Qualitative Study

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Mapping the scientific landscape and evolution of the *International Journal of Surgery*: a scientometric analysis (2004–2024)

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Aim: The purpose of this study was to analyze the publication characteristics and development of the *International Journal of Surgery* (IJS) over its 20-year history.

Methods: This study included articles published in *IJS* during the 20 years from 2004 to 2024. The data were analyzed using the Citespace, VOS viewer, and the 'Bibliometrix' package in R software. The authors studied the dynamics and trend patterns of *IJS* literature production through descriptive bibliometrics and identified the most prolific authors, publications, institutions, and countries. Bibliometric maps were utilized to visualize published articles' content and identify the most prolific research terms and topics in *IJS*, as well as their evolution over time.

Results: A total of 5964 publications in the *IJS* from 2004 to 2023 and 356 publications in 2024 were included in the analysis. The study revealed a positive trend in literature production, although the number of articles published in *IJS* has slightly decreased recently. The most productive country was China ($n = 1211$), the most productive institution was Sichuan University ($n = 151$), and the most prolific author was Wang Yang ($n = 87$). The top 15 most cited articles focus primarily on research reporting standard guidelines for surgical studies. Research published in *IJS* mainly targeted middle-aged and older adults, emphasizing postoperative complications and treatment outcomes. The future research focus in *IJS* might center on integrating artificial intelligence and deep learning technologies to revolutionize surgical research and practice.

Conclusions: The *International Journal of Surgery* significantly contributes to advances in surgical research. *IJS* prioritized enhancing patient outcomes and advancing surgical techniques, focusing on middle-aged and older adults, postoperative complications, and treatment outcomes. The journal emphasized robust evidence through retrospective, controlled, and cohort surgical studies. Integrating artificial intelligence and deep learning represented a significant frontier poised to revolutionize surgical care, shaping the future landscape of research and practice.

Keywords: bibliometric, bibliometrix, citespace, International Journal of Surgery, VOS viewer

Introduction

The *International Journal of Surgery* (*IJS*) is a peer-reviewed, broad-scope journal dedicated to advancing surgical research, education, and clinical practice globally. *IJS* aims to promote continued developments in surgery by sharing knowledge, ideas, and best practices across all surgical specialties. Founded in 2004 by Professor Riaz Agha from Barts Health NHS Trust, a pioneer in the field of surgery, *IJS* has been under his editorship since its inception. The first article of IJS, published in May 2004 and titled 'The Teaching of Surgery in the Undergraduate Curriculum — Reforms and Results', highlighted that surgery was no longer an isolated practice. Instead, surgeons began working closely with multidisciplinary teams to benefit patients, and students needed to gain experience with this new collaborative approach[1]. Since its inception, *IJS* has maintained its position at the forefront of surgical science, publishing various articles, editorials, reviews, and letters. In the 2023 Scimago Journal Rank (SJR) powered by Scopus, *IJS* is ranked in the first quartile (Q1) of Medicine: Surgery, placing second out of 212 journals.

With the advancement of computer-assisted statistics and software, bibliometric analysis has become a powerful tool for summarizing journal development patterns and describing the knowledge structure of disciplines using various scientometric

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analysis software[2]. Beyond comprehensive bibliometric analysis of a specific field[3,4], bibliometric analysis of a particular journal can provide a deeper understanding of that journal's development process[5,6]. Furthermore, scientometric analysis of the top journals in specific fields can help scholars quickly grasp the focus, frontiers, and potential future trends[7].

Given *IJS*'s leading position in the field of surgery, conducting a bibliometric analysis of this journal can provide valuable insights into the domain's knowledge structure. Such an analysis can enable readers, editors, reviewers of *IJS*, and academics interested in surgery to understand the discipline's current frontier, notable contributors, hotspots, and trending issues. Therefore, this study employed three bibliometric software tools to retrospectively analyze *IJS*'s productivity, impact, emerging knowledge, and contribution to the surgery discipline over the past 20 years.

HIGHLIGHTS

- This study presents the first comprehensive bibliometric analysis of the publication characteristics and development of the *International Journal of Surgery* over its 20-year history.
- China and the United States hold leading positions in terms of publications, citations, and academic influence.
- The most productive institution was Sichuan University, and the most prolific author was Wang Yang from Shanghai Fourth People's Hospital.
- The *International Journal of Surgery* focuses on middle-aged and older adults, postoperative complications, and treatment outcomes, emphasizing retrospective, controlled, and cohort studies. Key topics include surgical methods, diseases like papillary thyroid carcinoma, and emerging trends like artificial intelligence integration and deep learning.

Methods

Study design

This study presented a longitudinal bibliometric analysis of the *International Journal of Surgery*, one of the top surgery journals. Unlike traditional review methods, this approach describes the scientific progression within a journal. The institutional review board of West China Hospital, Sichuan University determined that ethical approval for this study was unnecessary.

Search strategy

Publications from January 2004 to May 2024 were retrieved from the Web of Science Core Collection (WoSCC), Scopus, and Pubmed databases. The research strategies involved using the 'International Journal of Surgery' as the source title. All publications from *IJS* were included.

Data extraction, standardization, and analysis

Two independent researchers collected and extracted the publications in the 'Plain Text' format of 'Full Records and References' from WoSCC and the 'CSV' format of 'Full Records' from Scopus and Pubmed. The data from the three databases were merged and converted to a unified format, and duplicate documents were removed. An econometric analysis of the literature was conducted for the 20 years from 2004 to 2023, followed by further analysis in 2024. CiteSpace 6.2.R4 Advanced, VOSviewer 1.6.19, and the R Package bibliometrix 4.1.2 were used for the bibliometric analysis of the included studies.

CiteSpace 6.2.R4 Advanced[8] was utilized for co-citation analysis (authors and references), dual-map of journals, and citation burst detection for keywords. The parameters were set as follows: time span (from January 2004 to December 2023), time slice (1 year per slice), links (strength: cosine; scope: within slices), selection criteria (g-index, k = 25), pruning (Pruning Sliced Networks and Minimum Spanning Tree).

VOSviewer (version 1.6.19)[9] was used for collaboration network analysis (countries, institutions, and authors) and to create co-occurrence of keywords. The LinLog/modularity method was employed in VOSviewer.

R Package Bibliometrix (version 4.1.2)[10] was used to calculate multiple countries' publications (MCP) ratio and to

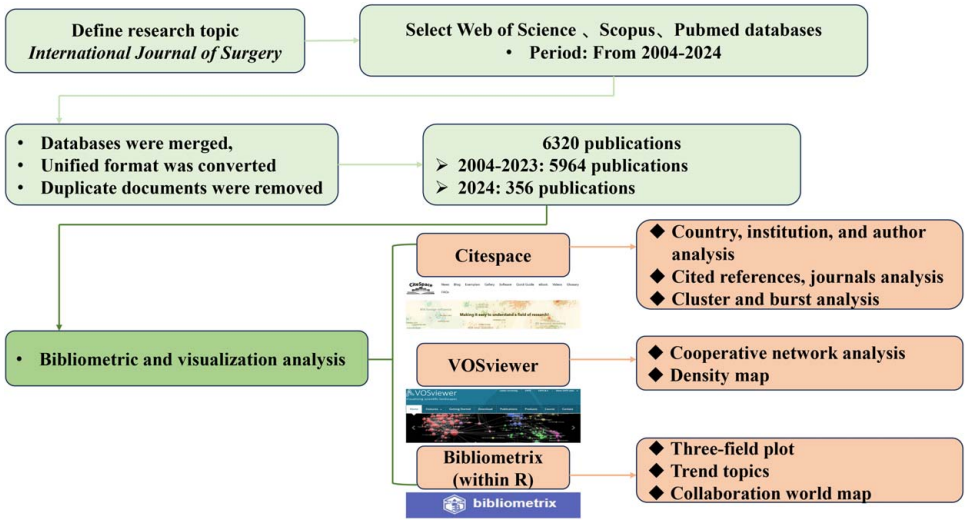

Figure 1. Flowchart of literature data retrieval and processing analysis.

