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Global Trends in Brain Tumor Diagnostic and Therapy A Review Bibliometric Evidence on Innovation and Collaboration

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Abstract: Brain tumors remain among the most difficult and lethal conditions in oncology and neurology, and the last several years have seen an unprecedented convergence of artificial intelligence (AI), molecular biomarker discovery, and advanced neuroimaging in the effort to improve diagnosis and treatment. This review synthesizes a large-scale bibliometric analysis of brain tumor research published between 2023 and 2025, drawing on 23,496 articles indexed in Scopus and analyzed using the Biblioshiny interface of the bibliometrix R package [26]. It brings together the study's findings on publication growth, leading journals and institutions, national research output and collaboration patterns, citation impact, and thematic evolution, and situates them within the wider bibliometric literature on neuro-oncology, machine learning in cancer, and precision medicine. The evidence indicates a research field expanding rapidly around AI-enhanced diagnostics, radiomics, and individualized treatment, led numerically by China and, in terms of citation influence, by the United States, with collaboration networks that remain geographically concentrated in East Asia and structurally short on the bridging authors and cross-border partnerships needed to diffuse innovation equitably. This review discusses what these patterns suggest about the maturity and direction of the field, highlights recurring methodological limitations of bibliometric mapping as a research tool, and outlines priorities for future research and international collaboration in brain tumor diagnostics and therapy.

1. Introduction

Brain tumors are widely regarded as among the most challenging and fatal classes of disease in oncology and neurology [1,2]. They arise from a broad range of cell types within the central nervous system (CNS) and span a wide clinical spectrum, from slow-growing benign lesions to aggressive malignancies such as glioblastoma multiforme (GBM) [1,2]. Their pathological and molecular heterogeneity complicates diagnosis, treatment planning, and outcome prediction [3], and despite advances in surgery, radiotherapy, and chemotherapy, prognosis for malignant brain tumors remains poor, with median survival for glioblastoma patients still only 12 to 15 months under optimal care [4,5]. This persistent unmet need has driven demand for new diagnostic, imaging, and treatment modalities [6,7], and recent progress in neuroimaging, molecular biology, and computational methods has reshaped the research landscape [8]. Magnetic resonance imaging (MRI) and computed tomography (CT), particularly when combined with functional imaging and contrast media, now provide sensitive, noninvasive visualization of tumor anatomy, perfusion, and invasion [9,10].

Artificial intelligence, in the form of machine learning (ML) and deep learning (DL), has become deeply integrated into radiology and clinical decision-making, supporting automated tumor segmentation, radiomic feature extraction, and predictive modeling for precision diagnosis and individualized treatment planning [8,11]. In parallel, advances in genomics and epigenetics have identified molecular biomarkers, such as IDH mutations, MGMT promoter methylation, and 1p/19q co-deletion, that are now central to

glioma classification and carry significant prognostic and therapeutic weight [8,12,13,14]. These developments have opened the door to targeted therapies and immunotherapies now under active clinical investigation [15]. Taken together, high-resolution imaging, AI-driven analytics, and molecular profiling are widely described as ushering in a new era of precision neuro-oncology [8].

Given this pace of change, systematically mapping the research landscape has become an important task in its own right. Bibliometric analysis offers a quantitative means of characterizing scholarly output, citation impact, and collaborative behavior, identifying leading authors, institutions, and journals, and revealing keyword co-occurrence networks and thematic evolution within a field [16]. A number of recent bibliometric studies have examined the evolving neuro-oncology literature from various angles. One review mapped automated brain tumor detection using machine learning and documented rapid growth in deep-learning and MRI-based approaches to glioma classification, attributing much of the increase to international collaboration between centers in India, China, and the United States [17]. A separate forty-year science-mapping study of brain tumor research (1980–2022) identified biomarkers, personalized treatment, artificial intelligence, and immunotherapy as emerging hotspots [18]. Another review of brain metastasis management research found a shift away from conventional whole-brain radiotherapy toward radiosurgery, immune checkpoint inhibitors, and molecularly targeted therapies [19]. A broader bibliometric review of deep learning in cancer research found China and the United States leading in productivity and collaboration, with the research agenda moving toward cancer classification, detection, and diagnostic modeling [20]. A bibliometric and visualization analysis of CAR-T cell therapy for glioblastoma documented growing interest in dual-target and immunity-enhancing strategies [21], and a literature review of imaging genomics research highlighted the synergies between AI, radiomics, and genomic data in improving diagnostic and treatment precision [22]. Collectively, this body of work points to an increasing convergence of computational intelligence and translational research across oncology.

