

# Sleep Disorders and Perioperative Stroke: A Global Bibliometric Analysis from 1999 to 2024

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**Purpose:** Perioperative stroke is a severe postoperative complication increasingly linked to sleep disorders such as insomnia, obstructive sleep apnea (OSA), and circadian disruption. This study aimed to map the global research landscape and identify major trends, collaborations, and evolving themes connecting sleep disorders with perioperative stroke.

**Methods:** Publications from 1999 to 2024 were retrieved from three major databases: WOSCC, Scopus, and PubMed, using combined sleep- and stroke-related search terms. After screening, 1727 eligible articles and reviews were analyzed using VOSviewer, CiteSpace, Bibliometrix, and Scimago Graphica to assess publication growth, co-authorship, institutional productivity, and keyword evolution.

**Results:** A total of 1727 documents from 1,464 journals were authored by 9,643 researchers across 117 countries. The annual growth rate was 7.91%, with an average of 69.53 citations per document. The United States, China, Canada, and the United Kingdom were the leading contributors, while Harvard Medical School ranked first institutionally (72 papers). Keyword and co-citation analyses revealed a thematic evolution, from early circadian and REM-sleep studies to more recent translational research focusing on OSA, cardiovascular risk, and perioperative cerebrovascular events.

**Conclusion:** Research on sleep disorders and perioperative stroke has evolved into a mature, collaborative, and multidisciplinary field. Integrating mechanisms such as inflammation, endothelial dysfunction, and circadian misalignment may enhance perioperative stroke prevention and personalized risk assessment.

**Keywords:** bibliometrics, perioperative stroke, sleep disorders, obstructive sleep apnea, circadian rhythm

## Introduction

Perioperative stroke—defined as ischemic or hemorrhagic stroke occurring during surgery or within 30 days post-operatively—remains one of the most devastating complications in surgical care, carrying substantial risks of long-term disability and excess mortality.<sup>1,2</sup> Reported incidences range from 0.1–0.7% in noncardiac, non-neurological surgery, rising to 1–5% or higher in high-risk cardiac, vascular, or neurosurgical procedures.<sup>3</sup> Large population-based analyses similarly estimate an overall incidence of 0.32%,<sup>4</sup> and contemporary evidence suggests that despite advances in perioperative care, the burden of perioperative stroke has not meaningfully improved.<sup>3,5</sup>

Established clinical risk factors, including age, atrial fibrillation, hypertension, diabetes, and previous cerebrovascular disease, remain fundamental to perioperative stroke risk assessment.<sup>1,3</sup> Yet these factors do not fully account for events occurring in patients without obvious vascular risk, underscoring the need to identify additional, potentially modifiable contributors.

Sleep disturbances and sleep disorders—including insomnia, circadian disruption, and obstructive sleep apnea (OSA)—have gained recognition as underdiagnosed but clinically relevant perioperative risks.<sup>6–9</sup> Mechanistic studies show that sleep disorders promote sympathetic overactivity, intermittent hypoxemia, endothelial dysfunction, oxidative stress, metabolic dysregulation, and systemic inflammation,<sup>10–16</sup> all of which may heighten perioperative cerebrovascular vulnerability. OSA, the most extensively studied sleep disorder in surgical patients, has been associated with increased



postoperative respiratory and cardiovascular events,<sup>17–21</sup> and emerging cohort data suggest possible links to perioperative stroke.<sup>22–24</sup>

Despite this growing evidence, research at the interface of sleep medicine and perioperative neurology is highly fragmented across disciplines, making it difficult to track scientific development or identify thematic priorities. Previous bibliometric studies have examined sleep disorders or perioperative stroke separately,<sup>25–27</sup> but none have mapped their intersection. A comprehensive bibliometric evaluation is therefore needed to clarify research dynamics and guide future mechanistic and translational efforts.

Bibliometric analysis provides a structured approach to quantify scientific output, visualize collaboration networks, and delineate thematic evolution.<sup>28–32</sup> Such analysis is particularly valuable in interdisciplinary fields with dispersed literature.

To address this gap, we performed the first multi-database bibliometric analysis (Web of Science, Scopus, Embase, PubMed; 1999–2024) on global research linking sleep disturbances/disorders to perioperative stroke. Using standardized workflows for deduplication, thesaurus merging, and cross-platform harmonization, and integrating VOSviewer, CiteSpace, Bibliometrix, and Scimago Graphica, we characterized publication trends, collaboration structures, citation landscapes, and emerging thematic hotspots. These insights highlight evolving research drivers and inform perioperative risk stratification and mechanism-guided clinical decision-making for sleep-impaired surgical patients.

## Materials and Methods

### Study Aim and Objectives

This bibliometric study aimed to map and characterize the global research landscape at the intersection of sleep disturbances/disorders and perioperative stroke from January 1, 1999 to December 31, 2024. The specific objectives were to: (1) quantify publication trends, core journals, and influential authors/institutions; (2) analyze collaboration networks among authors, institutions, and countries; and (3) identify intellectual bases, emerging thematic foci, and knowledge gaps to inform future research priorities in perioperative sleep medicine.

### Data Sources and Search Strategy

#### Databases Selection

A literature search was conducted following PRISMA-S guidelines using Web of Science Core Collection, Scopus, and PubMed, covering the period from January 1, 1999, to December 31, 2024. Scopus was included for its broad journal coverage, WoSCC for its reliable citation data, and PubMed to ensure representation of biomedical studies. Embase, although comprehensive, was not used due to its considerable overlap with Scopus and the need to maintain consistent citation formats for subsequent bibliometric analyses. This approach provided adequate coverage of the relevant literature while ensuring clarity and consistency in data processing.

#### Conceptual Search Framework

Searches incorporated three concept groups: (1) Sleep disturbances/disorders (eg, insomnia, sleep deprivation, circadian disruption, sleep-disordered breathing, obstructive sleep apnea). (2) Perioperative or surgical context (eg, perioperative, preoperative, intraoperative, postoperative, surgery, surgical procedures, anesthesia, anesthesiology). (3) Stroke or cerebrovascular outcomes (eg, stroke, ischemic stroke, hemorrhagic stroke, cerebrovascular event).

Database-specific syntax was used (eg, WoS TS=; Scopus TITLE-ABS-KEY; PubMed MeSH/tiab). Complete search strings are provided in [Supplementary Appendix A](#).

### Eligibility Criteria

#### Perioperative Operational Definition

To ensure transparent identification of perioperative relevance at the metadata level, a record was classified as perioperative if at least one perioperative indicator term appeared in the title, abstract, or author keywords. Eligible indicators included: perioperative, preoperative, intraoperative, postoperative, surgery, surgical procedure(s), anesthetic,

anesthesia, anesthesiology, operative, intra-operative monitoring, surgical complications. Records lacking such terms were excluded.

### Inclusion Criteria

Records were included if they: (1) Addressed both sleep disturbances/disorders and perioperative/surgical context, with or without explicit cerebrovascular outcomes; (2) Were indexed as Article or Review; (3) Were published in English; (4) Provided sufficient metadata (title, authors, affiliations, country, keywords, reference list).

### Exclusion Criteria

Records were excluded if they: (1) Were conference proceedings, editorials, letters, book chapters, or notes; (2) Lacked essential metadata needed for bibliometric mapping; (3) Represented duplicates across databases; (4) Addressed sleep disorders and stroke but without perioperative relevance per the operational definition.

### Screening Procedure

Two reviewers independently screened titles, abstracts, and metadata. Disagreements were resolved through consensus or third-reviewer adjudication. Inter-rater agreement for inclusion decisions was high, with a Cohen's kappa coefficient of 0.89 (95% CI: 0.84–0.93). The selection process is summarized in a PRISMA flow diagram ([Figure 1](#)).

## Data Import and Cleaning

Bibliographic records retrieved from Scopus (CSV), WOSCC (plaintext), and PubMed (NBIB) were imported into R (v4.3.1) using the bibliometrix package (v4.1.2) and converted into a unified data frame via `convert2df()`. A standardized cleaning procedure was applied across databases, restricting the dataset to English-language articles and reviews, removing entries with missing essential fields (eg, title or authors), and normalizing publication years.

To produce a consolidated corpus, records from the three databases were merged and deduplicated using a multi-step workflow that prioritized DOI matching, followed by title–year comparisons for non-DOI records. Additional string-matching rules were applied to identify residual duplicates across sources. After harmonization and deduplication, the final corpus comprised 1,727 publications spanning 1999–2024 ([Table S1](#)), which served as the basis for all subsequent analyses.

Author names, institutional affiliations, and keyword fields were standardized through a rule-based harmonization process. This included unifying institutional variants, resolving author-name inconsistencies, and applying a curated thesaurus to merge synonymous terms related to sleep disorders, perioperative care, and cerebrovascular events. These procedures ensured consistency across metadata fields prior to subsequent bibliometric and network analyses.

A complete description of the cleaning workflow—including deduplication criteria, disambiguation algorithms, institutional normalization rules, and thesaurus construction—is provided in [Supplementary Appendix B](#).

## Bibliometric and Visualization Analyses

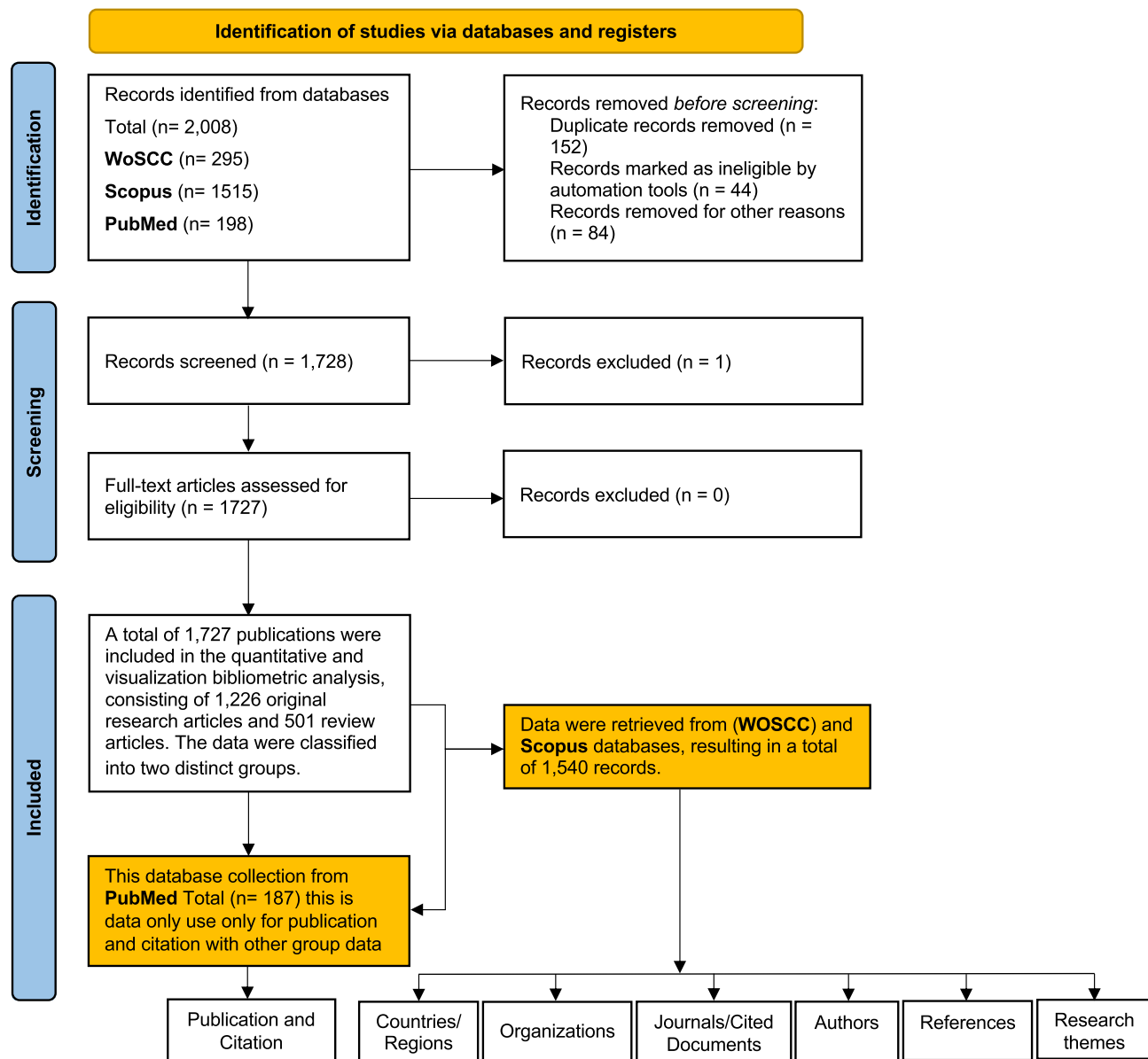
Analyses were conducted using bibliometrix (R), VOSviewer (v1.6.19), CiteSpace (v6.3.R1), and Scimago Graphica in a complementary manner to triangulate findings and enhance visualization.