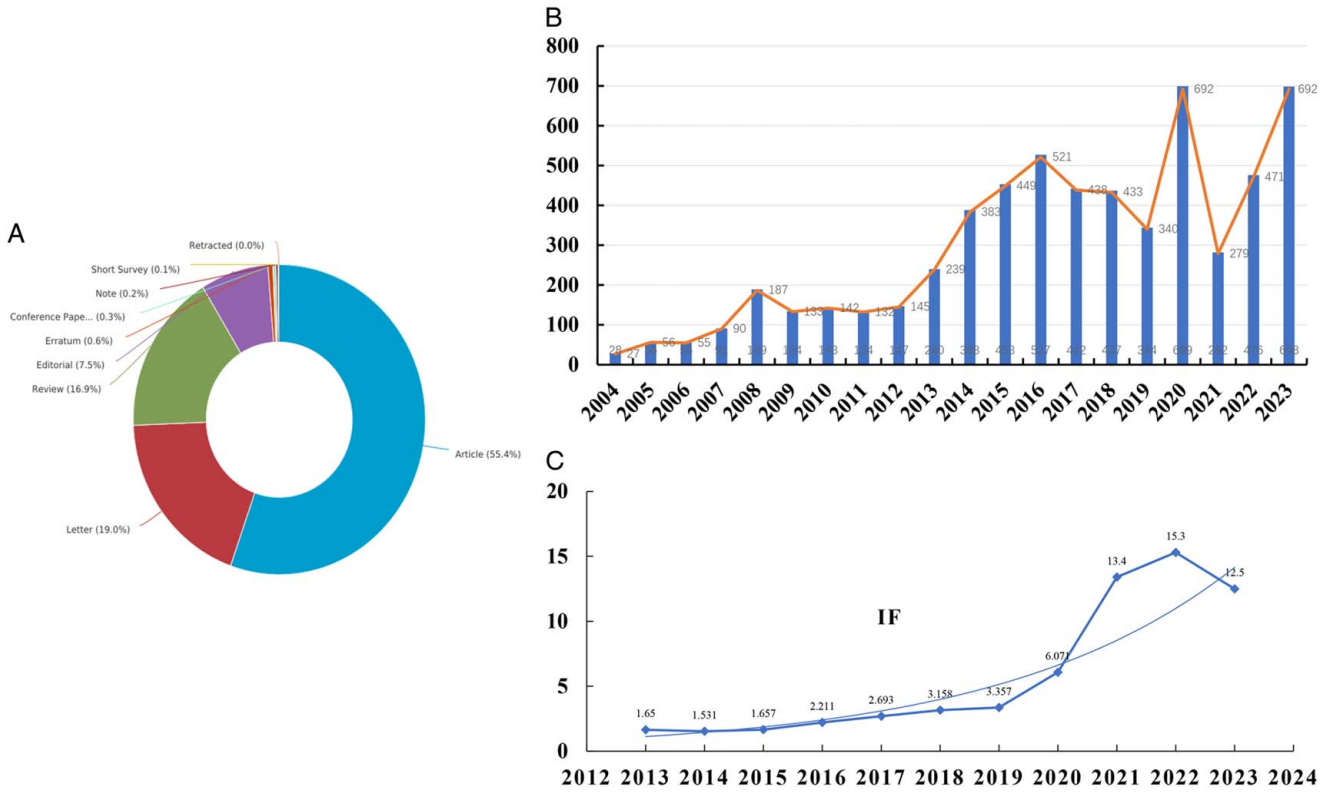

Figure 2. Study characteristics (A), annual publications (B), and impact factor (C) of the International Journal of Surgery between 2004 and 2023.

visualize countries' collaboration world map, countries' production over time, affiliations' production over time, and the three-field plot.

Charts interpretation

Betweenness centrality: betweenness centrality measures the importance of nodes in the network. Higher betweenness centrality indicates greater connectivity importance of the node.

Cluster view: using the likelihood ratio statistic, cluster views were generated from keyword lists of cited articles within each cluster. The keyword with the highest association for each cluster was automatically selected as the cluster name. Two indicators of Modularity, Q value (Q) and Weighted Mean Silhouette value (S), were used to evaluate the effectiveness of graph drawing. A modularity $Q > 0.3$ and a mean $S > 0.5$ were considered qualified for the clustering results.

Dual-map overlap: the dual-map overlap displays articles' distribution and citation trajectory in various disciplines. The left side shows the citing journals and the right side shows the cited journals.

Burst detection: burst detection identifies periods during which the number of citations for keywords changed dramatically, indicating a rise or decline in prominence.

Results

Study characteristics

The workflow of the study, from the search strategy to the data processing, is shown in Figure 1. The final search yielded 5964 publications in the *IJS* between 2004 ($n = 28$, 0.46%) and 2023 ($n = 698$, 11.7%). The most prevalent types of publications in *IJS* were Articles (55.4%), Letters (19.0%), and Reviews (16.9%) (Fig. 2A). There has been a significant increase in the volume of publications per year since 2008, although a notable drop occurred in 2021 ($n = 282$, 4.72%), likely due to the impact of

Table 1

Corresponding author's countries.

Country	Articles	SCP	MCP	Freq	MCP_Ratio
China	1211	1138	73	0.203	0.06
United Kingdom	858	748	110	0.143	0.128
Italy	342	287	55	0.057	0.161
USA	335	246	89	0.054	0.266
India	227	168	59	0.037	0.26
Turkey	138	136	2	0.022	0.014
Iran	108	82	26	0.018	0.241
Korea	107	96	11	0.017	0.103
Germany	102	71	31	0.017	0.304
Japan	102	95	7	0.017	0.069
Egypt	101	76	25	0.016	0.248
Pakistan	71	57	14	0.012	0.197
Spain	68	56	12	0.011	0.176
Barbados	60	55	5	0.01	0.083
Netherlands	59	45	14	0.01	0.237
France	58	48	10	0.009	0.172
Brazil	50	48	2	0.008	0.04
Australia	49	32	17	0.008	0.347
Ireland	41	39	2	0.007	0.049
Canada	37	24	13	0.006	0.351

MCP, multiple countries publication; SCP, single countries publication.

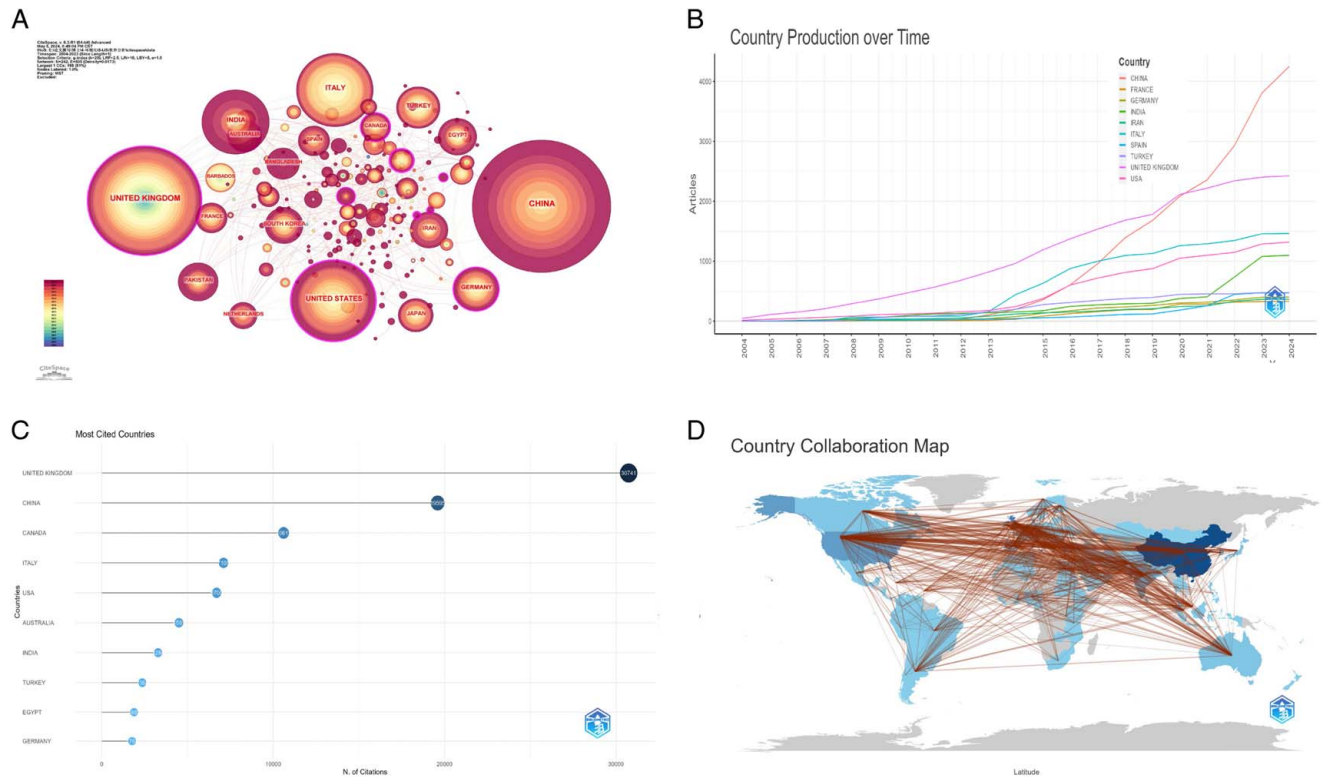

Figure 3. Analysis of countries engaged in publications in IJS. (A) Countries' co-occurrence map; (B) Top 10 countries with the most significant number of publications over time; (C) Top 10 most cited countries; (D) Countries' collaboration world map.