Most of these earlier bibliometric analyses, however, examined broader thematic scopes or considerably longer timelines. The underlying study reviewed here instead offers a narrow and contemporary bibliometric overview, focused specifically on brain tumor diagnostics, imaging, and therapeutics research published between 2023 and 2025 [26], a period chosen for its association with a surge of innovation in artificial intelligence, molecular biomarker discovery, and neuroimaging technology in the post-pandemic era. This review synthesizes that study's findings, evaluates their significance against the wider bibliometric literature in neuro-oncology, and considers what they imply for future research, clinical translation, and international collaboration.

2. Methodological Approach of the Underlying Bibliometric Study

The bibliometric data underlying this review were drawn from the Scopus database, one of the largest and most widely used repositories of peer-reviewed literature in medicine, health sciences, and technology [26]. The analysis covered English-language original research articles published between 2023 and 2025 addressing brain tumor diagnosis, imaging modalities, and treatment approaches [26]. A structured search strategy combined tumor-related terms (brain tumor, brain neoplasm, glioma, glioblastoma, astrocytoma, meningioma, brain cancer) with diagnostic and treatment terms (diagnosis, treatment, therapy, imaging, MRI, CT, artificial intelligence, deep learning, machine learning, radiotherapy, chemotherapy, surgery, biomarkers, prognosis, segmentation, classification), restricted to original articles in English published between 2023 and 2025 [26]. Exported records, including titles, author and institutional information, source journals, keywords, abstracts, publication years, citation counts, and reference lists, were cleaned in Microsoft Excel and Power Query to remove duplicates and incomplete records before analysis [26]. The resulting dataset was analyzed using Biblioshiny, the web interface of the bibliometrix R package, to examine publication trends, institutional and author productivity, collaboration networks, keyword co-occurrence, and thematic structure [16,23,24,26].

3. Publication Output and Growth Trends

The search identified 23,496 documents published across 3,570 journals, with an average document age of 1.25 years, indicating a field that is both timely and rapidly evolving [26]. Each paper received an average of 4.228 citations, and keyword analysis yielded 67,365 Keywords Plus terms and 38,085 author keywords, with glioma, glioblastoma, MRI, artificial intelligence, and radiotherapy emerging as the most common terms, reflecting the field's core focus on diagnostic advances, AI-driven modeling, and innovative therapeutics [26]. The dataset involved contributions from 93,510 authors, of whom only 249 published solo-authored articles and 285 papers were single-authored overall, underscoring how overwhelmingly collaborative the field has become; the average number of co-authors per paper was 8.81

[26]. International co-authorship accounted for 22.74% of publications, reflecting a genuinely global, if unevenly distributed, collaborative effort [26]. Annual citation patterns showed the expected diffusion lag: articles published in 2023 had accumulated a mean of 6.82 citations (2.27 per year), those from 2024 averaged 3.27 citations (1.64 per year), and 2025 articles, captured only through July of that year, averaged just 0.26 citations, consistent with newer work still being in an early citation phase [26].

4. Leading Journals in Brain Tumor Research

The Journal of Neuro-Oncology was the most productive outlet with 476 publications, followed by Cancers (437) and World Neurosurgery (410); Scientific Reports (407) and Frontiers in Oncology (370) were similarly prolific, reflecting broad interdisciplinary reach into both translational and clinical neuro-oncology [26]. Other major contributors included the International Journal of Molecular Sciences (268), Neuro-Oncology Advances (261), and Neuro-Oncology (259), while lower-volume but specialist journals such as Child's Nervous System (206) and Acta Neurochirurgica (188) remained influential in pediatric and surgical neuro-oncology [26].

Ranked by scholarly impact rather than volume, Biomedical Signal Processing and Control recorded the highest local h-index (25), g-index (37), and m-index (8.333) despite a smaller output of 142 documents, while Neuro-Oncology had the greatest total citation count (2,437 across 259 papers) and Nature Communications the highest g-index (36) with 1,747 citations across just 92 papers [26]. Several top journals, including the Journal of Neuro-Oncology, Cancers, World Neurosurgery,

Scientific Reports, and Frontiers in Oncology, showed sharply rising annual output between 2023 and 2025, with some more than doubling their published volume over the period, underscoring the accelerating pace of research activity [26].