### Quantitative Indicators

The following classical scientometric indicators were applied to describe structural patterns in the literature: (1) Price's Law, to characterize publication growth; (2) Lotka's Law, to evaluate author productivity distribution; (3) Bradford's Law, to identify core journals; (4) H-index, to assess author, institutional, and journal influence. Full computational details and model-fitting procedures are provided in [Supplementary Appendix C](#).

### Network Analyses

Network-based analyses were used to examine the relationships among authors, institutions, keywords, and cited literature: (1) VOSviewer for co-authorship, institutional collaboration, journal coupling, and keyword co-occurrence; (2) CiteSpace for co-citation structure, burst detection, and timeline visualizations; (3) bibliometrix for tri-field mapping and thematic evolution; (4) Scimago Graphica for geographic and temporal patterns. All analytical settings—including



**Figure 1** Literature screening and data processing flowchart. This flowchart summarizes the identification and selection of publications on sleep disorders and perioperative stroke (1999–2024). After excluding non-research document types and non-English papers, 2,008 records from WoSCC ( $n = 295$ ), Scopus ( $n = 1,515$ ), and PubMed ( $n = 198$ ) were screened. Following the removal of duplicates ( $n = 152$ ), automation-flagged records ( $n = 44$ ), and other exclusions ( $n = 84$ ), 1,728 records were reviewed. After full-text assessment, 1,727 publications were included in the final analysis (1,226 original articles and 501 reviews). WoSCC and Scopus data were used for bibliometric and visualization analyses, including publication and citation metrics, collaboration networks, institutional output, and keyword evolution, while PubMed data ( $n = 187$ ) were used solely for publication and citation analysis. PRISMA figure adapted from Page MJ, McKenzie JE, Bossuyt PM et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021 Mar 29;372:n71. doi: 10.1136/bmj.n71.<sup>33</sup>

normalization methods, clustering thresholds, time-slicing parameters, and robustness checks—are fully documented in [Supplementary Appendix C](#).

### Sensitivity Analysis

Sensitivity analyses were performed to ensure the robustness of clustering and network structures. Variations in keyword thresholds and author disambiguation rules yielded stable patterns, confirming that the major results were not sensitive to reasonable parameter changes. Detailed procedures and comparative outputs are available in [Supplementary Appendix C](#).

## Reproducibility and Data Availability

In accordance with journal policies for full reproducibility, all data and code required to replicate the analyses have been deposited in a public repository. This includes the raw and cleaned datasets, thesaurus files, disambiguation rules, and R/Python scripts for analysis and visualization. Complete software versioning, parameter settings, and intermediate matrices are detailed in the [Supplementary Appendices](#).

## Results

### Basic Characteristics of the Dataset

A total of 2,008 records related to perioperative stroke and sleep disorders were identified from Scopus, Web of Science Core Collection (WoSCC), and PubMed between 1999 and 2024 ([Figure 1](#)). After removing duplicates ( $n = 152$ ), automated exclusions ( $n = 44$ ), and manual screening ( $n = 84$ ), 1,728 records entered title and abstract screening. In total, 1,727 publications were included for analysis, consisting of 1,226 original research articles and 501 reviews.

For bibliometric and network visualization analyses, data from WoSCC and Scopus were combined, yielding 1,540 records. PubMed contributed an additional 187 records, which lacked complete cited-reference fields and were therefore used only to supplement descriptive publication and citation summaries.

Key dataset characteristics are presented in [Table 1](#). The analysis covered the years 1999–2024. The mean publication age was 8.43 years, and the annual growth rate was 7.91%. The dataset contained 12,066 references, with an average of 69.53 citations per article. For the core dataset (WoSCC + Scopus), the median citation count was 11 (IQR, 3–34), showing a skewed citation distribution driven by a small group of highly cited papers. A total of 9,643 authors contributed to this field, producing 127 single-author papers. The mean number of co-authors per article was 7.93, and 14.15% of publications involved international collaboration.

As WoSCC and Scopus index mainly English-language journals and have better coverage of high-income regions, the dataset likely reflects a partial view of global research activity and may underrepresent work from low-resource settings. It is noteworthy that the significant increase in the number of publications after 2020 coincides with the COVID-19 pandemic, although it is important to emphasize that a causal relationship cannot be inferred from the bibliometric data alone.

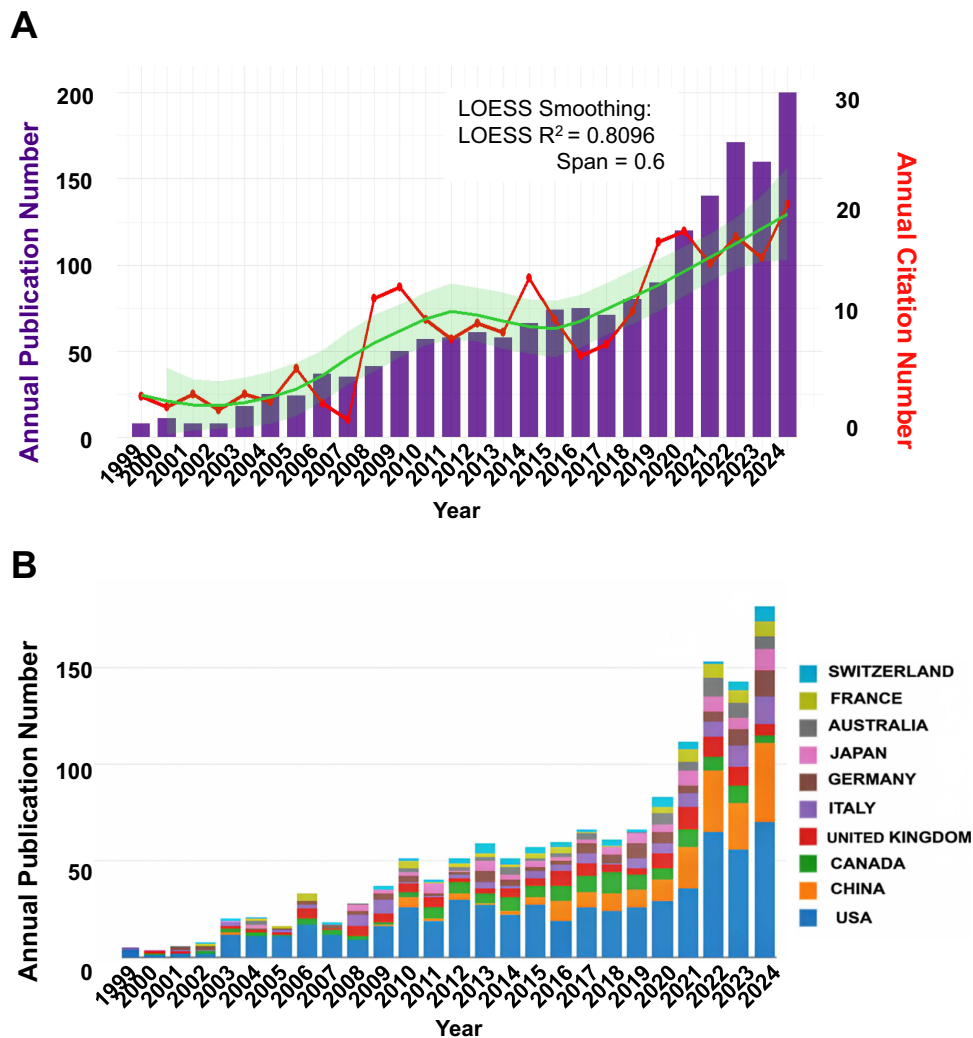
### Publication Characteristics and Trends

A total of 1,727 publications were included in the final dataset. The annual number of papers increased steadily over the 25-year period, with a marked rise beginning around 2010 and a peak of approximately 170–200 publications in 2024 ([Figure 2A](#)).

**Table 1** Top 10 Most Productive Institutions Ranked by Number of Publications

Rank	Institutions	Country	NP	Percentage (%)
1	Harvard Medical School	USA	72	4.16%
2	Mayo Clinic	USA	62	3.59%
3	Cleveland Clinic Foundation	USA	54	3.12%
4	Massachusetts General Hospital	USA	49	2.83%
5	Harvard University	USA	40	2.31%
6	Capital Medical University	China	38	2.20%
7	University of California	USA	38	2.20%
8	Brigham and Women's Hospital	USA	34	1.97%
9	University of Toronto	Canada	34	1.97%
10	Chang Gung Memorial Hospital	China	33	1.91%

**Abbreviation:** NP, Number of Publications.



**Figure 2** Publication and Citation Trends with LOESS Smoothing and Country Output. **(A)** Annual publication and citation trends from 1999 to 2024 are shown using LOESS smoothing (span = 0.6). Purple bars indicate yearly publications, and the red line represents yearly citations. The LOESS fit ( $R^2 = 0.8096$ ) demonstrates a strong association between publication and citation trends. **(B)** Publication output trends for the top 10 contributing countries (1999–2024) are shown through a stacked bar chart, with each color representing a different country's annual contribution, highlighting the global distribution of research activity.

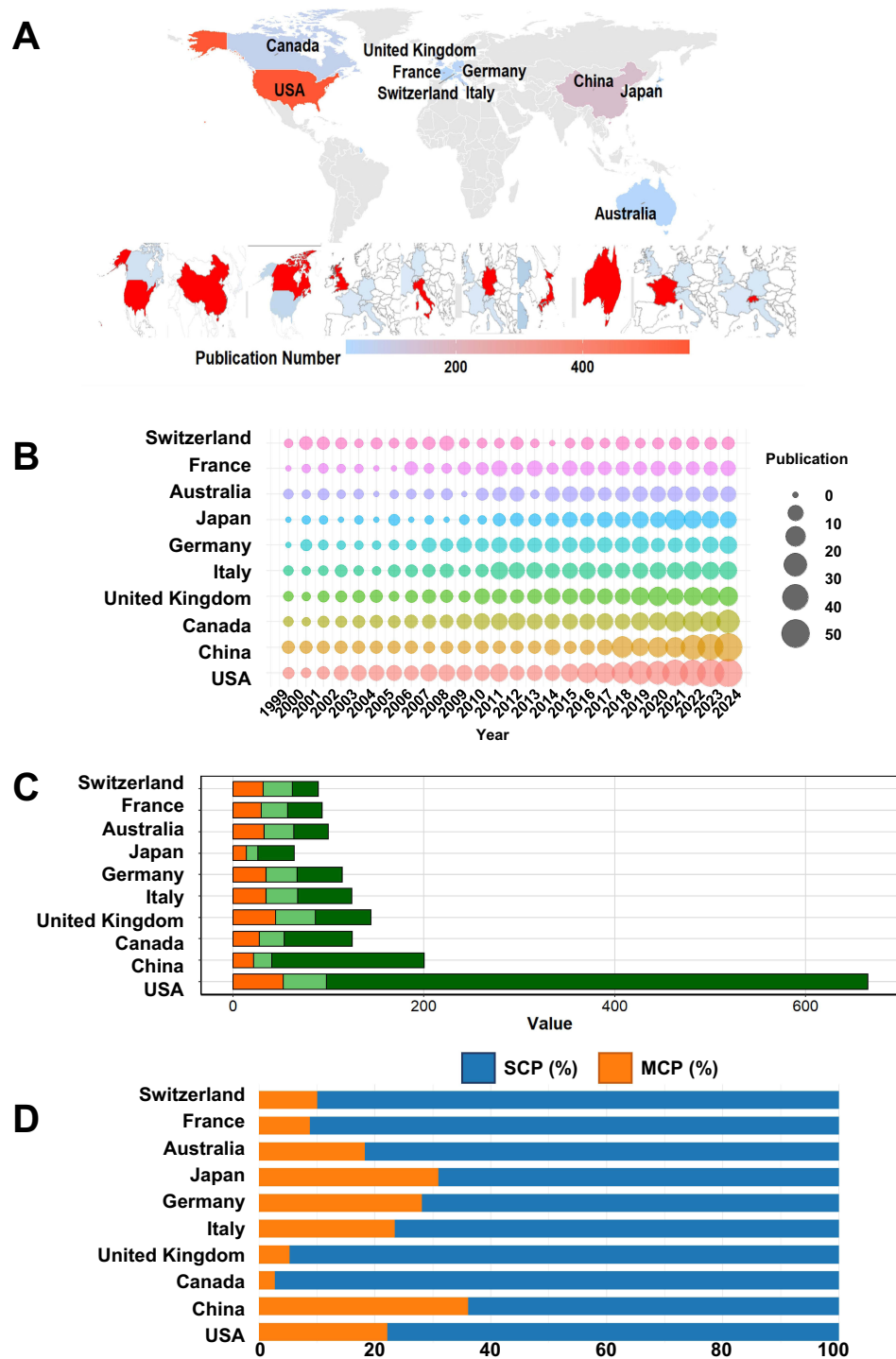
Before 2005, annual output remained below 10 papers. LOESS fitting ( $R^2 = 0.8096$ ; span = 0.6) confirmed a consistent upward trend in publication activity. Annual citation counts increased in parallel, indicating growing attention to the perioperative implications of sleep disorders.