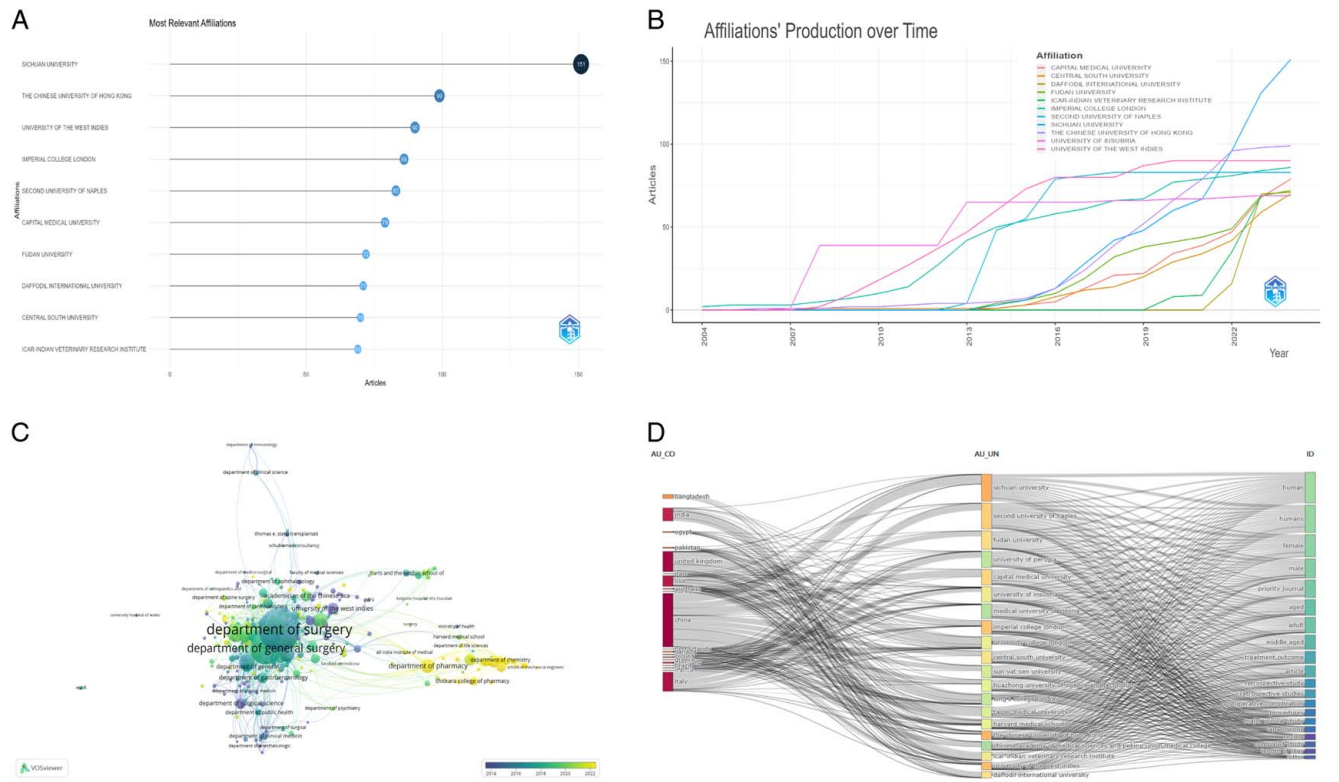

Figure 4. Analysis of institutions engaged in publications in IJS. (A) Top 10 most relevant institutions; (B) Top 10 institutions with the largest number of publications over time; (C) Department of institution co-occurrence map; (D) Three-field plot.

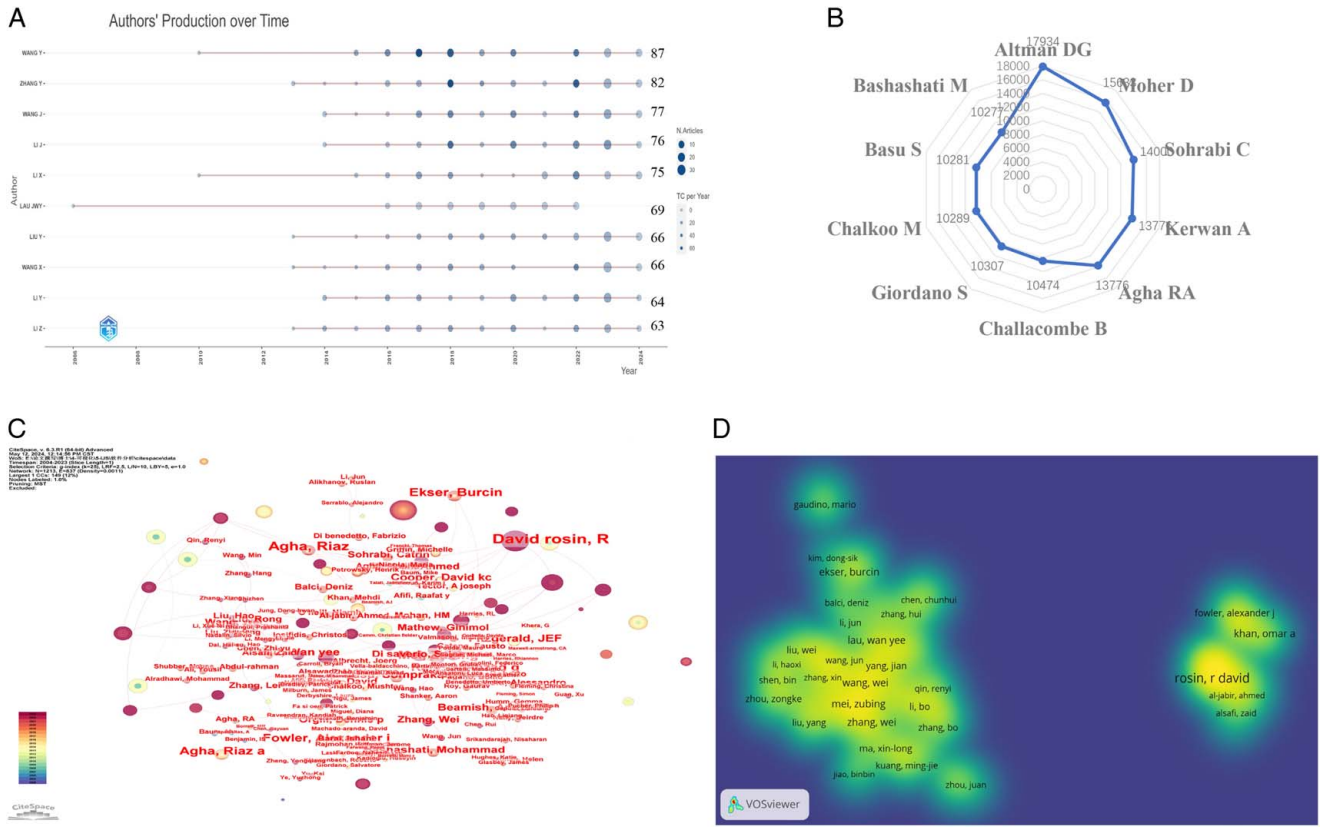

Figure 5. Analysis of authors engaged in publications in IJS. (A) Top authors with the largest number of publications over time; (B) Top 10 authors with citations; (C) Authors co-occurrence map; (D) Authors density map.

