in the top ten are Sir Ganga Ram Hospital (NP = 232, TC = 1,091) and Seth Gordhandas Sunderdas Medical College King Edward Memorial Hospital (NP = 369, TC = 6,828). All India Institute of Medical Sciences New Delhi received the highest number of citations for the 12,689 publications, followed by Tata Memorial Centre TMC, Mumbai (TC = 11,537) for 467 papers, Seth Gordhandas Sunderdas Medical College King Edward Memorial Hospital (TC = 6,828), and PGIMER Chandigarh (TC = 4,872). All India Institute of Medical Sciences New Delhi has emerged as 1st in H-index (40), followed by TMC Mumbai (H-index = 38), and SGSMCKEH (H-index = 33), etc., (Table 6).

The researcher has listed the top twenty most-cited research papers in Surgery, among the listed articles, the article entitled "The SCARE 2018 statement: Updating consensus Surgical Case Report (SCARE) guidelines" by Agha RA et al., appeared in International Journal of Surgery (TC = 2,462) noted as the most cited paper, followed by Bassi C et al. published an update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 6,828. "The SCARE statement: Consensus-based surgical case report guidelines" by Agha RA et al., published in International Journal of Surgery with 1,276 total citations, "3D printing based on imaging data: review of medical applications", by Rengier F et al. published in, International Journal of Computer Assisted Radiology and Surgery with 979 total citations, and "The SCARE 2020 Guideline: Updating consensus surgical case report (SCARE) guidelines", by Agha RA et al., published in International Journal of Surgery (2010) with 789 total citations is ranked 2nd, 3rd, 4th, and 5th respectively. "International consensus on standardization of data collection for complications associated with esophagectomy complications consensus group (ECCG)" by Low DE et al. published in Annals of Surgery with citation of 465 noted as least cited papers in the list, received 10th. Country collaboration on Surgery research (Fig. 3).

India vs USA (1,145) and India vs the United Kingdom (573) are the top collaborating countries with 134 collaborations (Fig. 4), followed by India and Italy with 320 collaborations, India, and China with 295 collaborations, India, and Germany with 271 collaborations, and India and the Australia with 267 research collaborations, etc. India and Korea (211 papers) are the least among the top ten collaborative countries.