5. Author Productivity and Influence

Author-level analysis identified a small number of highly productive contributors, with WANG Y publishing the most papers (766, fractional contribution 89.54), followed by ZHANG Y (614 papers, 73.20 fractionalized), LIU Y (563 papers, 66.59 fractionalized), and LI Y (560 papers, 66.16 fractionalized) [26]. When ranked by citation impact rather than volume, WANG Y again led with the highest h-index (27), m-index (9), and 3,911 citations from 766 papers, followed by LIU Y (h-index 25, 2,809 citations) and ZHANG Y (highest g-index of 42, 3,479 citations) [26]. The study notes that the prevalence of common East Asian surnames such as Wang, Zhang, and Li complicates author disambiguation in bibliometric analysis, a methodological caveat that underscores the value of persistent identifiers such as ORCID for accurate attribution [26]. Author-year analysis further showed that several of these researchers, including LIU Y and LI Y, achieved particularly high citations-per-year ratios in 2023, suggesting rapid uptake of early work in the review period [26].

6. Institutional and National Contributions

At the institutional level, Capital Medical University was the most productive affiliation with 935 publications, followed by the University of California (758), Fudan University (737), Harvard Medical School (644), Central South University (546), the University of Toronto (527), and the Mayo Clinic (521), with Southern Medical University, the German Cancer Research Center (DKFZ), and the University of Pennsylvania rounding out the top ten [26]. Several of these institutions, particularly Capital Medical University and Fudan University, showed steep year-on-year growth in output between 2023 and 2025, reflecting expanding national investment in neuro-oncology research, especially within China [26].

At the country level, China produced the largest number of articles (24,683 by the cumulative count reported, or 6,575 by corresponding-author count depending on the metric used), followed by the United States (22,745 or 3,741 by corresponding-author count), with Germany, India, Japan, France, and the United Kingdom also among the leading producers [26]. Collaboration patterns varied considerably by country: China's publications were predominantly single-country (SCP), with a multi-country publication (MCP) ratio of only about 12.9%, while the United States showed a notably higher MCP ratio of 21%, and countries such as Germany (38.1%), the United Kingdom (40.1%), and France (32.5%) showed the highest rates of cross-border collaboration among major producers [26].

Citation-impact analysis reinforced this picture of a productivity-impact divide: China led in total citations (25,295) but had a comparatively modest average of 3.80 citations per paper, while the United States (22,080 total citations, 5.90 per paper) and especially France (8,371 total citations, 15.50 per paper) achieved substantially higher per-paper impact despite lower publication volumes [26].

7. Citation Impact of Individual Papers

Among individual publications, two epidemiological review articles dominated citation counts: a 2024 paper in CA: A Cancer Journal for Clinicians accumulated 6,404 total citations and a normalized citation impact of 1,960.81, and a second 2024 paper in the same journal accumulated 4,037 citations with a normalized impact of 1,236.07 [26]. Beyond these outliers, more specialized but still highly cited work included studies in Infusion, the New England Journal of Medicine, Medical Image Analysis, and BMC Medical Informatics and Decision Making, reflecting substantial interest in both clinical trial results and computational decision-support tools for brain tumor diagnosis and management [26].

8. Thematic and Keyword Trends

Keyword frequency analysis showed “human” as the single most common term (22,554 occurrences), followed closely by “article” (18,073), reflecting the field's predominantly clinical and translational orientation, with “female,” “male,” and “adult” also appearing among the most frequent terms, alongside tumor-specific terms such as “glioblastoma” (12,139) and “glioma” (11,394) [26]. Thematic mapping using Callon centrality and density identified two major clusters: a “human” cluster, occurring 340,162 times and positioned as a highly central, established “motor theme” encompassing clinical research, patient populations, and translational studies; and a more specialized but internally cohesive “human cell” cluster (104,760 occurrences) focused on cellular and molecular research, including tumor biology and experimental therapeutics [26]. Emerging topic analysis, tracking terms by their median year of occurrence, identified “cancer survival,” “cancer patient,” and “outcome assessment” as themes that gained prominence early in the review period, while more technical terms such as “contrastive learning,” “image coding,” and “medical image processing” emerged sharply toward 2025, signaling a fast-growing convergence of deep learning and medical imaging informatics within brain tumor research [26].

