

BIBLIOMETRIC ANALYSIS ON DEEP BRAIN STIMULATION PROCEDURES CONDUCTED BETWEEN 2000-2023

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ABSTRACT

Objective: Deep brain stimulation (DBS) is a treatment method that uses electrodes to stimulate the brain, affecting brain activity and potentially causing medical conditions. It is commonly used to treat Parkinson's disease, essential tremor, dystonia, epilepsy, Tourette syndrome, and obsessive-compulsive disorder. This bibliometric study examines advanced bibliometric parameters in articles published since 2000, focusing on trends in publishing organizations, countries, funding sources, international collaborations, and trend keywords.

Materials and Methods: We have searched the Web of Science database to find articles on DBS which published since 2000. The search was performed by using the MESH keywords related to "Deep brain stimulation".

Results: This study presents a comprehensive analysis of 4,601 articles on Deep Brain Stimulation (DBS) from 2000 to 2023, focusing on publication trends, properties, funding, country contributions, and international collaborations. Noteworthy findings include a peak of 413 publications in 2020 and 14,992 citations in 2021. The overall trajectory demonstrates a significant increase in scientific output, with an average of 31.9 citations per article. Publication properties reveal diverse access categories, including 66 Early Access and 2,136 Open Access articles. The majority of records are in the Science Citation Index Expanded (93.980%). Clinical Neurology dominates research topics with 63.464% representation. Funding sources highlight major contributions from the USA, Germany, and China. The USA leads in research output, while the University of Toronto tops institutions. Major journals include "Stereotactic and Functional Neurosurgery" and "Movement Disorders." Keyword analysis emphasizes common themes like "deep brain stimulation" and "Parkinson's disease." International collaborations involve researchers from 75 countries, with the USA leading in total link strength. This study contributes valuable insights into the global landscape of DBS research.

Conclusion: This analysis highlights the dynamic nature of Deep Brain Stimulation research, highlighting global collaboration and diverse topics, emphasizing the crucial role of key countries, institutions, and journals.

Keywords: : Bibliometric analysis, Deep Brain Stimulation, articles.

INTRODUCTION

Deep Brain Stimulation (DBS) is a neurosurgical procedure that involves insertion of electrodes into specific brain regions, connected to an implantable pulse generator. The stimulation parameters include the selection of contacts, location, and control of amplitude, frequency, and pulse width [1,2]. While DBS is primarily used as a symptomatic treatment, it is also thought to influence the brain's cytoarchitecture by stimulating subcortical regions, which

promotes regeneration and adaptation [3]. This procedure was first described in the 1950s [4] and since the 1980s, DBS has been utilized to treat movement problems. Approximately 150,000 patients with movement disorders have had DBS devices implanted in the United States of America (USA) alone. DBS was first used to treat Parkinson's disease, but it is currently approved by the USA Food and Drug Administration (FDA) to treat essential tremor, dystonia, and Parkinson's disease [5]. Nowadays DBS is commonly used for various medical conditions, such as