Country-level trends showed distinct patterns (Figure 2B). The United States contributed the highest number of publications throughout the study period, and its annual output rose in proportion to global growth. China showed a different pattern, with modest early activity followed by rapid expansion after 2015, becoming a major contributor in recent years. Combined, the United States and China accounted for approximately 45% of global output during 1999–2005 and nearly 60% during 2020–2024. The US contribution remained stable at 30%–40%, whereas China's share increased from below 5% to more than 20%.

In comparison, the United Kingdom maintained a relatively stable publication share of about 8%–12% across the time span. Switzerland, France, and Japan also demonstrated increased activity after 2010, raising their combined contribution from under 3% to nearly 10%. These trends indicate a gradual transition from early U.S.-dominant output toward a more distributed, multi-country research landscape.

## The Contributing Countries or Regions

Global research activity showed clear geographic concentration (Figure 3A). Most publications originated from North America, Western Europe, and East Asia, with limited contributions from South America, Africa, and Central Asia. This pattern likely reflects differences in research capacity and database coverage.



**Figure 3** Global Distribution and Temporal Trends of Publications on Sleep Disorders and Perioperative Stroke. **(A)** Geographical map illustrating concentrations of research activity in North America, Europe, and East Asia, with limited representation from South America and Africa. **(B)** Dot plot showing publication numbers for the top 10 countries. Each dot represents the number of publications, with a color gradient indicating volume from low to high. Leading contributors include the United States, China, and Canada. **(C)** Horizontal bar chart showing publication counts and H-index by country, highlighting the USA and China as major contributors. **(D)** Stacked bar chart displaying two publication categories per country, illustrating dominant segments and thematic trends, particularly for the USA and China.

Annual publication trends by country showed distinct growth profiles (Figure 3B). The United States produced the highest number of papers throughout 1999–2024 and maintained a stable upward trend. China showed a marked increase after 2010, with a sharp acceleration after 2015, and in recent years its annual output approached that of the United States. The United Kingdom, Germany, and Italy displayed steady linear growth, while Switzerland, France, and Japan showed stronger increases during the last decade.

Cumulative output further highlighted the leading role of the United States (567 articles; 29,559 citations), followed by China (160 articles) and Canada (71 articles) (Figure 3C). Several European countries had higher citation impact. France, the United Kingdom, and Germany achieved mean citation counts exceeding 90 per article and high H-indices, indicating strong contributions to high-quality evidence.

Patterns of scientific collaboration varied across countries (Figure 3D). In the United States and China, more than 70% of publications involved domestic collaboration. In contrast, Switzerland, France, Germany, and the United Kingdom had international collaboration rates above 40%, suggesting a more outward-facing research structure.

The global collaboration network (Figure 4A) showed that the United States, China, the United Kingdom, and Canada occupied the most central positions. The US served as the main connecting hub with extensive links to Europe and Asia. China's connections expanded rapidly during the last decade. The network could be broadly grouped into an Atlantic cluster (United States, Europe, Canada) and an Asia–Pacific cluster (China, Japan, Australia), with bridging connections through major research countries such as the United States and the United Kingdom.

The temporal overlay (Figure 4B) showed that earlier collaborations were concentrated among US institutions and their established partners. In later years, connections involving China, Australia, and other Asia–Pacific contributors increased, and cross-regional interactions became more frequent. These developments indicate a gradual increase in global participation and broader research engagement across regions.

## Active Organizations and Productive Journals

Institutional output showed clear concentration among a small group of research centers. The top 10 institutions accounted for 25.04% of all publications, with seven located in the United States (Table 1). Harvard Medical School produced the most papers (72 articles), followed by Mayo Clinic (62 articles) and the Cleveland Clinic Foundation (54 articles). Outside the United States, Capital Medical University (38 articles) and Chang Gung Memorial Hospital (33 articles) were the leading contributors in China, while the University of Toronto (34 articles) was the most productive institution in Canada.

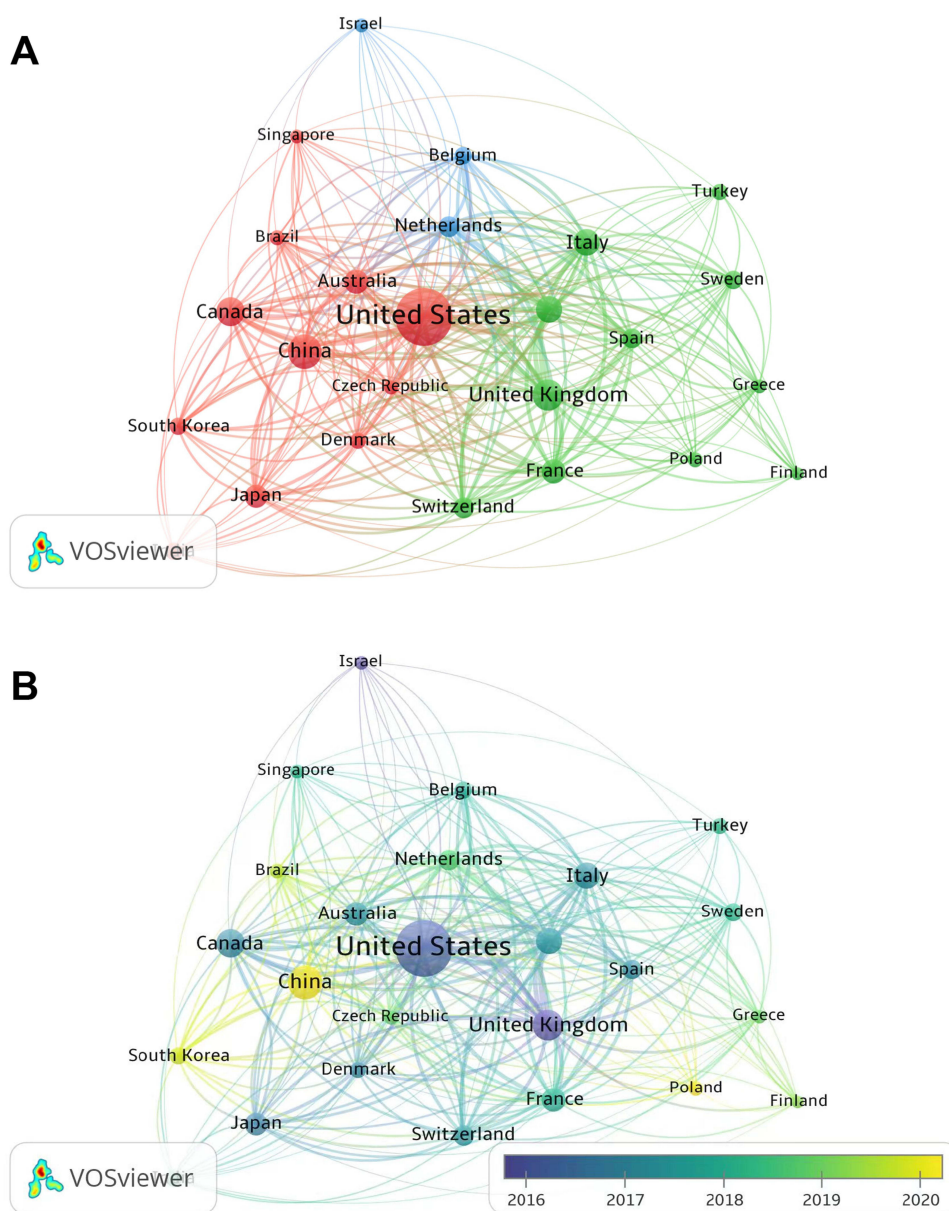
The collaboration network among institutions (Figure 5A) showed dense connections within the United States, with Harvard Medical School and Mayo Clinic forming the largest nodes. Cross-national links were comparatively fewer. Institutions such as Capital Medical University and the University of Toronto were connected to the global network but remained in peripheral positions relative to the US cluster.

The temporal overlay (Figure 5B) indicated that earlier publications were concentrated among US institutions, while contributions from China and Canada increased in more recent years. Although the network remained dominated by U.S.-based collaborations, participation from institutions in other regions has expanded gradually.

A total of 1,464 journals published research in this field. High-output journals were concentrated in bariatric surgery, perioperative medicine, and cardiovascular medicine (Table 2). Surgery for Obesity and Related Diseases (23 papers) and Obesity Surgery (21 papers) were the most productive, consistent with the prominence of bariatric surgery topics. Leading cardiovascular journals, including the Journal of the American College of Cardiology (13 papers) and Circulation (11 papers), were also among the top 10.

Citation impact was largely driven by high-ranking cardiovascular and general medical journals (Table 3). Eight of the ten most cited papers were published in these outlets or in Nature-branded journals. The most cited guideline article, published in the European Heart Journal, had 4,780 citations. A Circulation article had 4,688 citations. A 2008 guideline in Cerebrovascular Diseases also received more than 2,200 citations, suggesting that clinically relevant work can achieve high impact regardless of journal impact factor.

Time-series trends in institutional productivity (Figure 6A) revealed heterogeneous growth patterns among leading affiliations. Overall activity in this field was minimal before 2005. Publication output from Harvard-related institutions

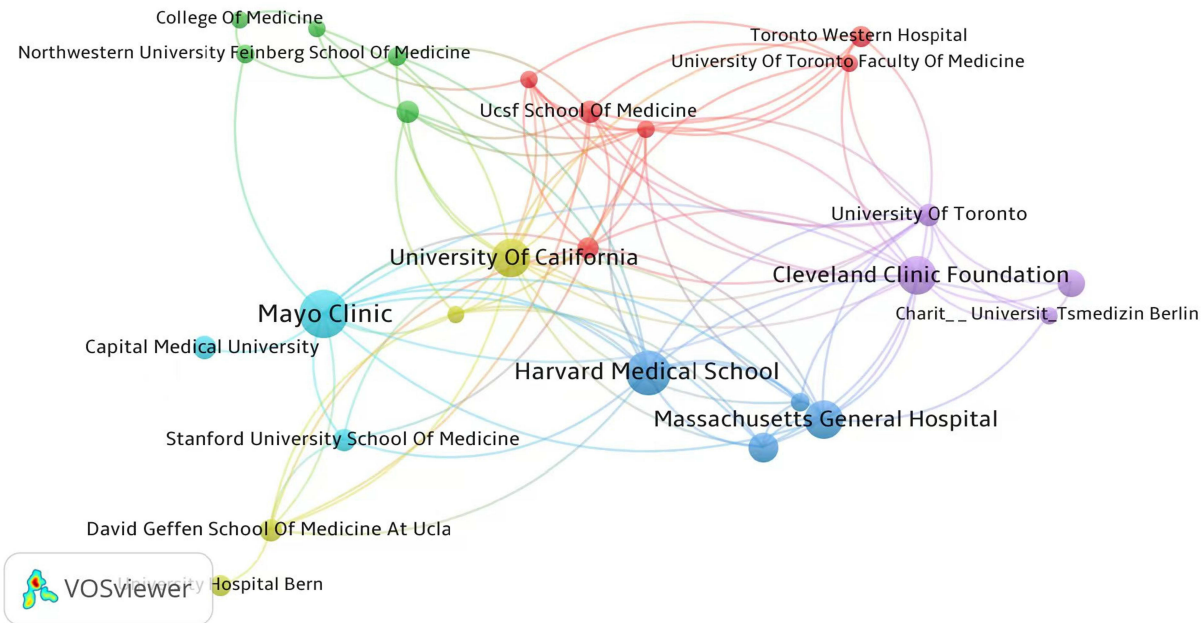


**Figure 4** International Collaboration Network and Regional Scientific Clusters (A) Cluster visualization identifies three major research alliances: a North American–European cluster (United States, United Kingdom, Germany), an Asia–Pacific cluster (China, Japan, Australia), and a smaller European–Middle Eastern cluster (Netherlands, Belgium, Israel). (B) Temporal evolution of international collaborations (2016–2020), with a yellow-to-blue gradient indicating increasing collaboration intensity. The USA, UK, and China remain dominant, while Australia, France, and Germany show expanded recent partnerships.