COVID-19-related restrictions on research worldwide[11]. The number of *IJS* publications increased in 2023 ($n = 698$, 11.7%), possibly due to many countries announcing the end of COVID-19 [12]. The annual growth rate of the *IJS* was 18.62%. The average citations per year are consistent with the number of articles published, indicating the high-quality of papers published in *IJS* (Fig. 2B). In addition, the impact factor (IF) of *IJS* has gradually increased from 2013 (IF = 1.65) to 2023 (IF = 12.5), demonstrating the journal's growing recognition and attention from international scholars (Fig. 2C).

Country analysis

A total of 80 countries contributed to publications in *IJS*. The top corresponding author's countries, based on the number of publications, are shown in Table 1 and Figure 3A. China had the highest number of publications ($n = 1211$, 20.3%), followed by the United Kingdom ($n = 858$, 14.38%) and Italy ($n = 342$, 5.73%). Over time, the growth rate in the number of publications was more pronounced in China and the United Kingdom than in other countries (Fig. 3B). The top three most cited countries were the United Kingdom ($n = 30\ 741$), China ($n = 19\ 595$), and Canada ($n = 10\ 612$) (Fig. 3C). According to the countries' collaboration world map (Fig. 3D), the United States had the highest centrality ($n = 0.34$), followed by Ireland ($n = 0.24$) and China ($n = 0.19$). Additionally, an analysis of the countries where the corresponding authors are based revealed that the top three countries in terms of the proportion of MCP to the total publications in that country (MCP_Ratio) were Canada (35.1%), Australia (34.7%), and Germany (30.4%).

Table 2

Authors' local impact.

Author	h_index	g_index	m_index	TC	NP	PY_start
Wang Y	26	40	1.733	1791	87	2010
Dionigi G	20	33	1.176	1198	45	2008
Zhang Y	20	32	1.667	1131	82	2013
Boni L	19	32	1.118	1124	44	2008
Rovera F	19	32	1.118	1095	42	2008
Wang J	18	25	1.636	832	76	2014
Conzo G	17	24	1.417	802	24	2013
Dionigi R	17	27	1	771	35	2008
li J	17	26	1.545	871	75	2014
li Z	17	24	1.417	739	63	2013
Wang X	17	26	1.417	740	64	2013
Agha RA	16	32	0.762	10843	32	2004
li Y	16	23	1.455	704	69	2014
Liu Z	15	27	1.5	777	35	2015
ma J	15	27	1.5	787	33	2015
Rausei S	15	21	1.25	461	24	2013
Wang Z	15	24	1.25	622	48	2013
Zhang H	15	23	1.25	626	52	2013
Amato B	14	22	1.273	535	30	2014
Gambardella C	14	23	1.273	605	23	2014

NP, number of publications; PY, publication year; TC, total citation.

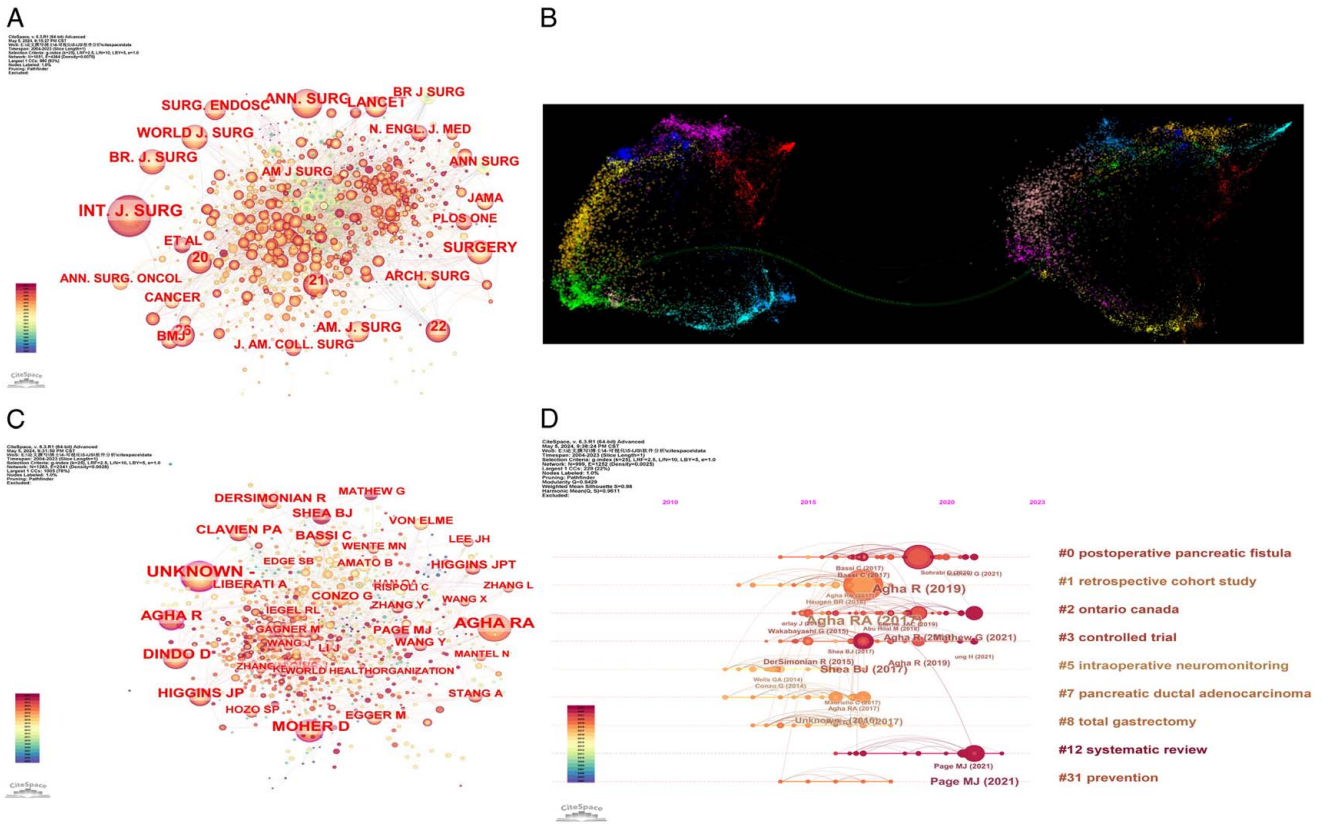

Figure 6. Journals, author, and references cited by IJS. (A) Cited authors map; (B) Overlay of journals; (C) Cited authors map; (D) Timeline view of cited references.

Institution analysis

The publications included in this study were written by a total of 6578 institutions. Information on the top 10 institutions, based on the number of publications, is shown in Figure 4A. The top three institutions were Sichuan University ($n = 151$, 2.53%), the Chinese University of Hong Kong ($n = 99$, 1.65%), and the University of the West Indies ($n = 90$, 1.51%). Additionally, five of the top 10 institutions in terms of publications were located in China. Regarding the number of articles published by institutions over time (Fig. 4B), Sichuan University has shown a more pronounced rate of publication growth since 2016 compared to other institutions. The overlay visualization of departments from institutions (Fig. 4C) indicates that, initially, the focus was mainly on the Department of Surgery in the *IJS*. However, starting in 2020, the Department of Surgery began collaborating with other departments, such as the Department of Pharmacy, the Department of Ophthalmology, and the Department of Public Medicine. To better understand the relationships between institutions, relevant countries, and keywords, the three-field plot is presented in Figure 4D. Currently, institutions in prominent contributing countries primarily focus on the surgical prognosis of middle-aged and elderly patients.

Author analysis

A total of 17 366 authors contributed to the publication of *IJS* literature from 2004 to 2023. The top three productive authors were Wang Y ($n = 87$) from Shanghai Fourth People's Hospital, Zhang YK ($n = 82$) from Peking University International Hospital, and Wang J ($n = 77$) from Southern Medical University (Fig. 5A). According to the authors' local impact analysis (Tables 2), Altman DG had the highest h_index ($n = 7$), g_index ($n = 7$), and m_index ($n = 1.733$), followed by Dionigi G (h_index = 20) and Zhang Y (h_index = 20). Further analysis of total citations showed that the top three authors were Altman DG ($n = 17\,934$), Moher D ($n = 15\,633$), and Sohrabi C ($n = 14\,000$) (Fig. 5B). Figure 5C illustrates the author's co-authorship network mapping and strength. The top-ranked author by centrality is Mccaul J, with a centrality of 0.02, followed by Agha R ($n = 0.01$) and Derbyshire L ($n = 0.01$) (Fig. 5C). From the perspective of density visualization, four leading authors, Rosin R, Agha R, Wang We, and Ekser B, have made significant contributions to collaborative efforts (Fig. 5D).