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Parkinson's disease, essential tremor, dystonia, epilepsy, Tourette syndrome, and obsessive-compulsive disorder. Its high precision and programmability make it a potential treatment for conditions like chorea, chronic pain, cluster headache, dementia, depression, addiction, and obesity. The method's ability to influence brain activity at a cellular and chemical level highlights its broad therapeutic potential across neurological and psychiatric disorders [1,2,6,7]. After placing bilateral DBS electrodes in four patients with treatment-refractory obsessive-compulsive disorder (OCD), Nuttin and colleagues published the first DBS usage for psychiatric indications in 1999. It was clinically beneficial for three of the patients. Many research on DBS for treatment-refractory mental illness have been conducted since then. But DBS is only recommended for severe, persistent mental illnesses that do not respond to treatment, and it should be managed by a skilled multidisciplinary team [8,9]. Bibliometric analyses are useful instruments for the quantitative assessment of the academic environment in a particular field of study. The evaluation of the most active journals, prolific authors, influential countries, significant universities, and niche topic areas is made possible by such examinations. These kinds of searches have been carried out in a variety of scientific disciplines. The methodical implementation of bibliometric techniques enables a thorough comprehension of the academic output, collaboration networks, and trends in many study fields. These evaluations aid in identifying important figures, new fields of study, and the overall influence of scientific efforts across a range of academic fields [8-13]. Limited bibliometric studies have been published on DBS [14-16], primarily focusing on specific domains or frequently cited articles. Hu and colleagues [14] conducted a comprehensive search on the Web of Science to identify the 100 most highly-cited papers in the field. The study systematically recorded and analyzed parameters such as the number of citations, countries and institutions of origin, year of publication, and research area. This investigation successfully identified the 100 most highly-cited studies, providing a historical perspective on advancements within the DBS field. Studies by Listik et al. [15] and Mishra et al. [16] have also contributed to the literature on DBS by focusing on dystonia treatment and investigating the most cited articles related to local field potentials in DBS. In this study we aimed to examine advanced bibliometric parameters in articles published since 2000, focusing on trends in publishing universities, countries of publication, funding sources, international collaborations, and trend keywords.

MATERIALS AND METHODS

A computerized literature search was conducted using the database, the Web of Science founded by the Institute for Scientific Information. (Web of knowledge. [homepage]. Available: <http://ipscience.thomsonreuters.com/>). There was no journal and language restrictions. The search was performed by using the MESH keywords related to "Deep brain stimulation". (TITLE: Brain Stimulations, Deep OR Deep Brain Stimulations OR Stimulation, Deep Brain OR

Stimulations, Deep Brain OR Brain Stimulation, Deep OR Electrical Stimulation of the Brain). The study conducted a search in the Web of Science database using specific keywords and found a total of 12,939 publications. The search was narrowed down to articles published since 2000 and resulted in a dataset of 5,393 articles. Non-medical articles were then excluded, leaving 4,937 articles. The focus was further narrowed to articles published in specific journals and indexed in ESCI and SCIE databases, resulting in a dataset of 4,755 articles. Articles that were not published in English were excluded, reducing the dataset to 4,601 articles. These 4,601 articles were used as the sample for the study. The text and Excel files corresponding to these articles were downloaded and analyzed using advanced bibliometric methods. The study methodology is summarized in Table 1.

Quantitative statistics

The features of publications, such as article types, categories, author distribution, country/regional distribution, number of annual publications, citation counts, and H-index, were reviewed using the online edition of "The WOS Literature Analysis Report". All of the recovered data were loaded into VOSviewer 1.6.19 (Leiden University, Leiden, Netherlands) and Microsoft Excel 2019 for visual analysis by taking inspiration from previous studies [17-20]. VOSviewer application simplifies scientific knowledge visualization with advanced large map management features, enabling comprehensible presentation of large bibliometric maps.

RESULTS

Number of publications and citations

Following the inclusion criteria, a total of 4,601 articles on the subject of DBS were identified in this study. The review of research papers on DBS from 2000 to 2023 reveals three main trends. The early period saw a gradual increase in publications, with significant milestones in 2008 and 2009. The middle period saw a significant increase, reaching a peak of 413 papers in 2020. The last years (2021-2023) saw notable contributions, with 2021 being the most significant. The highest number of publications was 413 in 2020, followed by 8.605% and 7.540% in 2021 and 2022 respectively. The highest number of citations was 14,992 in 2021. The trajectory of scientific output has seen a rapid increase since 2000, with publications peaking in 2020 and a decline in articles. The overall number of citations for the chosen articles is 110,065 when self-citations are not included, for a cumulative total of 146,750 citations. The scholarly importance and significance of the included articles are demonstrated by the average number of citations (31.9) for each item in the collection. Figure 1, entitled "Citations and Publications over Time", visually represents these trends.