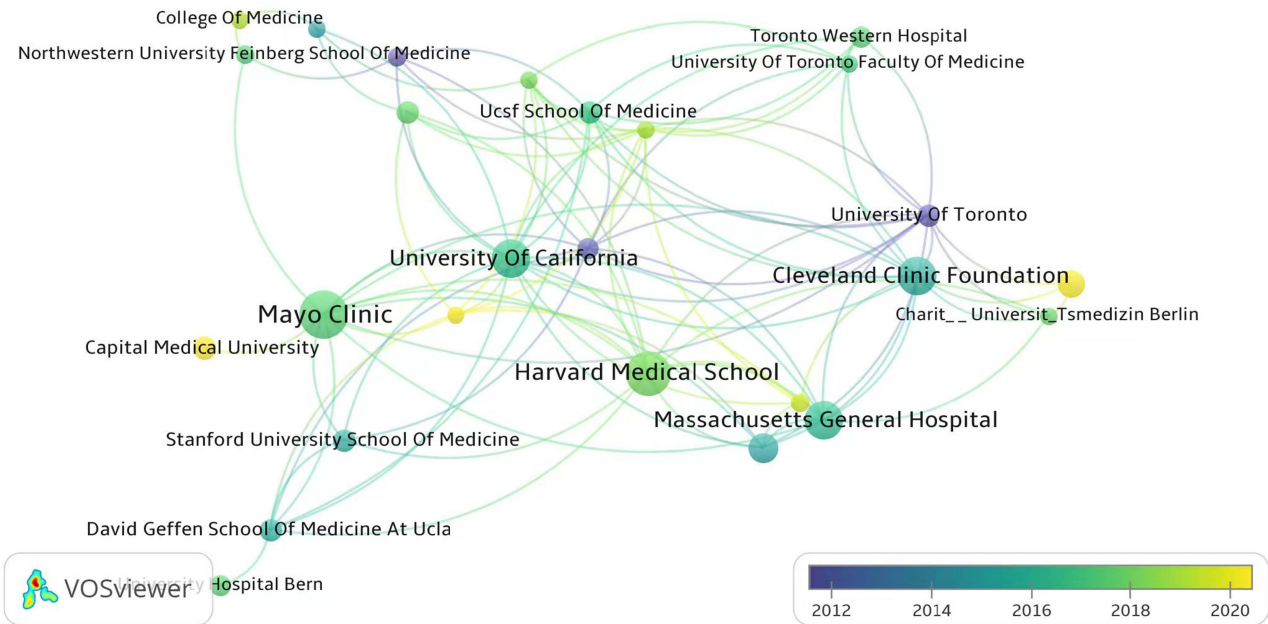
and the University of California system increased steadily between 2005 and 2015 and then remained at a persistently high level, indicating early consolidation of expertise in these centers. In contrast, Johns Hopkins University showed a later but steeper rise after 2015, while Chang Gung Memorial Hospital exhibited a gradual but continuous increase from around 2010 onward, reflecting a progressive shift of research activity toward East Asia.

At the journal level, annual publication trends for major outlets (Figure 6B) indicated steady increases since 2010. Anesthesia and Analgesia showed the longest continuous contribution. Sleep Medicine and Europace displayed rising output over the past decade, while Otolaryngology–Head & Neck Surgery showed rapid growth after 2019, aligning with increasing interest in surgical management of obstructive sleep apnea. These patterns reflect broader growth in perioperative and sleep-related research across multiple disciplines.

A



B



**Figure 5** Institutional Collaboration Networks Among the Most Productive Organizations. **(A)** Co-authorship network map visualized using VOSviewer. Each node represents an institution, node size corresponds to publication volume, and link thickness indicates collaboration strength. Harvard Medical School, Mayo Clinic, and University of California form the central cluster, with dense intra-US cooperation and emerging international connections involving Capital Medical University, the University of Toronto, and Mayo Clinic. **(B)** Overlay visualization of the temporal evolution of institutional collaborations, where the color gradient (2012–2020) represents the average year of publication. More recent institutions (yellow) mainly originate from Asia-Pacific and North America, reflecting expanding global participation and sustained growth of multi-center research in sleep and perioperative stroke.

**Table 2** Top 10 Most Prolific Journal Ranked by Total Number of Publications

Rank	Source	h_index	g_index	m_index	TC	NP	PY_start	Percentage (%)
1	Surgery For Obesity and Related Diseases	11	23	0.786	1099	23	2012	1.33
2	Obesity Surgery	10	18	0.333	327	21	1996	1.21
3	Anesthesia And Analgesia	9	14	0.409	1054	14	2004	0.81
4	Journal of the American College of Cardiology	11	13	0.407	2516	13	1999	0.75
5	Circulation	11	11	0.733	9040	11	2011	0.64
6	Journal of the American Heart Association	9	11	0.643	638	11	2012	0.64
7	Sleep Medicine	8	10	0.471	638	10	2009	0.58
8	Europace	8	8	0.667	3101	8	2014	0.46
9	Sleep	8	8	0.381	1815	8	2005	0.46
10	European Heart Journal	7	7	0.438	14,480	7	2010	0.40

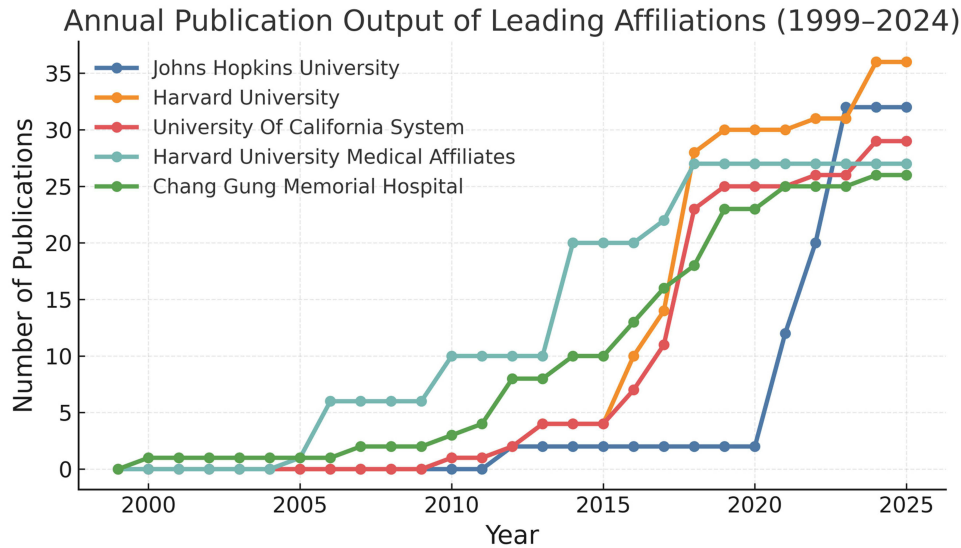
**Abbreviations:** NP, Number of Publications; TC, Total Citations; PY\_start, Publication Year Start.

**Table 3** The Ten Leading Journals, Highly Cited Documentation, and Their Impact Factors in Perioperative Stroke and Sleep Disorders Research

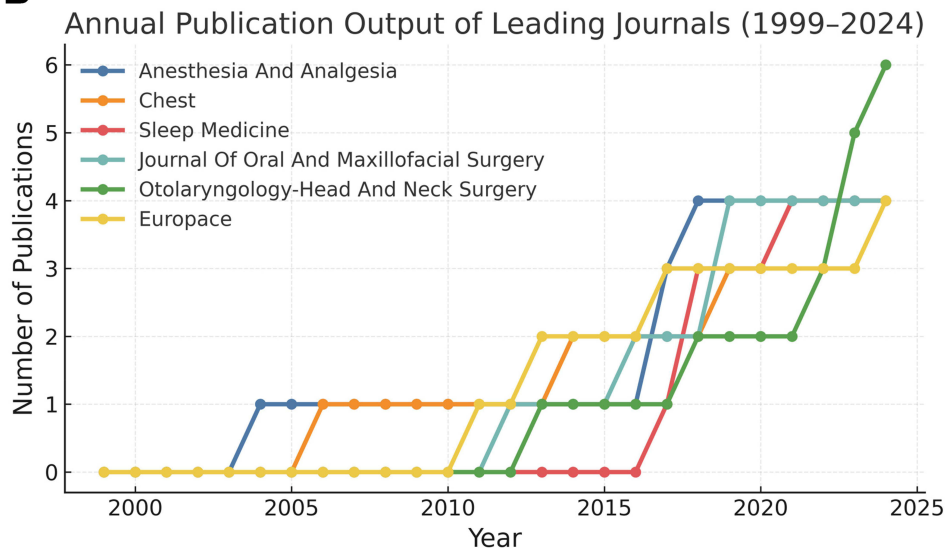
Rank	Article	Type	Journal	Total Citations	TC per Year	Normalized TC	DOI	IF (2024)	JQ	Ref. No.
1	Hindricks G, 2021	Article	European Heart Journal	4780	956.00	63.34	10.1093/eurheartj/ehaa612	37.6	Q1	[34]
2	Roger V, 2012	Article	Circulation AHA/ASA	4688	334.86	33.74	10.1161/CIR.0b013e31823ac046	35.5	Q1	[35]
3	Marin J, 2005	Article	The Lancet	4114	195.90	12.25	10.1016/s0140-6736(05)71141-7	98.4	Q1	[36]
4	Blüher M, 2019	Review	Nature Reviews Endocrinology	3773	539.00	31.73	10.1038/s41574-019-0176-8	31	Q1	[37]
5	Eltzschig H, 2011	Review	Nature Medicine	2753	183.53	24.33	10.1038/nm.2507	58.7	Q1	[38]
6	Ringleb P, 2008	Article	Cerebrovascular Diseases	2297	127.61	10.58	10.1159/000131083	2.2	Q3	[39]
7	Stevens Pe, 2024	Article	Kidney international	2156	1,078.00	104.62	10.1016/j.kint.2023.10.018	14.8	Q1	[40]
8	Calkins H, 2017	Article	Heart Rhythm	1715	190.56	24.40	10.1016/j.hrthm.2017.05.012	5.5	Q1	[41]
9	Kushida Ca, 2005	Review	Sleep	1541	73.38	4.40	10.1093/sleep/28.4.499	5.3	Q1	[42]
10	Epstein Ae, 2008	Article	Journal of the American College of Cardiology	1408	78.22	5.23	10.1016/j.jacc.2008.02.032	21.1	Q1	[43]

**Abbreviations:** NP, Number of Publications; TC, Total Citations; DOI, Digital Object Identifier; IF, Impact Factor as of 2024; JQ, Journal Quartile (JCR); Ref. No, Reference Number.