9. Collaboration Networks

Author-level collaboration analysis found a single, densely interconnected cluster dominated by common East Asian surnames (Wang, Zhang, Li, Liu, Chen), suggesting geographically or institutionally concentrated collaboration, most likely within East Asia [26]. Notably, all nodes in this network showed zero betweenness centrality, meaning no individual authors served as bridges between otherwise separate groups, a structural feature that could limit knowledge diffusion and interdisciplinary integration despite the network's internal density [26]. PageRank analysis identified WANG Y, ZHANG Y, LIU Y, and LI Y as the most influential nodes, again suggesting strong local prominence rather than broad cross-network reach [26].

At the national level, collaboration was more geographically dispersed. The United States functioned as a central hub, with 585 collaborative articles involving China, 322 involving Canada, and 311 involving the United Kingdom [26]. China, while the largest single producer, also maintained substantial collaborative ties with the United States, Germany (124 collaborations), and the United Kingdom (140) [26]. European countries showed extensive intracontinental collaboration, for example between Germany and Switzerland (217 collaborations), the Netherlands (172), and Austria (159) [26]. Middle Eastern countries such as Saudi Arabia and the United Arab Emirates showed a growing but comparatively modest international footprint, and African and Latin American countries were markedly underrepresented in the global collaboration network, with South Africa recording only 14 collaborations with the United States and Brazil 95 [26].

10. Discussion: Situating the Findings within the Broader Literature

The pattern uncovered by this bibliometric analysis, rapid growth led by China and the United States, an increasing focus on AI-driven diagnostics and radiomics, and collaboration networks concentrated in East Asia, is broadly consistent with earlier bibliometric work on related topics. It echoes findings that international collaboration between India, China, and the United States has driven growth in machine-learning-based brain tumor detection research [17], and aligns with the observation that China and the United States jointly lead productivity and collaboration in deep learning applications across cancer research more broadly [20]. It also complements longer-horizon bibliometric work showing that biomarkers, personalized treatment, and immunotherapy have become durable research hotspots over several decades [18], and is consistent with a documented shift in brain metastasis research away from conventional radiotherapy toward targeted and immune-based therapies [19]. The growing prominence of computational and imaging-genomics themes identified here mirrors similar trends noted in reviews of CAR-T cell therapy for glioblastoma [21] and of imaging genomics more broadly [22]. Taken together, this

convergence across independent bibliometric analyses lends confidence that the trends identified, AI-driven precision diagnostics, biomarker-based classification, and an uneven but growing international collaboration structure, reflect genuine shifts in the field rather than artifacts of any single study's search strategy.

At the same time, the underlying study highlights structural weaknesses that recur across much of this literature. The near-total absence of intermediary, or "bridging," authors in the individual-level collaboration network is a striking finding: despite dense collaboration within clusters, there are very few individuals connecting otherwise separate research communities, which the study suggests may constrain the diffusion of ideas across subfields and geographic regions [26]. Similarly, the marked disparity between China's publication volume and its comparatively modest per-paper citation impact, set against the United States' and France's higher per-paper impact with lower volume, illustrates a common tension in bibliometric assessment between raw productivity and academic influence, a tension also noted in prior deep-learning-in-cancer bibliometrics [20].

The underlying study also reports substantial recent progress in immunotherapy and chemotherapy approaches to brain tumors, including immune checkpoint inhibitors, CAR T-cell therapy, and personalized vaccine-based immunotherapies, alongside advances in chemotherapy delivery such as temozolomide dosing changes and liposomal or nanoparticle-based drug delivery [26]. These clinical and translational advances, increasingly coupled with AI-assisted drug design and predictive modeling, point toward a broader shift in the field from single-modality treatment toward intelligent, multimodal precision therapy [26].

11. Limitations of the Evidence Base

Several limitations inherent to bibliometric mapping, and specific to this dataset, warrant consideration when interpreting these findings.

Single-database coverage. The analysis relied exclusively on Scopus, and while it is among the largest peer-reviewed databases available, restricting the search to a single source may exclude relevant work indexed elsewhere (for example in PubMed-only or region-specific databases), potentially skewing the apparent balance of national and institutional contributions [26].