Table 1: Search methodology

Step	Action	Details
1	Keyword Search	Conduct a search in the Web of Science database across all databases from 1973 to 2024.
2	Selection of Article Document Type	Focus on articles, reducing the count to 6134 publications.
3	Determination of Time Span	Select articles published from the year 2000 onwards within the timeframe of January 1 to December 31, 2023.
4	Exclusion of the Year 2024	Exclude data from the year 2024 as it is not yet completed.
5	Exclusion of Non-Medical Articles	Exclusion of Non-Medical Articles
6	Focus on ESCI and SCIE Journals	Exclude articles indexed in other databases, resulting in 4755 articles
7	Selection of English Publications	Choose English as the publication language, further reducing the count to 4601
8	Creation of the Sample	Form the study sample with 4601 selected articles.
9	Downloading Data and Conducting Analyses	Download plain text and Excel files of the selected articles and perform advanced bibliometric analyses

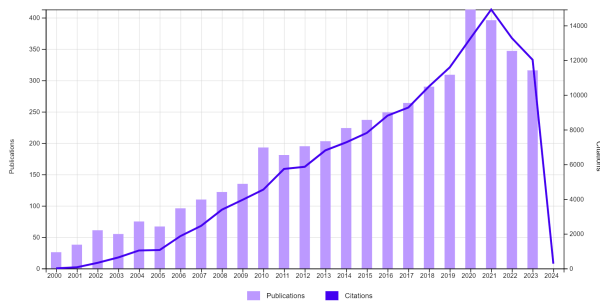


Figure 1: Number of publications and citations by years

Publication properties

It was found that there were 66 publications available in Early Access, meaning they were available online before their official journal publication. A significant number of articles, 2,136 in total, were classified as Open Access, allowing free public access. Out of these, 920 were classified as Gold, meaning they could be accessed for free immediately after publication. Additionally, there were 354 Gold-Hybrid articles, where authors pay to make their individual articles Open Access within a subscription-based journal. The Free to Read category consisted of 382 articles that were freely accessible after a specific embargo period. Green Published articles numbered 1,276, which were articles archived by authors in repositories or institutional platforms after publication. There were also 394 Green Accepted articles, submitted to repositories or platforms after being accepted but before official publication. Finally, 314 Green Submitted articles were deposited in repositories or platforms before being accepted for publication. The analysis of publications distribution revealed that the Science Citation Index Expanded (SCI-EXPANDED) accounted for 93.980% of total records, followed by the Social Sciences Citation Index (SSCI) at 7.824% and the Emerging Sources Citation Index (ESCI) at 6.020%. Only a small number of journals were published in the Conference Proceedings Citation Index - Social Science &

Humanities (CPCI-SSH) indexes.

The analysis of data from the Web of Science categories of 4,601 selected articles reveals a diverse distribution of topics. Clinical Neurology accounts for the highest number of records, representing 63.464% of the total articles. Neurological sciences closely follows with 40.209%, highlighting the focus on neurological research. Surgery is also significant with 27.820% of the articles dedicated to surgical aspects. Neuroimaging, Psychiatry, and Medical Research Experimental contribute significantly, indicating the interdisciplinary nature of the study. Other categories like Psychology, Radiology, and Pediatrics have varying degrees of representation. The data suggests that the selected articles extensively explore medical and health-related topics across a wide range of specialties and disciplines.

Funding agencies, countries and universities

DBS research has been funded by many different institutions, with the United States (USA) Department of Health and Human Services and the National Institutes of Health (NIH) being the leading contributors. Medtronic follows closely behind with 6.06%. Other major contributors include the German Research Foundation (DFG) and the National Natural Science Foundation of China (NSFC), while United Kingdom (UK) Research and Innovation, the Michael J Fox Foundation and the Canadian Institutes of Health Research also play important roles. 47.87% of registrations did not include data on the source of funding. The major countries contributing to the funding of DBS research account for a significant 27.14% of articles, as evidenced by the significant support provided by the NIH. Moreover, the presence of major players such as Medtronic, a medical technology company, further highlights the influential role of US-based organizations in supporting DBS studies. Germany also stands out, with the DFG playing an important role and contributing 3.69% to the overall funding landscape. The collaborative efforts between these countries and their respective institutions, together with significant contributions from institutions in the USA and