A



B



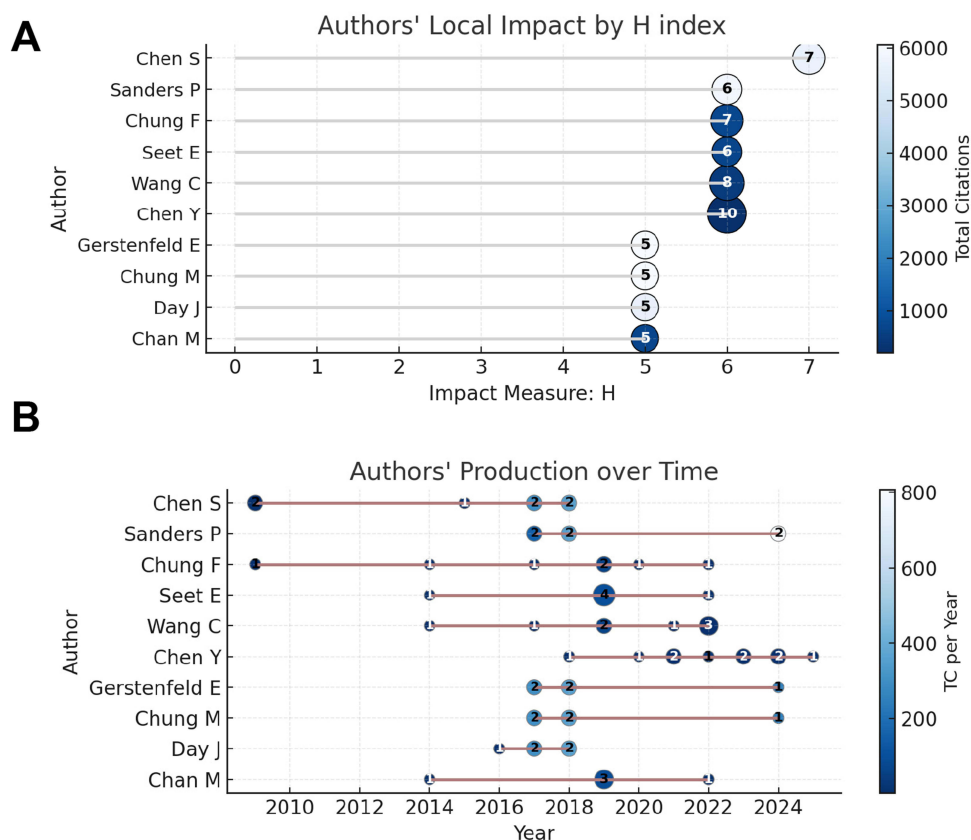
**Figure 6** Longitudinal Productivity of Leading Affiliations and Journals. **(A)** Cumulative publication output of the five most productive research institutions in the field of sleep disorders and perioperative stroke. Johns Hopkins University and Harvard University exhibit sustained growth since 2010, followed by the University of California System and Harvard Medical Affiliates, indicating strong institutional continuity and leadership. **(B)** Temporal evolution of publication counts among the top five source journals—*Journal of Anesthesia and Analgesia*, *Sleep Medicine*, and *Journal of Oral and Maxillofacial Surgery*. The upward trend across all journals highlights the field's expansion from basic neuroscience toward multidisciplinary and clinical sleep research applications.

## Active Authors

A total of 9,643 authors contributed to the included publications. Author productivity and citation metrics identified several leading contributors in this field (Figure 7A, B and Table 4). Zhang Y (18 papers) and Wang X (17 papers) were the most productive authors, followed by Chung F (13 papers), Bassetti C (11 papers), and Birch D (11 papers).

Citation indicators showed that several authors had strong influence within the dataset. Chen S had an H-index of 6 and 6,013 total citations; Sanders P had an H-index of 6 and 5,468 citations. Authors such as Hindricks G and Calkins H also had high annual citation counts (Figure 7B).

The co-authorship network formed several distinct clusters (Figure 8A). The largest was centered on Zhang Y and included frequent collaborators such as Wang X, Chung F, Bassetti C, and Birch D. Another prominent cluster included



**Figure 7** Authors' Local Impact and Production Over Time. **(A)** Local impact of authors, measured by their H-index, with total citations represented by a color gradient (blue to white). Authors such as Chen S and Sanders P have the highest H-index, correlating with their significant number of citations, exceeding 5,000 total citations. **(B)** Annual publication output of authors from 2010 to 2024. The chart displays authors' production over time, with each dot representing a year of publication. The color gradient indicates total citations per year (TC per year), showing trends in productivity and citation impact over time for each author.

Chen S, Natale A, and Calkins H, with work mainly focused on sleep–cardiac rhythm associations. A smaller subcluster involving Lockley S.W. and Czeisler C.A. appeared connected to the main network through limited but identifiable links.

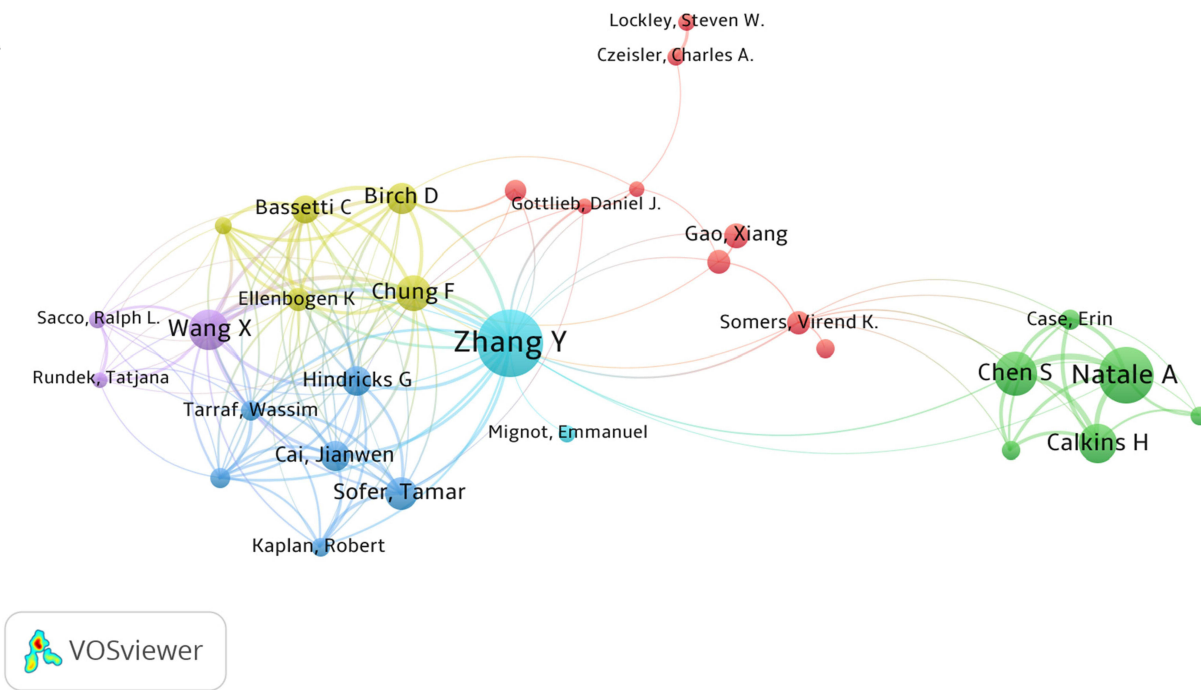
Temporal overlay mapping (Figure 8B) showed increased activity among several core authors in recent years, reflected by warmer node colors. Both the Zhang Y cluster and the Chen S–Natale A–Calkins H cluster demonstrated

**Table 4** Top 10 Most Prolific Authors Ranked by Total Number of Publications

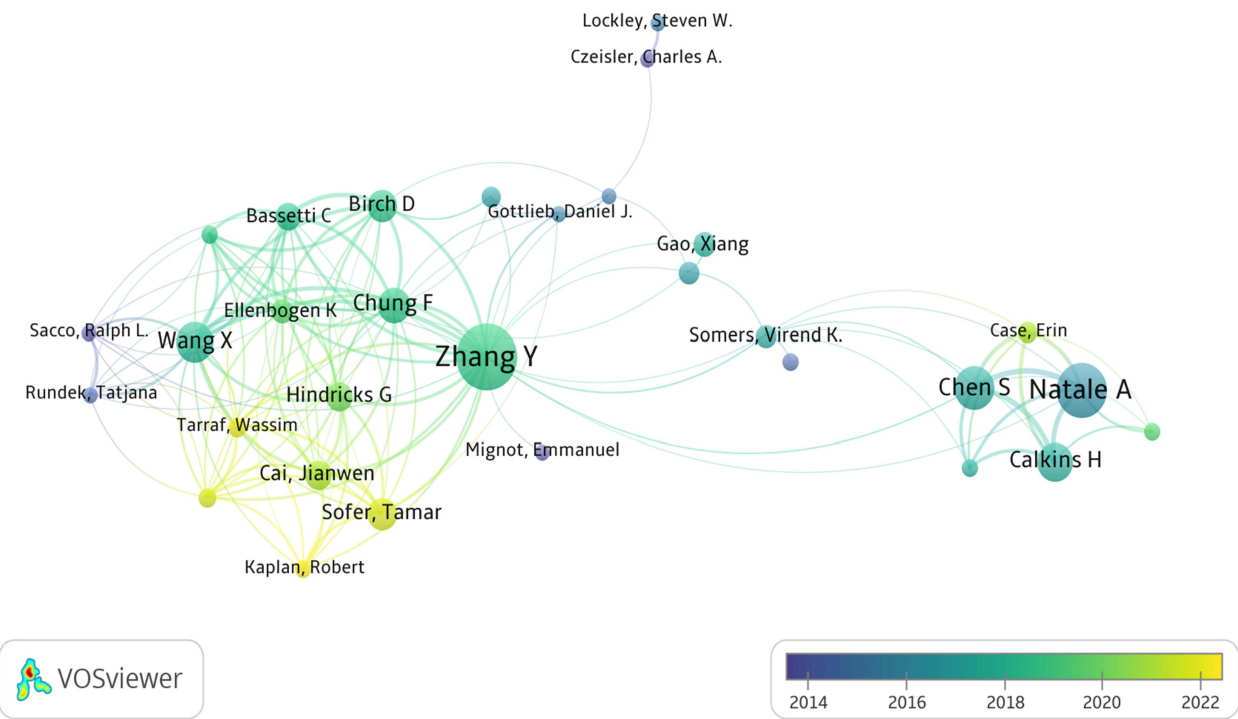
Rank	Author	NP	h_index	g_index	m_index	TC	PY_start	Ref. No
1	Zhang Y	18	9	15	1.125	246	2018	[44–60]
2	Wang X	17	8	14	1	209	2018	[51,56,59–73]
3	Chung F	13	10	13	0.4	1218	2001	[17,44,74–85]
4	Bassetti C	11	10	11	0.5	397	2006	[86–96]
5	Birch D	11	7	11	0.583	126	2014	[97–107]
6	Chen S	10	8	10	0.471	6013	2009	[41,81,108–115]
7	Ellenbogen K	9	9	9	0.5	7908	2008	[41,43,110–112,114,116–118]
8	Hindricks G	9	9	9	0.563	15820	2010	[34,41,110–112,114,117,119,120]
9	Natale A	9	9	9	0.375	6350	2002	[41,110–112,114,116,121–123]
10	Calkins H	8	8	8	0.571	8376	2012	[41,110–112,114,116,122,124]

**Abbreviations:** NP, Number of Publications; TC, Total Citations; PY\_start, Publication Year Start; Ref. No, Reference Number.