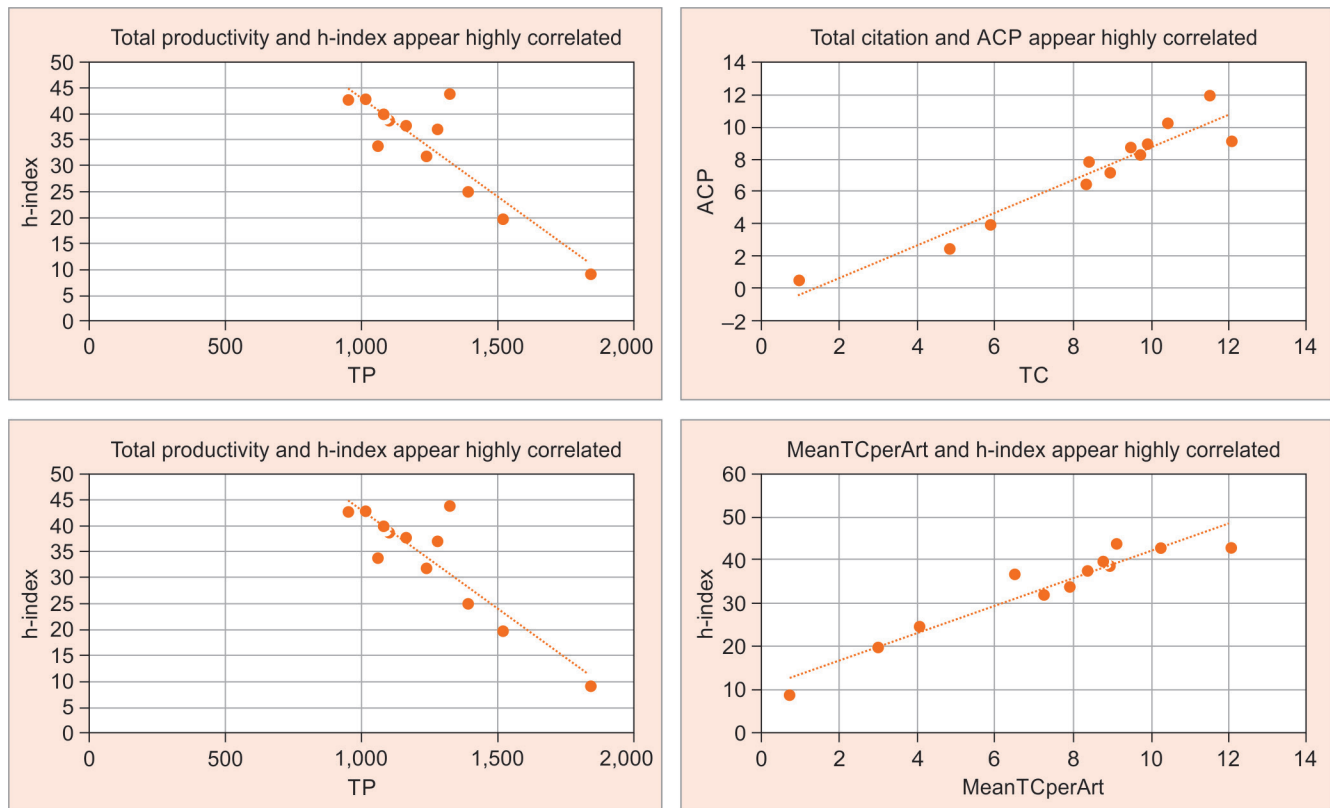


Fig. 2: Correlation between research metrics

Table 5: Productive organization on surgery research in India during 2000–2021

Affiliation	Articles	TC	h-index
AIIMS, New Delhi	1,477	12,689	40
PGIMER, Chandigarh	888	4,872	31
TMC	467	11,537	38
SGPIMS	409	2,344	22
SGSMCKEH	369	6,828	33
CMCH Vellore	352	2,251	22
MAHE	337	2,804	20
NIMHANS	336	1,558	18
SGRMH	278	2,172	21
KGMU	232	1,091	16

Mapping Co-occurrence of All Keywords in Surgery Research

For mapping the keywords, co-occurrences of keywords are considered. A minimum of 10 occurrences are considered. Just 2,512 of the 31,169 keywords satisfy the requirements. For 2,512 keywords, the overall strength of the co-occurrence links with the other terms was computed. Keywords, cluster (9), links (25,935), and total link strength (62,574) were found in total (1,000). These, 2,512 keywords are then grouped into 9 clusters and represented with different colors (Fig. 5). Cluster 1 (red) represents 147 keywords. (Oxidative stress, acid, epilepsy, expression, a-beta, accuracy, activation, aggression, anesthesia, brain, blood, cell death, cognitive impairment, cell, diagnostic criteria, differentiation, decline, deep

brain stimulation, major depression, mice, rats, rats) mapping co-occurrence of all keywords through VOS viewer (Fig. 4).

The Figure 5 also shows the top ten most occurred keywords in Surgery research were prevalence ($n = 375$), schizophrenia ($n = 367$), depression ($n = 361$), disorders ($n = 279$), symptoms ($n = 271$), risk ($n = 194$), meta-analysis ($n = 184$), scale ($n = 183$), disorder ($n = 182$), health ($n = 175$), anxiety ($n = 162$).

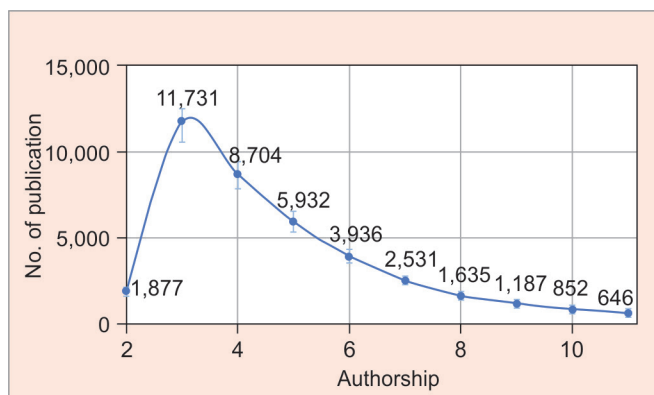
Finding of the Study

The major findings of the study are as follows:

- Publication on Indian surgery has steadily increased over the past 12 years, as data shows that from the year 2010 0.60 to 12.29%, the maximum number of papers are published in 2021.