Journals, authors, and references cited by IJS

We conducted a detailed analysis of the journals, authors, and references most frequently cited by the *IJS*. Excluding self-citation, the primary journals cited by *IJS* were Annual of Surgery ($n = 725$), Surgery ($n = 595$), and British Journal of Surgery ($n = 537$). Additionally, the co-occurrence map revealed that Nature ($n = 0.11$) has the highest centrality, followed by surgery ($n = 0.08$) and cancer ($n = 0.07$) (Fig. 6A). The dual-map overlay of journals in Figure 6B indicates that research published in health/nursing/medicine journals was frequently cited by research in medical/clinical journals. The most frequently cited authors by

Table 3

The top 15 high-impact articles published by *IJS* between 2004 and 2023.

Title	Corresponding author	Times cited	Main find	Year
Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement	David Moher	8344	This study proposed PRISMA (preferred reporting items for systematic reviews and meta-analyses)	2010
The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies	Erik von Elm	5718	The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) was proposed	2014
The SCARE 2020 Guideline: Updating Consensus Surgical Case Report (SCARE) Guidelines	Riaz A. Agha	4579	The survey responses were incorporated as modifications, and an improved SCARE Checklist is now presented for use	2020
The socio-economic implications of the coronavirus pandemic (COVID-19): a review	Riaz A. Agha	3967	This review summarized the socio-economic effects of COVID-19 on individual aspects of the world economy	2020
WHO declares global emergency: a review of the 2019 novel coronavirus (COVID-19)	Riaz A. Agha	3494	This review summarized the current state of knowledge surrounding COVID-19	2020
The PRISMA 2020 statement: an updated guideline for reporting systematic reviews	Matthew J. Page	3424	This study presented the PRISMA 2020 27-item checklist, an expanded checklist	2021
The SCARE 2018 Statement: Updating Consensus Surgical Case Report (SCARE) Guidelines	Riaz A. Agha	2027	A modified and improved SCARE checklist is presented	2018
Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration	Matthias Egger	1628	The STROBE Statement, this document, and the associated Website (http://www.strobe-statement.org/) should be helpful resources to improve reporting of observational research	2014
The SCARE Statement: Consensus-based surgical case report guidelines	Riaz A. Agha	1489	CARE Guideline supports transparency and accuracy in publication of case-reports	2016
CONSORT 2010 explanation and elaboration: Updated guidelines for reporting parallel group randomized trials	David Moher	1485	The CONSORT 2010 Statement, this revised explanatory and elaboration document, and the associated website (www.consort-statement.org) should be helpful resources to improve reporting of randomised trials	2012
STROCSS 2019 Guideline: strengthening the reporting of cohort studies in surgery	Riaz A. Agha	1079	The STROCSS 2019 guideline is hereby presented as a considered update to improve reporting of cohort, cross-sectional and case–control studies in surgery	2019
CONSORT 2010 statement: updated guidelines for reporting parallel group randomized trials	Kenneth F. Schulz	712	This study organized a CONSORT Group meeting to update the 2001 statement	2011
The STROCSS statement: strengthening the Reporting of Cohort Studies in Surgery	Riaz A. Agha	693	This study presented the STROCSS guideline for surgical cohort, cross-sectional, and case–control studies consisting of a 17-item checklist	2017
The PROCESS 2020 Guideline: Updating Consensus Preferred Reporting Of Case Series in Surgery (PROCESS) Guidelines	Thomas Franchi	587	This was a DELPHI consensus exercise to update the PROCESS guidelines	2020
STROCSS 2021: strengthening the reporting of cohort, cross-sectional, and case–control studies in surgery	Mathew, Ginimol	542	Present updated STROCSS 2021 guidelines to ensure ongoing good reporting quality among observational studies in surgery	2021

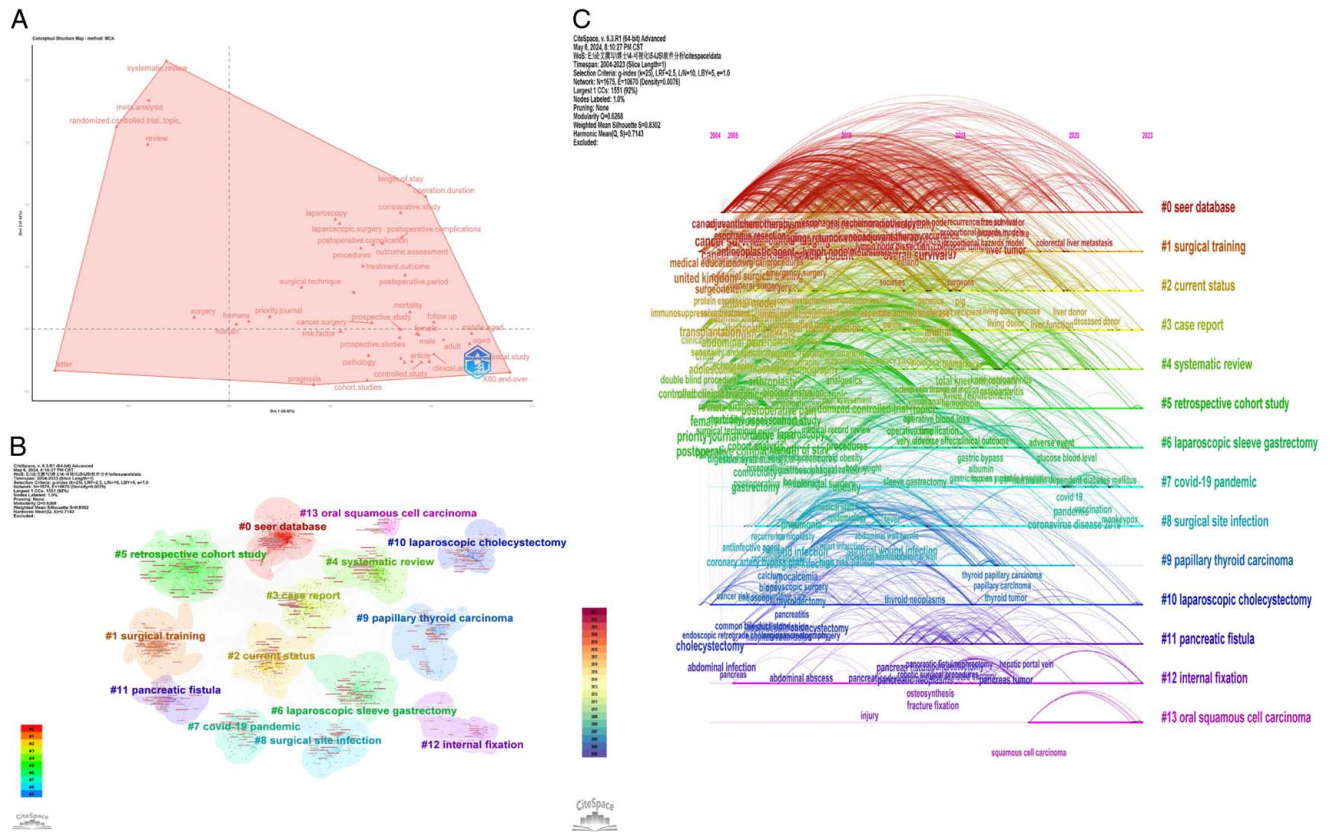

Figure 7. Keywords analysis. (A) Conceptual structure map; (B) Keywords clusters; (C) Timeline view of keywords clusters.