**A**



**B**

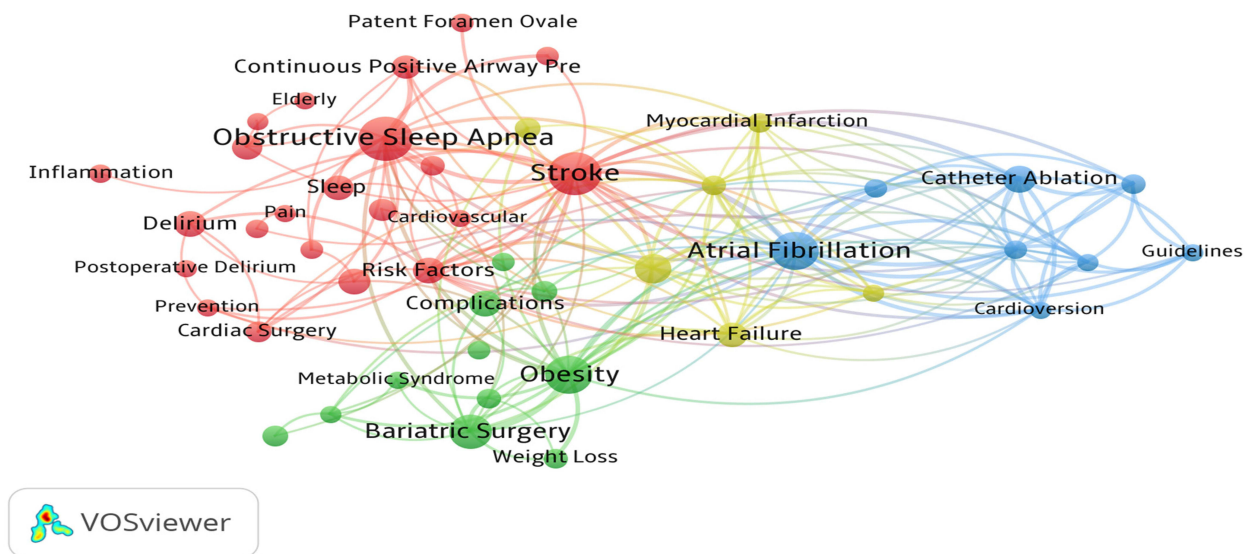


**Figure 8** Author Productivity, Academic Impact, and Collaboration Networks. **(A)** Co-authorship network showing collaboration clusters among key contributors, with node size representing publication volume and color indicating cluster affiliation. Zhang Y. and Wang X. serve as central nodes bridging multiple collaboration groups. **(B)** Overlay visualization of the temporal evolution of collaborations, with a color gradient (2010–2020) representing the average publication year, highlighting a shift toward newer multidisciplinary partnerships in recent years.

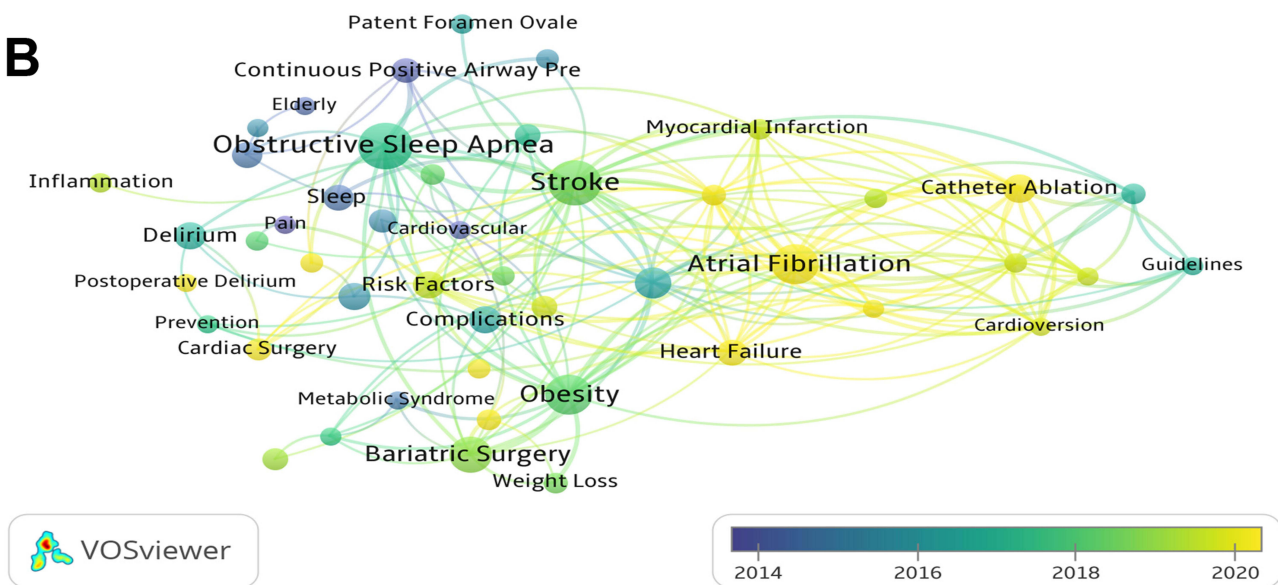
a rise in publication activity and collaborative links. Overall network density increased over time, suggesting growing collaboration across institutions and subfields.

To reduce potential bias from author name duplication, standardized Author IDs from WoSCC and Scopus were used, and automated disambiguation procedures were applied through bibliometrix.

A



B



**Figure 9** Keyword Co-occurrence Network and Temporal Overlay Visualization. **(A)** VOSviewer map of keyword co-occurrence (minimum occurrence  $\geq 25$ ). Node size reflects keyword frequency, link thickness indicates association strength, and color represents thematic clusters. Prominent terms—including sleep, stroke, obstructive sleep apnea, atrial fibrillation, hypertension, and surgery—demonstrate the interdisciplinary convergence of neurology, cardiology, and sleep medicine. **(B)** Overlay visualization illustrating the chronological evolution of research focus, with earlier mechanistic studies (yellow; eg, “stroke”, “obstructive sleep apnea”) highlighting the field’s shift toward more outcome-oriented research.

## Knowledge Base and Disciplinary Integration

Keyword co-occurrence analysis identified three major thematic clusters within the field (Figure 9A). The first cluster was centered on sleep-disordered breathing, including terms such as obstructive sleep apnea, sleep apnea, and continuous positive airway pressure, which were frequently linked to perioperative neurological and inflammatory outcomes such as delirium and inflammation. The second cluster focused on metabolic and cardiovascular factors, including obesity, bariatric surgery, metabolic syndrome, and weight loss. A third cluster was related to cardiovascular arrhythmias and stroke risk, with atrial fibrillation, catheter ablation, and cardiovascular outcomes as common terms.

Keywords such as stroke, risk factors, and complications appeared at the boundaries between clusters, suggesting relevance across multiple themes. Cluster labels were generated through the LLR method in VOSviewer and were manually reviewed for accuracy.

Temporal keyword mapping (Figure 9B) showed that earlier publications (2014–2016) focused on core disease terms such as obstructive sleep apnea, stroke, and obesity. Between 2016 and 2018, terms related to cardiovascular complications, including atrial fibrillation and heart failure, became more prominent. Since 2018, management-related keywords such as catheter ablation and guidelines have increased in frequency.

Annual keyword usage (Figure 10A) rose markedly after 2015. Core terms such as sleep, stroke, and obstructive sleep apnea persisted throughout the study period. Terms related to perioperative or cardiovascular settings, including perioperative, anesthesia, and hypertension, increased after 2015. More recent topics such as systemic inflammation, ischemic stroke, and epidemiology appeared more frequently after 2020.

Burst keyword analysis (Figure 10C) illustrated shifts in research attention. Early bursts (2000–2012) included arrhythmia, sleep apnea syndrome, and ischemic stroke. Mid-period bursts (2008–2016) involved terms related to clinical outcomes and perioperative risk, such as atrial fibrillation and treatment outcome. Recent bursts (2016 onward) included delirium, neurologic dysfunction, and systemic inflammation, indicating growing interest in postoperative neurological and inflammatory complications.

The three-field plot linking journals, authors, and keywords (Figure 10B) showed that high-frequency terms such as sleep, stroke, hypertension, and ischemic stroke were connected to publications in bariatric surgery, sleep medicine, anesthesiology, and cardiovascular journals. Productive authors such as Wang X, Zhang Y, and Birch D were also linked to these central topics. The keyword word cloud (Figure 10D) highlighted sleep, stroke, positive airway pressure, obstructive sleep apnea, and anesthesia as the most frequently used terms.

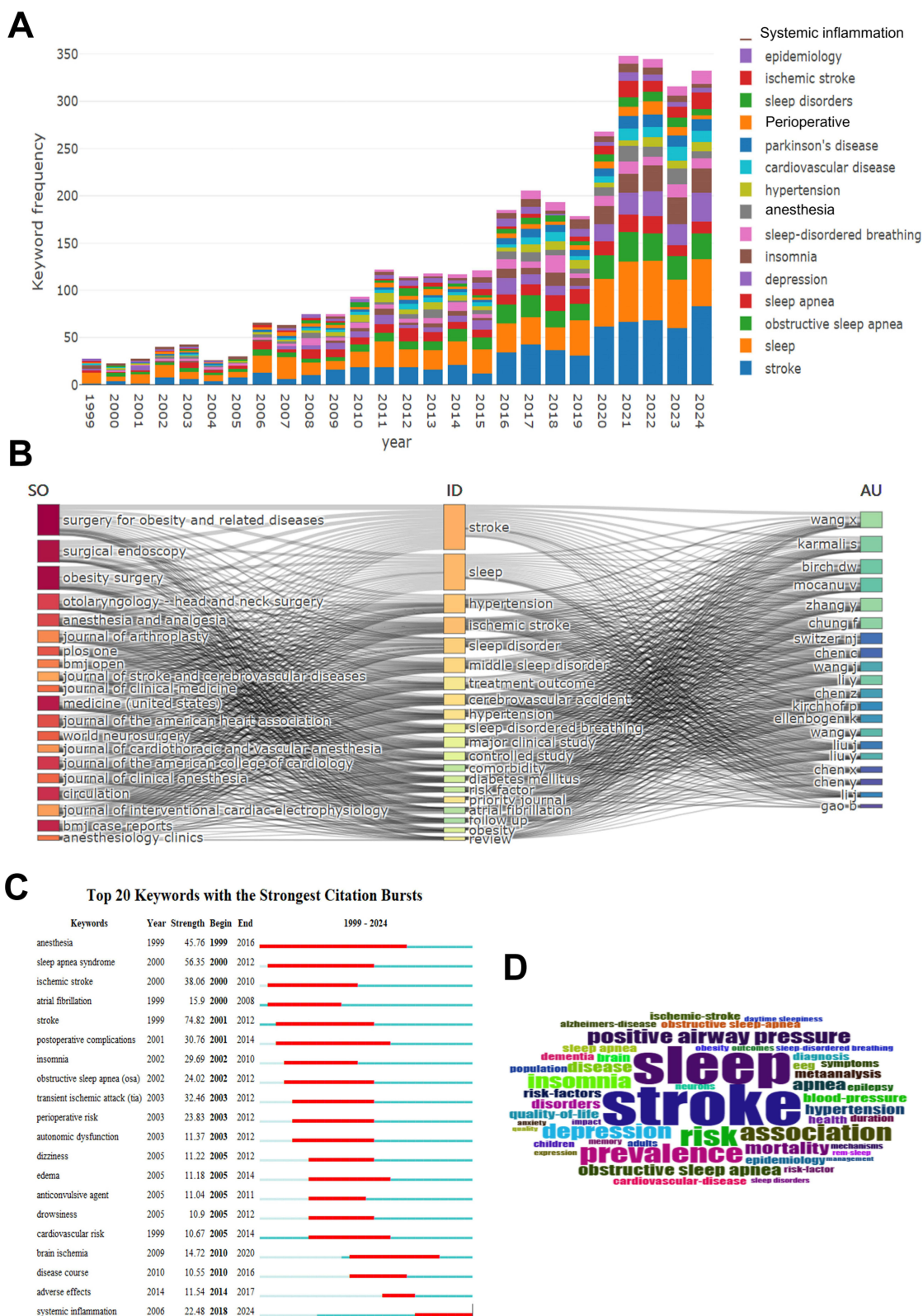
## Research Trajectory and Frontier Evolution

By integrating time-resolved analyses of keywords, co-cited references, and burst terms, this study reconstructs a coherent trajectory and internal logic for the evolution of research hotspots and the underlying knowledge base in this field. The keyword cluster timeline (Figure 11A) displays nine major research themes (#0–#8) and their activity over 1999–2024. Cluster labels were automatically generated using CiteSpace’s LLR algorithm and then manually checked for semantic clarity and interpretability. Overall, the research focus has shifted from dispersed exploration to a cardiovascular mechanism-centered phase, and ultimately toward integration with cutting-edge neuroscience.