Keyword-based search strategy. Because inclusion depended on a fixed set of search terms applied to titles, abstracts, and keywords, studies using nonstandard terminology, or emerging techniques not yet captured by the chosen keyword list, may have been systematically underrepresented [26].

Short and asymmetric time window. The three-year window, with 2025 data captured only through July, means recent publications have had far less time to accumulate citations than earlier ones, which likely understates the eventual impact of the most recent work and should temper any direct year-over-year citation comparisons [26].

Author name disambiguation. As the underlying study itself notes, the predominance of common transliterated surnames (Wang, Zhang, Li, Liu, Chen) creates a genuine risk of conflating distinct individuals or splitting a single author's output across name variants, which could distort author-level productivity and influence rankings in the absence of consistent persistent identifiers [26].

English-language and article-type restriction. Limiting the search to English-language original research articles excludes non-English scholarship and other document types (reviews, conference proceedings, preprints), which may understate research activity in non-English-speaking regions and omit relevant syntheses or early-stage findings [26].

Correlational, not causal, interpretation. Bibliometric indicators such as publication counts, citation totals, and collaboration frequency describe patterns of scholarly activity but cannot by themselves establish which research directions will prove most clinically valuable; high output or citation volume is not equivalent to therapeutic impact.

12. Implications for Research and Practice

The underlying study's findings carry several practical implications. Closing the gap between AI research output and clinical practice is described as an urgent priority, requiring multicenter validation, shared infrastructure, and clinician training and ethical guidance for integrating AI tools safely into diagnostic and treatment pathways [26]. The pronounced disparity in global research participation, with African and Latin American countries markedly underrepresented in collaboration networks, points to a need for equitable

partnerships and scalable solutions that extend molecular biomarker testing and advanced diagnostics to low- and middle-income countries [26]. Multidisciplinary collaboration among clinicians, data scientists, and engineers is identified as essential for translating bibliometric momentum into real-world diagnostic and therapeutic gains [26].

13. Future Directions

Building on the underlying study, several avenues for future bibliometric and translational research follow naturally. Extending the analysis window beyond three years would allow better assessment of the long-term citation impact and clinical uptake of the AI and biomarker-driven techniques identified here [26]. Future bibliometric work could also examine clinical translation and implementation more directly, linking publication and collaboration patterns to real-world adoption and patient-centered outcomes rather than citation counts alone [26]. Investigating the funding structures, policy environments, and institutional incentives that shape collaboration networks may help identify concrete levers for improving global research parity, particularly for underrepresented regions [26]. On the clinical and technical side, priorities identified include multicenter validation of AI diagnostic tools, development of research capacity in underrepresented regions, and creation of shared, openly accessible knowledge platforms to accelerate the translation of computational and molecular advances into everyday neuro-oncology practice [26].

14. Conclusion

This review has synthesized bibliometric evidence describing a brain tumor research field in the midst of rapid, technology-driven transformation. Between 2023 and 2025, publication output surged, propelled largely by advances in artificial intelligence, molecular biomarkers, and neuroimaging, with China and the United States as the leading producers, though diverging notably in their productivity-to-citation-impact profiles [26]. Journals such as the Journal of Neuro-Oncology and Biomedical Signal Processing and Control emerged as key venues for high-impact imaging, computational, and biomarker research, while thematic analysis revealed a field organized around two complementary poles: broad, patient- and outcome-focused clinical research, and more specialized cellular and molecular investigation [26]. Collaboration network analysis painted a more cautionary picture, revealing a densely connected but geographically concentrated research community, notably in East Asia, with few bridging authors or institutions to link otherwise separate research clusters, and with African and Latin American countries still largely peripheral to global partnership structures [26]. Molecular markers such as IDH mutation and MGMT promoter methylation status remain central to precision approaches in glioma and glioblastoma care, but the underlying study is clear that large-scale clinical validation across diverse patient populations and health systems is still needed before these advances can be considered broadly translatable [26]. Taken as a whole, the evidence points to a field with substantial scientific momentum but an uneven collaborative foundation; realizing the full clinical benefit of AI-driven, biomarker-informed neuro-oncology will likely depend as much on deliberately building cross-border, cross-disciplinary, and cross-income-level partnerships as on further technical innovation itself.

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