Table 2: Top publishing journals

Publishing journals	n	Category Quartile	Journal Impact Factor™ (Five year)
STEREOTACTIC AND FUNCTIONAL NEUROSURGERY	270	Q4	1.8
MOVEMENT DISORDERS	223	Q1	9.5
JOURNAL OF NEUROSURGERY	203	Q2	4.6
NEUROMODULATION	196	Q3	3.3
PARKINSONISM RELATED DISORDERS	169	Q2	4.4
BRAIN STIMULATION	137	Q1	9.3
WORLD NEUROSURGERY	131	Q4	2.1
NEUROSURGERY	119	Q1	5
ACTA NEUROCHIRURGICA	104	Q3	2.4
JOURNAL OF NEUROLOGY NEUROSURGERY AND PSYCHIATRY	95	Q1	10.8
FRONTIERS IN HUMAN NEUROSCIENCE	94	Q3	3.6
FRONTIERS IN NEUROLOGY	79	Q2	3.9
JOURNAL OF CLINICAL NEUROSCIENCE	73	Q4	2.1
JOURNAL OF NEUROLOGY	67	Q1	5.6
BRAIN SCIENCES	66	Q3	3.4
NEUROLOGY	64	Q1	10.4
CLINICAL NEUROLOGY AND NEUROSURGERY	63	Q4	2
MOVEMENT DISORDERS CLINICAL PRACTICE	58	Q2	3.8
CLINICAL NEUROPHYSIOLOGY	55	Q1	4.5
FRONTIERS IN NEUROSCIENCE	55	Q2	5.2
NEUROSURGICAL FOCUS	53	Q2	4.9
NEUROIMAGE	52	Q1	7
JOURNAL OF PARKINSON'S DISEASE	49	Q1	6.1
OPERATIVE NEUROSURGERY	48	Q3	_*
BRAIN	44	Q1	14.6

Journal Impact Factor™2022: 2.3

Germany, underscore the global nature of DBS research.



Figure 2: Missing

The following regions/ countries are those where the majority of research articles on DBS have been published: With a substantial contribution of 38.66%, the United

States tops the list, closely followed by Germany with 14.73%. Third place is held by England with 9.06%, followed closely by the People’s Republic of China (8.39%), Canada (7.69%), and other major contributors. This demonstrates that the United States and Europe lead the way in DBS research (Figure 2a). According to the number of published articles, the University of Toronto leads the field in DBS research with 247 articles (5.367%), followed by the State University System of Florida with 214 articles (4.650%) and University Health Network Toronto with 209 articles (4.542%). Notable international participants that have made noteworthy contributions to the DBS literature include the University of Florida, the University of London, and the University of California System. This wide range of establishments includes healthcare organizations like the Mayo Clinic and the Cleveland Clinic Foundation as well as academic giants like Harvard University and University College London (Figure 2b).

Top publishing journals

The publications were published in 488 different journals. Among the major journals, "Stereotactic and Functional Neurosurgery" led with 270 publications, accounting for 5.868% of the total, followed by "Movement Disorders" with 223 publications (4.847%). Other important journals included "Journal of Neurosurgery" (4.412%), "Neuromodulation" (4.260%) and "Parkinsonism Related

Disorders” (3.673%). These journals have varying quartile rankings and Impact Factors, showcasing the diverse landscape of neurosurgical literature (Table 2).