IJS were Agha R ($n = 305$), Moher D ($n = 215$), and Dindo D ($n = 191$). In terms of centrality analysis, Agha R ($n = 0.25$) has the highest centrality, followed by Moher D ($n = 0.11$) and Bassi C ($n = 0.09$) (Fig. 6C). Cluster analysis of the references cited by the *IJS* identified nine clusters (Fig. 6D). The largest cluster (#0), labeled as 'postoperative pancreatic fistula,' included 47 members. The major citing article of the cluster was 'Strengthening the reporting of cohort, cross-sectional, and case–control studies in surgery'[13]. This article was frequently cited because it provided essential methodological guidance for conducting and reporting surgical research, which was highly relevant when studying complex conditions like postoperative pancreatic fistula. Adhering to these guidelines made articles a foundational reference for researchers aiming to produce high-quality, transparent, and reproducible findings in the field of surgery, particularly in the context of postoperative pancreatic fistula. The second-largest cluster (#1), labeled 'retrospective cohort study', included 34 members. The major citing article for the cluster was 'Robotic versus conventional laparoscopic gastrectomy for gastric cancer: a retrospective cohort study'[14], which was widely cited because it compared two surgical techniques—robotic and conventional laparoscopic gastrectomy—using a retrospective cohort study design. Such a study is particularly valuable in evaluating the outcomes, advantages, and potential risks associated with different surgical approaches. By analyzing a large set of patient data retrospectively, the study provided insights into the effectiveness, safety, and potential benefits of robotic surgery compared to traditional methods, making it a key reference for researchers and clinicians interested in optimizing surgical techniques for gastric cancer. The third-largest cluster (#2), labeled as 'Ontario Canada,' included 32 members. The major citing article of the cluster was 'Laparoscopic hepatectomy is safe and effective for the management of patients with colorectal cancer liver metastases in a population-based analysis in Ontario, Canada. A retrospective cohort study'[15], showing that laparoscopic hepatectomy was associated with lower postoperative complications and shorter length of hospital stay for treating colorectal cancer liver metastases in Ontario, Canada.

Most frequently cited studies of IJS

Table 3 presents the top 15 highly impactful articles published by the *IJS*. These most cited articles primarily focused on research reporting guidelines. In 2010, David M and his colleagues proposed reporting guidelines for systematic reviews and meta-analyses, significantly contributing to the standardization of related studies[16]. Subsequently, the updated PRISMA 2020 statement was introduced for reporting systematic reviews in BMJ[17]. Erik VE *et al*. developed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies[18,19]. Riaz *et al*.[20] proposed consensus-based guidelines for surgical case reports, known as the SCARE Statement, which were further revised in 2018[21] and 2020[22]. The CONSORT 2010 statement and an elaboration of the updated guidelines for reporting parallel group randomized trials were also published[23,24]. The STROCSS statement for

reporting cohort studies in surgery was introduced in 2017[25] and subsequently updated in 2019[26] and 2021[13]. Additionally, the updated Consensus Preferred Reporting of Case Series in Surgery (PROCESS) guidelines were published in 2020[27]. Beyond research reporting guidelines, the top 15 most cited papers also address the socio-economic implications of COVID-19[28,29].

Keywords co-occurrence analysis

Keyword co-occurrence is an effective bibliometric analysis method for capturing current topics in the study of scientific knowledge structure. We analyzed the co-occurrence of keywords in the field based on their frequency of occurrence (Fig. S1, Supplemental Digital Content 1, http://links.lww.com/JS9/D503, 7A). Articles published in the *IJS* predominantly focused on middle-aged ($n = 1943$) and older adults ($n = 1693$), with a significant emphasis on postoperative complications ($n = 1338$) and treatment outcomes ($n = 1389$). The most common types of studies published in the *IJS* were retrospective studies ($n = 1635$), controlled studies ($n = 1143$), and cohort studies ($n = 886$). Moreover, 14 distinct clusters were generated using the log-likelihood ratio to analyze co-occurring keywords (Fig. 7B, Table 4). Surgical methods such as laparoscopic sleeve gastrectomy, laparoscopic cholecystectomy, and internal fixation were prominently featured in *IJS* publications. Additionally, diseases such as papillary thyroid carcinoma and pancreatic fistula were of primary concern. Notably, the article titled 'Long-term predictors of success after laparoscopic sleeve gastrectomy (LSG)' was a key reference for several clusters, supporting the safety, effectiveness, and durability of LSG as a definitive bariatric procedure[30] (Fig. 7C).

Changes in trends of research of IJS

Changes in publication trends in the *IJS* were explored using thematic terminology analysis (Figs 8A). The basic themes identified in *IJS* publications were female-related articles and surgery histopathology. The motor themes included pathology, cancer surgery, and human studies, while the niche theme was Coronavirus 2019. Additionally, the analysis identified emerging or declining themes such as nonhumans, animals, and letters. According to the trend analysis, artificial intelligence (AI) and deep learning were potential future development trends (Fig. 8B). Figure 8C displays the top 25 keywords with the strongest citation bursts. Since 1999, the keyword with the strongest citation burst was 'priority' (burst strength = 101.21, 2004–2013). The keyword 'letter' exhibited the highest burst strength of 325.97 from 2020 to 2023. The most recent burst keywords included 'clinical outcome', 'adverse event', and 'liver tumor'.

Recent advance in 2024

We conducted a further analysis of the literature published in the *IJS* up until 1 May 2024. The top three countries in terms of publication volume for 2024 were China ($n = 192$), the United States ($n = 21$), and South Korea ($n = 17$) (Fig. 9A). The top three institutions making significant contributions were Sichuan University ($n = 20$), Chi Mei Medical Center ($n = 17$), and I-Shou University ($n = 12$) (Fig. 9B). Our analysis of the word frequency tree revealed that the hotspots in 2024 closely align with the trends we previously predicted (Fig. 9C). The most innovative paper in *IJS* for 2024 is titled 'Hypothermic oxygenated perfusion in liver transplantation: a meta-analysis of randomized controlled

Table 4

Summary of the largest 14 clusters based on publication in *IJS*.

Cluster-ID	Size	Silhouette	Label	Major citing article	Average year
0	221	0.764	seer database	Impact of response evaluation for resectable esophageal adenocarcinoma – a retrospective cohort study[30]	2012
1	177	0.799	surgical training	Advanced laparoscopic fellowship training decreases conversion rates during laparoscopic cholecystectomy for acute biliary diseases: a retrospective cohort study[31]	2010
2	162	0.85	current status	Long-term predictors of success after laparoscopic sleeve gastrectomy[29]	2013
3	156	0.737	case report	Long-term predictors of success after laparoscopic sleeve gastrectomy[29]	2010
4	153	0.81	systematic review	Changing the innate consensus about mesh fixation in trans-abdominal preperitoneal laparoscopic inguinal hernioplasty in adults: Short and long-term outcome. Randomized controlled clinical trial[32]	2014
5	114	0.91	retrospective cohort study	Long-term predictors of success after laparoscopic sleeve gastrectomy[29]	2010
6	112	0.798	laparoscopic sleeve gastrectomy	Long-term predictors of success after laparoscopic sleeve gastrectomy[29]	2012
7	97	0.928	covid-19 pandemic	Western Pacific countries preparedness for monkeypox emergence: a call for action – Correspondence[33]	2020
8	96	0.844	surgical site infection	A retrospective study evaluating the use of Permacol surgical implant in incisional and ventral hernia repair[34]	2013
9	80	0.9	papillary thyroid carcinoma	Risk of malignancy in thyroid nodules classified as TIR-3A: what therapy?[35]	2012
10	65	0.869	laparoscopic cholecystectomy	Short-term outcomes of robotic versus open pancreaticoduodenectomy in elderly patients: a multicenter retrospective cohort study[36]	2012
11	54	0.886	pancreatic fistula	Elderly patients have similar short-term outcomes and 5-year survival compared to younger patients after pancreaticoduodenectomy[37]	2015
12	51	0.925	internal fixation	Is a dynamic locking plate(Targon FN) a better choice for treating of intracapsular hip fracture? A meta-analysis[38]	2016
13	13	0.999	oral squamous cell carcinoma	Conspectus on nanodiagnostics as an incipient platform for detection of oral potentially malignant disorders and oral squamous cell carcinoma[39]	2022