In the early period (early 2000s), clusters such as “#0 herbal medicine” were active, reflecting exploratory and heterogeneous research on sleep and cardiovascular risk. In the middle period (around 2010 onward), clusters such as “#1 obstructive sleep apnea” and “#2 cardiac failure” became persistently active, signaling an emerging focus on the sleep–cardiovascular axis. The “#4 atrial fibrillation” cluster exhibits a pronounced peak on the timeline, underscoring the growing recognition of atrial fibrillation as a key comorbidity and stroke risk factor. In the recent period (after 2015), the research landscape extends further into clinical management and neuroscience. Clusters such as “#5 hrs guideline” and “#7 neurological disorder” show marked increases in activity, while “#6 glymphatic system”—representing the brain waste-clearance pathway—emerges as a new cluster, suggesting that research is expanding from macro-level cardiovascular risk toward perioperative brain health and neural mechanisms.

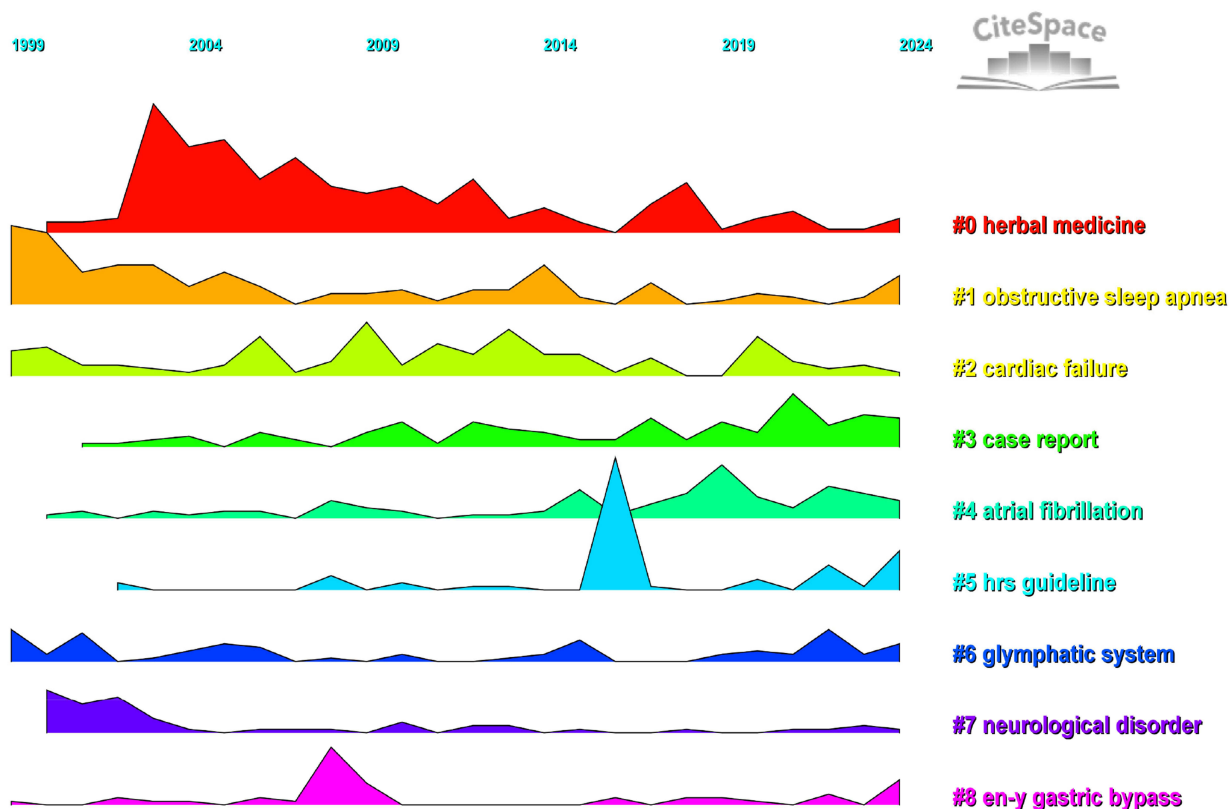
The burst analysis of key references (Figure 11B) illuminates the formation of the knowledge base driving these thematic shifts. The five references with the highest burst intensities were published between 2008 and 2016, primarily in leading journals such as *Anesthesia & Analgesia*, the *Journal of the American College of Cardiology*, and the *New England Journal of Medicine*. Their citation bursts typically peaked 2–4 years after publication, between 2018 and 2021. This “lag effect” suggests that the knowledge framework currently shaping research paradigms and clinical practice was largely formed in the mid-2010s and then progressively absorbed and amplified in subsequent years.

A timeline analysis of co-cited references (Figure 12A) further corroborates this evolutionary pattern. The co-citation network contains ten relatively stable clusters (#0–#9), which display a relay-like pattern of continuous activity and mutual fusion over time. Clusters such as “#0 obstructive sleep apnea” and “#9 obstructive sleep apnoea” span the entire time axis, forming the “backbone” that links various subfields. Clusters such as “#1 bariatric surgery” and “#5 en-y



**Figure 10** Evolution and Burst Analysis of Research Keywords in Sleep–Stroke Studies. **(A)** Annual keyword trends showing increased topic diversity after 2010, with *stroke*, *sleep*, *obstructive sleep apnea*, *insomnia*, and *hypertension* as the most frequent terms. **(B)** Keyword co-occurrence and author collaboration networks linking major topics such as “stroke” and “sleep”, with central contributors including Wang X and Zhang Y. A Sankey diagram illustrates the shift from epidemiological to translational and mechanistic research. **(C)** Top 20 citation burst keywords identified by CiteSpace, highlighting emerging themes such as anesthesia, sleep apnea syndrome, ischemic stroke, and atrial fibrillation. **(D)** Word-cloud visualization showing dominant terms and co-occurrence strength, with *sleep* and *stroke* remaining the core conceptual anchors across related research domains.

A



B

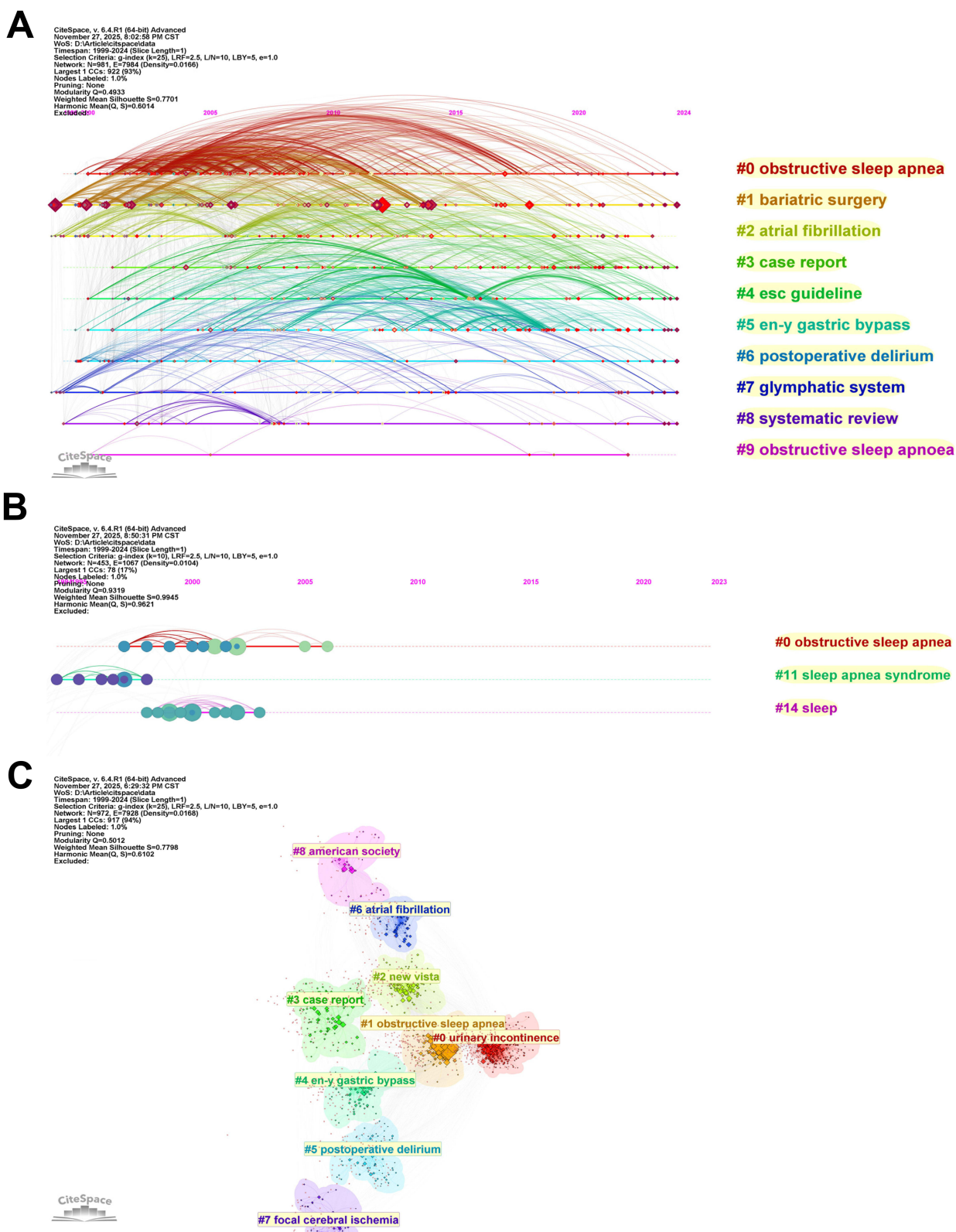
### Top 5 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	1999 - 2024
Chung SA, 2008, ANESTH ANALG, V107, P1543, DOI 10.1213/ane.0b013e318187c83a, DOI	2008	3.32	2012	2013	
Redline S, 2010, AM J RESP CRIT CARE, V182, P269, DOI 10.1164/rccm.200911-1746OC, DOI	2010	3.66	2014	2015	
Fein AS, 2013, J AM COLL CARDIOL, V62, P300, DOI 10.1016/j.jacc.2013.03.052, DOI	2013	3.36	2015	2017	
Al Halabi Shadi, 2015, JACC CLIN ELECTROPHYSIOL, V1, P200, DOI 10.1016/j.jacep.2015.02.018, DOI	2015	3.31	2016	2018	
McEvoy RD, 2016, NEW ENGL J MED, V375, P919, DOI 10.1056/NEJMoa1606599, DOI	2016	5.09	2019	2021	

**Figure 11** Temporal and Structural Mapping of Co-Citation Clusters in Sleep–Stroke Research. **(A)** CiteSpace timeline visualization showing major co-citation clusters over two decades. Early clusters (eg, obstructive sleep apnea, heart failure) reflect foundational neurobiological work, while recent clusters (eg, case report, cardiovascular event, glymphatic system) indicate increasing translational and clinical focus. Cluster size represents citation volume and duration. **(B)** Top 5 references with the strongest citation bursts, with red bars marking periods of peak influence and highlighting key publications shaping current understanding of sleep physiology, cardiovascular risk, and perioperative stroke mechanisms.

gastric bypass” become active in the mid-to-late period, reflecting growing attention to specific clinical scenarios such as bariatric surgery. More recently, clusters such as “#6 postoperative delirium” and “#7 glymphatic system” have risen rapidly, corresponding to perioperative neurological outcomes and brain clearance pathways as newly prominent explanatory frameworks. These patterns indicate that the field’s knowledge structure has evolved from a relatively single focus on sleep–cardiovascular associations to a multi-dimensional, complex network that integrates surgical context, neurological outcomes, and frontier mechanisms.