Keywords analysis

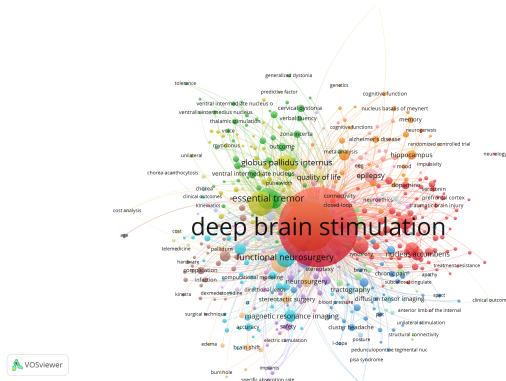


Figure 3: Keyword analysis with Vosviewer

In a comprehensive analysis of published articles in the field of DBS using Vosviewer, a total of 5709 keywords were identified, 482 of which were repeated at least 5 times. Figure 3 shows the data visualization of the most frequently used keywords. Meanwhile, Table 3 presents numerical values showing the frequency of occurrence of these keywords. According to Table 3, notable keywords and their total link strengths include "deep brain stimulation" with 3120 occurrences and a total link strength of 7719, "parkinson's disease" with 1203 occurrences and a total link strength of 3159, and "subthalamic nucleus" with 687 occurrences and a total link strength of 2079. This comprehensive overview sheds light on common themes in the DBS literature and their interconnections

Table 3: Most frequent keywords

Keyword	Number of occurrences	Total link strength
deep brain stimulation	3120	7719
parkinson's disease	1203	3159
subthalamic nucleus	687	2079
dystonia	297	845
parkinson disease	248	665
dbS	226	592
essential tremor	217	629
functional neurosurgery	177	620
thalamus	160	520
tremor	151	496
movement disorders	144	417
globus pallidus internus	130	373
neuromodulation	130	403
deep brain stimulation (dbS)	118	224
depression	115	380
globus pallidus	107	349
epilepsy	98	298
obsessive-compulsive disorder	84	230
quality of life	83	244
basal ganglia	80	245
nucleus accumbens	77	211
magnetic resonance imaging	71	244
microelectrode recording	67	228
tourette syndrome	63	191
cognition	58	197
complications	58	175
neurosurgery	58	150
local field potentials	51	162