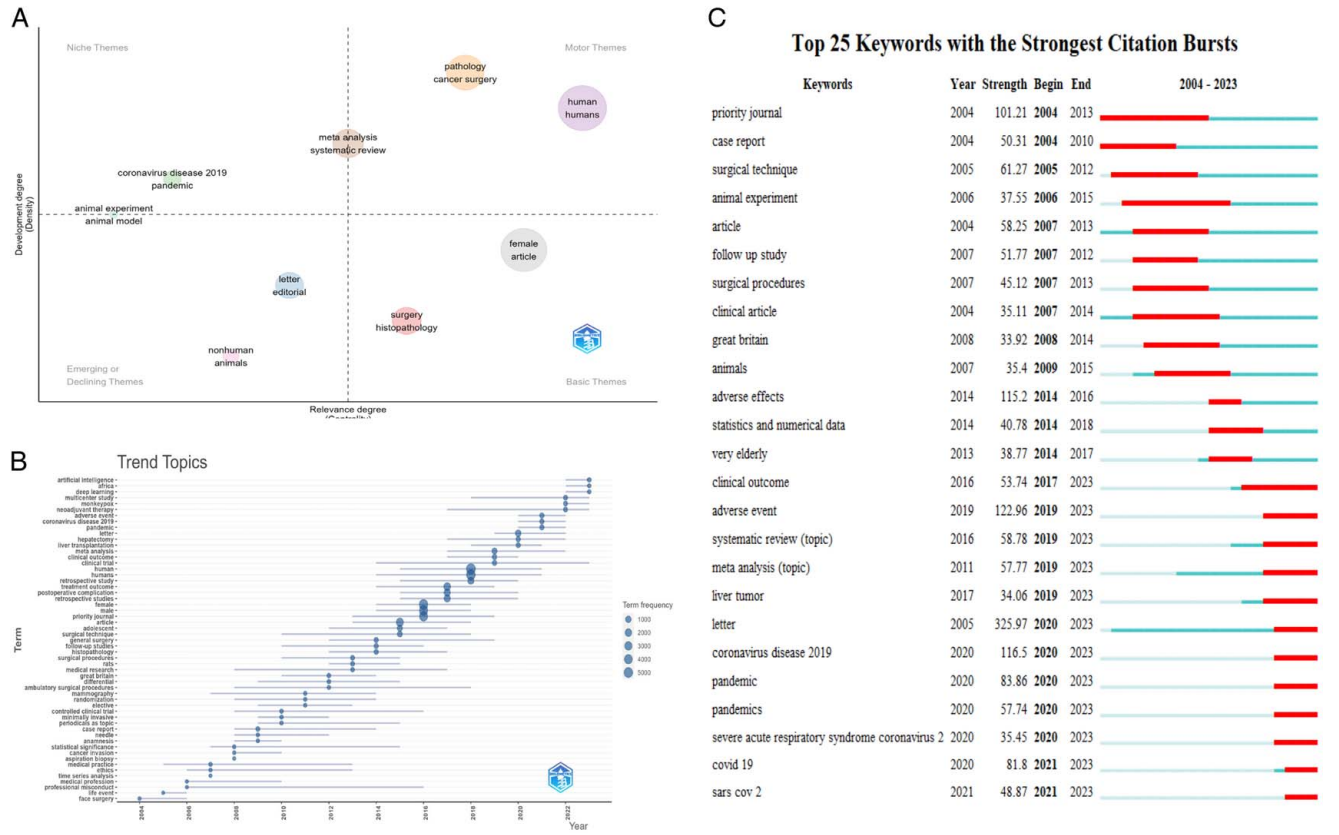

Figure 8. Hotspots and trends analysis. (A) Thematic evolution map; (B) Trend topics; (C) Top 25 keywords with the strongest citations bursts.

trials and matched studies'[31], which suggested that hypothermic oxygenated machine perfusion could be a valuable method for improving outcomes in liver transplantation, though further research is needed for long-term validation.

Discussion

Principal findings

This study provided the most up-to-date scientometric analysis of the characteristics of publications in the *IJS* from 2004 to 2024. Trends in publication productivity, countries, institutions, authors, references, and topics were presented. Our descriptive bibliometric analysis showed that *IJS* primarily focuses on original articles (55.4%), letters (19.0%), and reviews (16.9%) related to surgery. Before 2012, the annual number of articles published by *IJS* was relatively stable. Between 2013 and 2019, the annual publication volume dramatically increased, peaking in 2020 with 699 articles. The slight decline in publication volume from 2021 to 2022 might be related to the outbreak of COVID-19 and the subsequent economic downturn[32]. From the perspective of article citations, the average citation per article is 20.39, which significantly exceeds the journal's impact factor (IF = 12.5), indicating that the papers published in the *IJS* are of high-quality and have been extensively referenced by scholars worldwide. Given *IJS*'s influence in the surgical field, the issues reflected in this journal likely highlight future areas of concern for the discipline. We have further analyzed and discussed these issues below.

Future direction-enhance collaboration

Enhancing collaboration is pivotal for advancing the surgical field, as evidenced by comprehensive data analysis. With contributions spanning 80 countries, international cooperation emerges as a cornerstone strategy for future progress. Notably, China and the United Kingdom have exhibited significant growth in publication rates, underscoring the importance of fostering cross-national collaboration to harness diverse expertise and resources.

At the institutional level, promoting collaboration among institutions is paramount to facilitate the sharing of research outcomes and foster collective innovation[33]. Institutions such as Sichuan University in China have demonstrated substantial growth in publication output, suggesting significant potential for collaboration in other regions. Furthermore, encouraging collaboration among authors, particularly across disciplines and institutions, can catalyze breakthroughs in surgical research.

Interdisciplinary collaborations are increasing, as evidenced by partnerships with fields like pharmacy and ophthalmology, indicating a shift towards comprehensive approaches to surgical challenges[34]. By embracing interdisciplinary collaboration, researchers can explore diverse areas, from surgical innovation to postoperative care, leading to holistic advancements in the field[35].

Overall, strengthening collaboration across international borders, institutions, and disciplines holds promise for addressing the multifaceted challenges in the surgical domain. By fostering a culture of collaboration and leveraging diverse expertise, the surgical community can drive research innovation and ultimately improve patient outcomes globally.

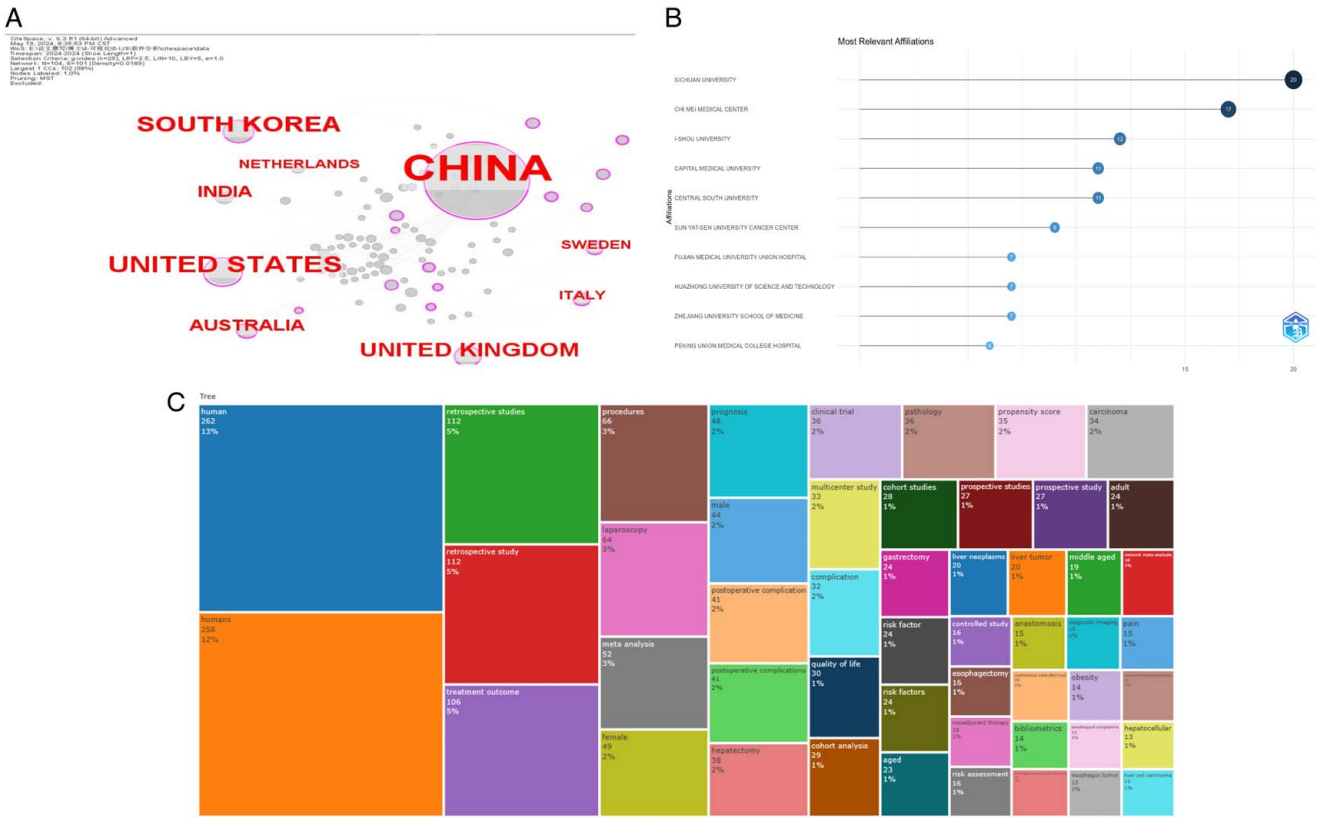

Figure 9. Recent advance in 2024 of IJS. (A) Countries co-occurrence map; (B) Top 10 most relevant institutions; (C) Words cloud.