The recent keyword bursts shown in [Figure 12B](#) further pinpoint current research frontiers. Sustained, high-intensity bursts are mainly observed for terms such as “postoperative delirium”, “atrial fibrillation”, and “glymphatic system”. The prominence of postoperative delirium reflects the centrality of perioperative neurocognitive disorders as a clinical concern. The continued bursts of atrial fibrillation-related terms underscore its persistent central role in stroke risk



**Figure 12** Thematic Evolution and Knowledge Structure of Sleep–Stroke Research. **(A)** CiteSpace timeline view of co-citation clusters illustrating the temporal progression of dominant research themes. Early clusters (eg, sleep pattern, surgery) transitioned toward mechanistic and translational topics such as the glymphatic system, cardiovascular disease, and obstructive sleep apnea, reflecting the field’s maturation and clinical integration. **(B)** Cluster network visualization showing interconnections among major thematic domains. Central clusters (eg, obstructive sleep apnea, sleep syndrome) serve as bridges between foundational sleep science and applied perioperative research. **(C)** Density map of the co-citation network highlighting areas of high intellectual influence and interdisciplinary convergence. Dense red zones correspond to influential topics linking sleep physiology, neurovascular regulation, and perioperative stroke prevention.

assessment. The emergence of mechanistic keywords such as “glymphatic system” indicates that advanced concepts from neuroscience are being actively introduced into this field to explain the links between sleep disorders and cerebrovascular events.

On this basis, the clustered co-citation network (Figure 12C) provides a macro-level knowledge map of the contemporary research ecosystem. Major clusters such as “#1 obstructive sleep apnea”, “#6 atrial fibrillation”, “#5 postoperative delirium”, “#4 en-y gastric bypass”, “#2 new vista”, and “#7 focal cerebral ischemia” collectively form a three-dimensional framework centered on “sleep disorders–perioperative management–cardio-cerebral outcomes”. The clusters are densely interwoven through co-citation relationships rather than isolated, indicating that this field has developed into a highly interconnected and collaborative knowledge network that continues to incorporate new theories and methods through clusters such as “new vista”.

## Discussion

### Overview and Knowledge Progression

Based on bibliometric mapping of literature from 1999–2024, this study systematically delineates the research landscape and evolutionary trajectory of the field at the intersection of sleep disorders and perioperative stroke. Overall publication output has grown exponentially, with the most recent 5-year period (2020–2024) accounting for more than 40% of all publications, indicating that the field has entered a phase of accelerated expansion. This trend reflects not only the rapid convergence of sleep medicine, stroke neurology, and perioperative medicine, but may also be partly related to heightened attention to the “sleep–brain–inflammation” axis in the context of the COVID-19 pandemic.

Geographical and institutional analyses demonstrate clear structural shifts. The United States maintains a dominant position in both output and citations, serving as the central hub of the global collaboration network. Western European countries such as the United Kingdom and Germany contribute relatively fewer papers but have high mean citation counts and H-indices, positioning them as key “knowledge sources” of high-quality evidence. China’s share of publications has increased from less than 5% in the early period to over 20% in the past decade, making it one of the main drivers of global growth and forming a dual-core structure with the United States. At the institutional level, traditional US centers such as Harvard Medical School and Mayo Clinic remain highly productive, while emerging institutions such as Capital Medical University have expanded rapidly, suggesting a transition from a predominantly “Euro-American-centered” pattern to a more distributed system supported by multiple backbone institutions across several countries. Compared with previous bibliometric studies that have focused either on perioperative stroke in general surgical populations or on sleep disorders more broadly,<sup>25–27</sup> the present work narrows the lens to the perioperative setting and is the first, to our knowledge, to clearly highlight surgery-specific risk factors and postoperative neurological complications as prominent themes, thereby filling an important gap at this clinical intersection.

The thematic evolution analyses reveal a three-stage progression of research focus: from fundamental sleep physiology, to a “OSA–cardiovascular risk–stroke” axis, and finally to perioperative management, postoperative delirium, and glymphatic system–related neural mechanisms. This trajectory closely parallels clinical advances, whereby sleep disorders have shifted from being viewed as incidental “comorbid symptoms” to being recognized as modifiable, perioperative risk factors for stroke.

### Mechanism-Related Themes: From Bibliometric Maps to Hypothesis Generation

It is important to emphasize that this study, by design, is bibliometric and therefore describes patterns of research interest rather than directly evaluating biological mechanisms or intervention efficacy. Within this framework, frequently occurring and recently emerging mechanistic themes in the co-occurrence and burst analyses should be interpreted as reflecting current hypothesis directions in the field.

Across the included literature, contemporary mechanistic discussions converge on three broad axes, which also align with the dominant clusters observed in the bibliometric maps.

#### Sleep-Disordered Breathing – Cardiovascular Remodeling – Stroke Axis

Keywords such as obstructive sleep apnea and atrial fibrillation appear consistently and with high frequency, indicating sustained attention to cardiovascular pathways in stroke vulnerability. Prior experimental and clinical studies provide

context for this pattern. Sleep-disordered breathing, particularly obstructive sleep apnea (OSA), has been associated with endothelial dysfunction, oxidative stress, and impaired cerebrovascular autoregulation.<sup>12,14,125,126</sup> These upstream disturbances may promote chronic hypertension, atrial structural and electrical remodeling, and prothrombotic tendencies, all of which could increase the risk of ischemic or embolic events under perioperative stress.

Repeated nocturnal hypoxia–reoxygenation cycles, alterations in intrathoracic pressure, and sympathetic surges have been linked mechanistically to hypertension through sympathetic activation, RAAS dysregulation, and endothelial injury.<sup>127–130</sup> In parallel, OSA-related oxidative and inflammatory signaling may contribute to atrial fibrosis and conduction abnormalities, fostering an arrhythmogenic substrate.<sup>15,131</sup> Once atrial fibrillation—either paroxysmal or sustained—occurs, the risk of cardioembolic stroke increases substantially, and postoperative atrial arrhythmias have been associated with early stroke after surgery.<sup>132,133</sup> Narrative reviews further describe a prothrombotic milieu in OSA, including elevations in fibrinogen, platelet activation, and impaired fibrinolysis.<sup>15</sup>

Although our study does not assess these mechanisms directly, the prominence of related keywords suggests that this cardiovascular–sleep axis remains a central conceptual pathway in current perioperative stroke research.

### Inflammatory and Systemic Response Axis

The keyword burst analysis ([Figure 10C](#)) highlights systemic inflammation and neuroinflammation as emerging terms over the past 5–8 years. This is consistent with growing discussion that sleep disruption—particularly fragmented sleep and intermittent hypoxia—may amplify inflammatory signaling.<sup>17–19,134</sup> In perioperative settings, where surgical trauma, hemodynamic fluctuations, and anesthesia already impose inflammatory stress, these pathways may theoretically compound cerebrovascular vulnerability.

Inflammatory signaling has also been proposed as a contributor to endothelial dysfunction and atrial remodeling, linking this axis to the cardiovascular mechanisms described above.<sup>135–139</sup> While the bibliometric analysis does not evaluate biomarker levels or causal pathways, the recurrence of inflammation-related terms suggests increasing interest in inflammation as a modifiable component of perioperative stroke risk.

### Neurocognitive and Brain-Clearance Axis

Clusters involving postoperative delirium and glymphatic system have become increasingly active in recent years ([Figures 11A and 12A](#)). These themes reflect a shift toward perioperative brain health and interest in how sleep, anesthesia, and circadian disruption may influence glymphatic function or neurocognitive outcomes.

Studies outside the scope of this review have proposed that impaired sleep–wake cycling or altered CSF–interstitial fluid exchange could reduce clearance of inflammatory or neurotoxic metabolites, potentially contributing to delirium or postoperative neurological dysfunction. The appearance of these concepts in recent high-impact literature likely explains their prominence in the keyword evolution and co-citation networks.

Taken together, the bibliometric results provide a “heat map” of research attention, identifying hypotheses that are repeatedly discussed and rapidly gaining traction. This information can help prioritize future mechanistic and clinical investigations. However, the present analysis itself does not evaluate the validity or effect size of these mechanistic pathways and should not be interpreted as evidence of efficacy.

## Emerging Scientific and Clinical Directions

The thematic patterns identified in this study highlight several clinically relevant gaps in current perioperative practice. First, despite the consistent appearance of terms such as screening and STOP-BANG in the keyword analyses, perioperative sleep disorder screening—particularly for OSA—remains inconsistently implemented in routine surgical pathways. Prior studies have shown that a substantial proportion of surgical patients harbor undiagnosed sleep-disordered breathing,<sup>7,20,21</sup> underscoring the potential value of incorporating standardized sleep assessments into preoperative workflows.

Second, although keywords related to machine learning, risk prediction, and perioperative outcomes have increased in frequency, few existing risk models explicitly include sleep- or circadian-related metrics. The integration of objective sleep measures, nocturnal blood pressure patterns, or respiratory event indices into perioperative prediction models may help refine stroke risk stratification, but these approaches remain underexplored.

Third, the geographical and procedural distribution of the literature reveals substantial imbalance. Research is concentrated in high-income countries and large cardiovascular centers, whereas data from low- and middle-income regions and from non-cardiac surgical populations remain limited. This restricts the generalizability of current evidence and highlights the need for broader, more diverse research participation.

Based on these observations, several methodological directions emerge: (1) the incorporation of validated sleep and circadian assessment tools into prospective perioperative cohorts; (2) expansion of multicenter and cross-regional collaborations to address geographic and procedural gaps; (3) translation of emerging mechanistic themes—such as inflammation, endothelial dysfunction, and glymphatic disruption—into hypothesis-driven clinical studies using stratified trial designs; (4) systematic evaluation of the incremental predictive value of sleep-related variables in big-data and machine-learning models.

These implications should be interpreted within the limitations of the underlying literature but reflect clear opportunities for advancing perioperative stroke prevention.

## Limitations and Future Perspectives

This study has several inherent limitations. First, although the search strategy emphasized perioperative relevance, variations in indexing terminology mean that some included publications may refer to surgical contexts broadly rather than addressing perioperative stroke directly. The findings therefore represent a literature map centered on perioperative themes rather than a narrowly defined systematic review.

Second, reliance on WoSCC and Scopus introduces potential coverage bias toward English-language and high-income-region journals. Research outputs from low-resource settings or non-indexed regional publications may be underrepresented.

Third, citation-based indicators depend on publication age, field size, and self-citation. Highly cited articles are not necessarily of higher quality, and newer studies may be disadvantaged by the time lag inherent to citation accumulation. Similar limitations apply to co-occurrence and clustering analyses, which are sensitive to parameter selection and database structure. Although sensitivity checks showed stable major patterns, finer structural details should be interpreted cautiously.

Future work should validate the mechanistic hypotheses highlighted by this bibliometric analysis within rigorously defined perioperative cohorts. Standardized perioperative sleep assessment protocols, broader international collaboration, and open-science practices—such as sharing search strategies, data-cleaning scripts, and controlled vocabularies—may help establish an updatable foundation for this interdisciplinary field. Ultimately, integrating sleep and circadian health into perioperative evaluation may support more precise prevention strategies for cerebrovascular complications, but such approaches require targeted empirical testing before clinical adoption.

## Conclusions

This bibliometric analysis maps 25 years of research linking sleep disorders to perioperative stroke and demonstrates a steady expansion of interdisciplinary activity across anesthesiology, neurology, and sleep medicine. Research themes have shifted from early circadian and respiratory mechanisms toward perioperative neuroinflammation, cardiovascular remodeling, and post-operative neurological complications. Although mechanistic terms appear prominently in recent literature, these patterns reflect evolving research interest rather than evidence of causal pathways. The findings highlight several priorities for future work, including standardized perioperative sleep assessment, incorporation of sleep and circadian metrics into risk prediction models, and broader multicenter collaboration to address geographic and procedural gaps. By outlining the structure and progression of this field, the study provides a data-informed foundation for advancing perioperative cerebrovascular risk mitigation.

## Data Sharing Statement

All raw/cleaned datasets, thesaurus files, parameter settings, code/scripts, and full visualization parameters have been deposited in a public repository (<https://zenodo.org/records/17851373>). Exact software versions and instructions for replication are included in [Supplementary Appendices](#).

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## Author Contributions

AAS: data curation, investigation, formal analysis, visualization, writing—original draft, writing—review and editing.

SD: data curation, investigation, writing—original draft.

XG: conceptualization, methodology, formal analysis, supervision, visualization, project administration, writing—original draft, writing—review and editing.

EW: conceptualization, resources, supervision, funding acquisition, writing—review and editing.

All authors have read and approved the final version of the manuscript, agreed to submit the article to *Nature and Science of Sleep*, and agree to be accountable for the content of this paper.

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## Disclosure

The authors declare that they have no financial or non-financial competing interests that could be perceived to influence the work reported in this paper.

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