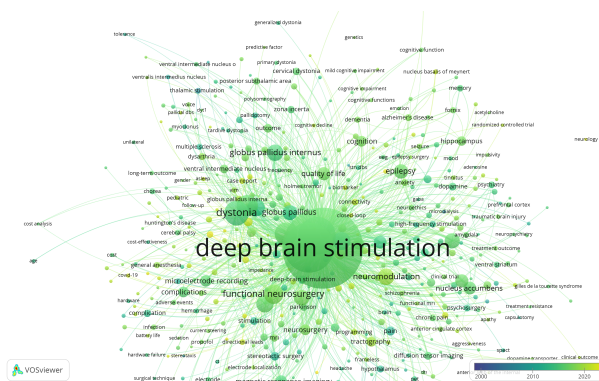


Figure 4: Overlay visualisation of the keywords

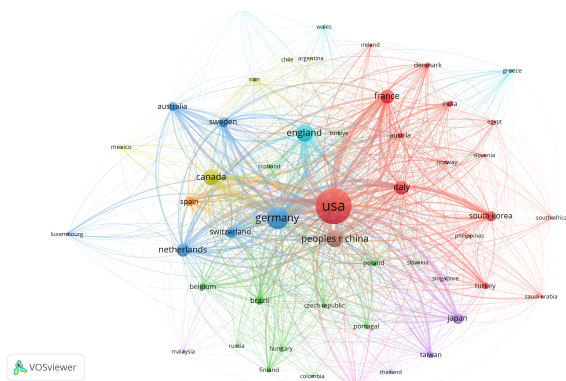


Figure 5: Bibliographic coupling between countries

Table 4: International collaborations

Country	Number of documents	Number of citations	Total link strength
The USA	1779	68036	1744371
Germany	674	26498	981000
England	413	17850	574222
Peoples Republic of China	385	4537	396868
Canada	353	20192	477287
Italy	276	11478	372087
France	274	13003	438914
Netherlands	237	9869	327395
Japan	161	3887	157508
Switzerland	156	5405	275572
South korea	147	2458	182316
Sweden	138	6209	197245
Spain	126	4666	183159
Australia	114	3366	162142
Brazil	104	2257	115707
Belgium	64	2277	74894
Turkey	69	454	73901
Taiwan	59	779	76266
India	52	515	58904
Poland	45	407	51126
Austria	43	4790	88058
Denmark	41	1410	73913
Israel	39	2987	65336
Portugal	34	347	36551
Iran	31	127	28934
Czech Republic	30	367	43081
Finland	30	586	39131
Norway	22	1443	33549
Greece	21	425	20810
Hungary	15	129	16529
Mexico	15	384	12183
Scotland	13	820	16879
Saudi Arabia	12	73	20123
Slovenia	12	111	19590
Luxembourg	11	592	20930
Egypt	10	398	22211
Ireland	10	223	16480
Colombia	9	159	6303
Argentina	8	246	5246
Chile	8	23	5590
Malaysia	8	128	6315
Singapore	8	80	10673
New Zealand	7	102	4532
Philippines	7	42	8899
Russia	7	66	9161
South Africa	7	192	8675
Wales	7	299	6840
Slovakia	6	48	5236
Thailand	5	29	8030

International collaborations Furthermore, Figure 4's overlay illustration provides a concise summary of the temporal dynamics of the most popular keywords throughout time. The visualization's yellow hues indicate keywords that became prominent after 2020, offering insights into new trends and changes in the field's concentration. The temporal component that this dynamic analysis brings to the knowledge of keyword trends provides insightful information about the development of major themes in the field of DBS research.

According to the international collaboration analysis conducted with Vosviewer, the data was as follows. Figure 5 visualizes this data. Researchers from 75 countries contributed to the literature on DBS, with a minimum of 5 published articles per country, resulting in a total of 50 countries. Figure 5 illustrates bibliographic coupling between countries, where countries of the same color indicate collaborative efforts. The sizes of the circles represent the countries with the highest publication rates, and the thickness of the lines indicates the level of collaboration, referred to as Total Link Strength (TLS). table 1 below provides detailed information on the number of documents, citations, and total link strength for each country. table 1 presents information on the collaboration metrics and research output in the field of DBS across different countries. The quantity of documents, citations, and overall link strength are important measures. With 1779 documents, 68036 citations, and a total link strength of 1744371, the United States leads all categories. The People's Republic of China, Canada, Germany, and England are some of the other noteworthy providers.

DISCUSSION

This study analyzes 4,601 articles published in ESCI/ SCIE indexes of Web Of Science database since 2000 DBS, focusing on trends in publishing organizations, countries, funding sources, international collaborations, and trend keywords. The analysis shows a significant increase in scientific output, with an average of 31.9 citations per article. The noticeable increase in publications, which peaked in the active year 2020, is indicative of the DBS domain's growing scholarly production and scientific interest. This trajectory is a useful indicator of the dynamic and changing environment, indicating a more scientific focus on this area. The identified patterns of citations indicate significant patterns of scholarly influence in the field of DBS research. The increasing trend of citations, which peaked in 2021, indicates that these academic publications are becoming more and more well-known and influential. The curated publications' scholarly value and resonance are substantiated by their computed average citations per article (31.9), which reflects their impact on the broader scientific debate. A wide range of subjects are covered by DBS research when the Web of Science data is categorized, with the most common themes being clinical neurology, neurological sciences, and surgery. This broad range of themes highlights the multidisciplinary character of DBS research and its cross-disciplinary applicability in