Table 6: Top ten most cited papers on the Indian Surgery research during 2010–2021

Title	Authors	Source title	TC	APY	NTC
The SCARE 2018 statement: Updating consensus surgical case report (SCARE) guidelines	Agha RA	International Journal of Surgery	2,462	489	337.50
The 2016 update of the International study group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 years after	Bassi C	Surgery	1,479	215.66	198.56
The SCARE statement: Consensus-based surgical case report guidelines	Agha RA	International Journal of Surgery	1,276	182	160.94
3D printing based on imaging data: Review of medical applications	Rengier F	International Journal of Computer Assisted Radiology and Surgery	979	69.46	74.86
The SCARE 2020 guideline: Updating consensus surgical case report (SCARE) guidelines	Agha RA	International Journal of Surgery	789	264.66	266.41
Recommendations for Laparoscopic Liver Resection A Report From the Second International Consensus Conference Held in Morioka	Wakabayashi G	Annals of Surgery	837	95.87	91.52
A phase III study of belatacept-based immunosuppression regimens vs cyclosporine in renal transplant recipients (BENEFIT Study)	Vincenti F	American Journal of Transplantation	625	47.30	50.99
Estimating the global incidence of traumatic brain injury	Dewan MC	Journal of Neurosurgery	502	123.75	121.73
Borderline resectable pancreatic cancer: A consensus statement by the International study group of pancreatic surgery (ISGPS)	Bockhorn M	Surgery	517	52.33	53.70
International consensus on standardization of data collection for complications associated with esophagectomy complications consensus group (ECCG)	Low DE	Annals of Surgery	465	55.5	52.98

**Fig. 3:** Pattern of authorship

- During the year 2010–2021 about 219 sources related to surgery are retrieved from journals, books, etc., total 14,956 documents have been published in Indian Surgery.
- In 2010, research was published with 952 publications (6.36%) with 11,486 total citations, whereas the significant growth rate can be seen in the year 2021 with 1,839 publications (12.29%) with 950 total citations.
- Indian Journal of Surgery (JIF = 0.656, Quartile = 4, H-Index = 20) as the leading source with 1,689 publications with 4,734 citations, and Obesity Surgery has the highest number of h-index.

- Two authors have published more than 200 articles, and 6 authors have published more than 100 articles related to surgery. Kumar A, affiliated with the (AIIMS) New Delhi has 215 publications (1,588) citations. Three authored publications (NP = 11,731) have the maximum number of research papers.
- All India Institute of Medical Sciences New Delhi (NP = 1,477, TC = 12,689) found to be the leading organization in surgery research in India and "The SCARE 2018 statement: Updating consensus Surgical case Report (SCARE) guidelines" by Agha RA et al., appeared in International Journal of Surgery (TC = 2,462) noted as the most cited paper.

DISCUSSION

Research participants need incentives linked to productivity and a well-defined career path in the field. Numerous bibliometric analyses in the fields of general surgery and other medicine have been released. A few studies have mapped out the surgical research output in India. According to the study's goal, as compared to India's research production on surgery shares, industrialized nations like the United States and the European Union contribute to the bulk of global scientific publications. With 134 collaborations, India and the United States (1,145) and India and the United Kingdom (573), rank first and second, respectively (Holmgren and Schnitzer, Kappi and Ahmed).^{5,12} The growth rate increased from 0.60 to 12.29%, indicating that surgical publications have increased in recent years (Kanna et al.).⁴ Looking, towards the top ten journal publications, the Indian Journal of Surgery holds 1689 publications compared

to the International Journals of Surgery (242). Contributors and users of health research should thus have access to national and international literature and knowledge bases so they may become familiar with the instruments and uses of contemporary information technology.

CONCLUSION

It is evident from the study that Indian surgical research and academic paper publications have a high impact on global research production. A national health research plan must be created immediately in order to boost research production, enhance quality, and carry out more focused studies. The study analyzes India's success in surgical research using data from publications and a number of quantitative and qualitative metrics. The study examines India's global publication share, growth rate, citation quality, International Collaborative Publications, publication share, and distribution in subfields using data from the Web of Science database covering 11 years. The report makes the case for accelerating and elevating Indian surgery research. Bibliometric analysis is also crucial for developing the best strategies for enhancing the research activity. To have a clear picture and to take the required steps to improve the research performance, a thorough bibliometric analysis of surgery research in India and comparisons with that of other nations is crucial. The effectiveness of the Nation's Major Surgery Research Institutes should be assessed, and their results should be compared to those of similar institutions elsewhere. The proliferation of literature has emerged as a major worry for all three groups, as researchers, surgeons, and library professionals strive to remain up to date on new discoveries in their disciplines, and information workers attempt to organize this knowledge.

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