Future direction-standardize research

The standardization of international surgical research has played a crucial role in enhancing the quality and transparency of studies. Analyzing the highly impactful papers published by the *IJS* reveals that reporting guidelines have been central to this process.

In the surgical research domain, Riaz A. Agha and colleagues developed the SCARE statement, establishing consensus-based guidelines for surgical case reports[20]. This guideline addressed the lack of standardization in case report submissions, making them more systematic and comprehensive. Subsequent modifications and improvements to the SCARE checklists in 2018[21] and 2020[22] reflected the evolving needs of research practices. For surgical cohort studies, the STROCSS statement was first introduced in 2017[25] and updated in 2019[26], 2021[13], and 2024[36]. These updates highlight the need for ongoing refinement of reporting standards to keep pace with methodological advancements and practical demands. Furthermore, the PROCESS guideline, updated in 2020, offered a revised consensus standard for reporting surgical case series[27]. These guidelines emphasized the need for detailed and systematic descriptions when reporting surgical case series to enhance research transparency and reproducibility.

From the perspective of surgical prevention, treatment, and prognosis, we identified 678 guidelines, systematic reviews, and meta-analyses published in the IJS. These studies specifically focus on enhancing surgical prevention strategies, optimizing treatment approaches, and improving patient prognosis. For instance, they examine the use of cryosurgery for unresectable pancreatic cancer[37], the impact of early mobilization after Achilles tendon repair[38], and the application of radiomics for preoperative prediction in colorectal cancer[39]. The research highlights the potential of emerging technologies, such as hypothermic oxygenated perfusion (HOPE) and radiomics[31], while also assessing the effectiveness and risks of traditional methods. These findings help surgeons make informed decisions, optimize treatment plans, and improve patient outcomes.

In addition to providing standardized guidelines for the surgical specialty, the *IJS* also offers standardized guidelines and criteria for various medical research disciplines. David Moher and his colleagues proposed the PRISMA guideline in 2010 for reporting systematic reviews and meta-analyses, laying the groundwork for standardizing related studies[16]. These guidelines emphasized the necessity of transparent and comprehensive reporting in systematic reviews, ensuring the reproducibility and reliability of research findings. The updated PRISMA 2020 further refined these standards, incorporating more detailed requirements to accommodate the complexities of modern research[17]. Additionally, Erik von Elm *et al.* introduced the STROBE guideline, providing a clear framework for reporting observational studies[19]. This guideline improves the quality of observational study reports, enabling readers to better assess the validity and applicability of the findings. The CONSORT 2010[24] statement provides updated guidelines for reporting parallel group randomized trials, along with explanations and elaborations. This update reinforced the transparency and completeness of trial reporting, ensuring standardized practices in trial design, implementation, and result dissemination.

In summary, the development and ongoing update of these reporting criteria have helped standardize international surgical research. They enhance research report quality, transparency, reproducibility, and application. These standards will grow with research methods and practical demands, supporting surgical research standardization.

Future direction - potential hotspot

Current research trends

Focus on middle-aged and older adults: a significant portion of research published in the *IJS* is concentrated on middle-aged (1943 publications) and older adults (1693 publications). This demographic focus likely reflects the higher incidence of surgical interventions and postoperative complications in these age groups. As individuals age, they often face an increased risk of conditions requiring surgical treatment, such as cardiovascular diseases, cancers, and degenerative diseases[40].

Emphasis on postoperative complications and treatment outcomes: postoperative complications (1338 publications) and treatment outcomes (1389 publications) are prominent topics of interest. This focus underscores the importance of improving surgical techniques, patient management, and recovery processes to enhance patient safety and long-term outcomes[41]. Research in these topics helps identify risk factors, optimize surgical procedures, and develop protocols to mitigate complications[42].

Key surgical methods and diseases: surgical techniques such as laparoscopic sleeve gastrectomy, laparoscopic cholecystectomy, and internal fixation are frequently studied, reflecting advancements in minimally invasive surgery and its benefits in reducing recovery time and complications[43,44]. Diseases like papillary thyroid carcinoma[45] and pancreatic fistula[46] are of particular concern. Research on these diseases aims to improve diagnostic methods, surgical interventions, and postoperative care.

Potential future focus

Artificial intelligence and deep learning: AI and deep learning are poised to revolutionize surgical research and practice[47,48]. These technologies can enhance diagnostic accuracy, personalize treatment plans, predict surgical outcomes, and improve robotic surgery[49]. Future research may explore the integration of AI in preoperative planning, intraoperative navigation, and postoperative care.

Recent keyword bursts: keywords with recent citation bursts, such as 'clinical outcome', 'adverse event', and 'liver tumor', indicate growing interest and emerging trends in these areas. Research on clinical outcomes and adverse events aims to optimize patient safety and treatment efficacy, while studies on liver tumors focus on improving surgical techniques and outcomes for hepatobiliary diseases.

Strengths and limitations

A notable strength of this study lies in the utilization of advanced bibliometric software, which effectively captures a comprehensive overview of surgical research published in the *IJS*. This approach allows for a detailed analysis of the distribution and characteristics of research articles, as well as the identification of prevailing topic trends within this scientific domain. However, there are some limitations in this study. The topic analysis in this study focused solely on author keywords from each paper, which may not fully capture the complexity of the various research areas in surgery. Additionally, the included studies were not subjected to critical appraisal, and the analysis does not assess the societal impact of the research, whether positive, negative, or neutral.

Conclusion

The study's findings underscore the extensive and varied nature of pedagogical research in international surgery studies published in *IJS* from 2004 to 2024, providing valuable insights into the evolution and key topics within this field. Notably, China and the United Kingdom exhibit significant growth in publication rates. The most productive institution is Sichuan University in China. The emergence of prominent authors with high centrality metrics, such as Mccaul James and Agha Riaz, underscores their influential role in facilitating collaboration networks.

In summary, the *IJS* reflects ongoing and evolving trends in surgical research, with a strong emphasis on improving patient outcomes and advancing surgical techniques. The focus on middle-aged and older adults, postoperative complications, and treatment outcomes highlights the journal's commitment to addressing key clinical challenges. The prominence of retrospective, controlled, and cohort studies underscores the importance of robust evidence in guiding surgical practice. Looking ahead, the integration of artificial intelligence and deep learning represents a significant frontier for innovation, promising to enhance precision and personalization in surgical care. As the journal continues to evolve, these trends and emerging technologies will shape the future of surgical research and practice.

Ethical approval

This scientometric article includes no data or information regarding a patient or trial participant.

Consent

Not applicable.

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Author contribution

C.L.: wrote the original manuscript and revised it; J.H.: wrote the original manuscript, performed bibliometric analysis, and collected the literature search; C.H.: revised the manuscript; W.Z.: provided design improvement and grant and revised the manuscript.

Conflicts of interest disclosure

The authors declare no conflicts of interest.

Research registration unique identifying number (UIN)

This study is a metrology research and there is no suitable registry available for this type of research.

Guarantor

Chong Li and Weihua Zhuang.

Data availability statement

Chong Li and Weihua Zhuang had full access to all of the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis.

Provenance and peer review

Not applicable.

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