a number of different medical specialties. Limited bibliometric studies on DBS have been published [14-16], with Hu and colleagues [14] and Mishra et al. [16] identifying the most highly-cited papers on the Web of Science. Other study by Listik et al. [15] have focused on DBS and local field potentials in DBS. The current study focuses on the bibliometric landscape of DBS by analyzing a vast dataset of 4,601 articles, contrasting with Hu et al.'s (2017) [14] focus on the 100 most highly-cited papers. The research provides a more comprehensive understanding of evolving trends in DBS literature, including publication properties, international collaborations, and funding dynamics. The findings reveal a diverse range of citation counts within the dataset, providing insights into the varied impact of DBS literature. The current study also explores thematic trends, interdisciplinary dimensions, and geographical and institutional landscapes shaping DBS research. Advanced bibliometric methods like VOSviewer help identify key keywords and their temporal dynamics, providing a holistic understanding of emerging trends and potential future research trajectories. Essentially, Hu et al. [14] provide a useful overview of the most highly-cited research, but our analysis adds value to the academic conversation by providing a more modern and thorough bibliometric analysis of the DBS literature, covering a wider range of publications and revealing subtle aspects that support a stronger comprehension of the development of the field. As compared to Hu et al.'s [14] reported mean citations per paper (304.15), our results show a wide variety of citation counts within the larger dataset, offering insights into the various effects of DBS literature. Furthermore, our research broadens the scope of the analysis by incorporating subject trends, transdisciplinary aspects, and the institutional and regional contexts that influence DBS research. Advanced bibliometric techniques such as VOSviewer assist the identification of key keywords and their temporal dynamics, which adds to a comprehensive awareness of current trends and possible future research paths in the DBS domain. Our study and Mishra et al.'s investigation [16] aim to identify influential articles in DBS research, but differ in their specific focuses. Our study provides a comprehensive bibliometric analysis of DBS research from 2000 to 2023, including international collaborations and funding sources, while Mishra et al. focus on local field potentials (LFPs) between 2002 and 2019. Both studies highlight the subthalamic nucleus's importance in DBS research, but differ in their approaches to citation trends. Both provide complementary perspectives on the evolving landscape of DBS research. Mishra et al.'s study [16] on DBS LFPs has a high citation count, indicating its impact within their niche. However, our study reveals a diverse range of citation counts within the broader DBS literature, providing a nuanced understanding of the overall impact. Both studies focus on the subthalamic nucleus (STN), highlighting its central role in DBS research. Mishra et al. focus on clinical aspects, highlighting the need for larger patient cohorts and randomized controlled trials. Our study, while not focusing on LFPs, offers a broader view of thematic trends, interdisciplinary dimensions, and international collaborations within the entire DBS literature. Both studies contribute to

a more nuanced understanding of evolving trends, influential works, and potential future research trajectories in the dynamic field of deep brain stimulation. The United States leads in DBS research, followed by Germany and England. The University of Toronto is a key institution, highlighting the importance of academic entities in shaping research dynamics, providing a comprehensive understanding of geographical and institutional factors. Furthermore, by revealing the complex web of international collaborations involving academics from 75 countries, our analysis illuminates the collaborative character of DBS research. This feature extends beyond the geographic analysis that Hu et al. [14] provided, offering a broader perspective on the international cooperative efforts driving the advancement of DBS research. Also the current study explores funding dynamics in the global collaborative ventures of institutions like the US Department of Health, the National Institutes of Health, and Medtronic, highlighting the significant contributions from 75 countries. The analysis of top publishing journals in one topic provides a comprehensive understanding of the research landscape and may help authors for journal selection [12,13,19-20]. The table of top publishing journals in deep brain stimulation (DBS) provides insights into the research landscape's dynamics and influence. It includes the number of publications, category quartile, and Journal Impact Factor (JIF) for each journal. For instance, "STEREOTACTIC AND FUNCTIONAL NEUROSURGERY" has 270 publications but falls into Quartile 4 with a lower JIF. "MOVEMENT DISORDERS" has fewer publications but a higher JIF. Notable journals like "BRAIN" and "NEUROLOGY" are crucial for DBS research. Keywords analysis is a method of examining key terms or concepts in a text to understand a specific topic, identify key terms, and understand emphases. It is particularly useful in scientific research, articles, theses, and literature reviews. The frequency of keywords indicates focus and emphasis on a specific topic. Keyword analysis can also reveal the popularity and trends of specific topics and terms within the literature [12,13,19-20]. The keyword analysis highlights the importance of DBS in addressing various movement disorders and medical conditions. Key keywords include "deep brain stimulation," "parkinson's disease," "subthalamic nucleus," and "dystonia," with terms like "essential tremor," "globus pallidus internus," and "neuromodulation" highlighting diverse aspects of DBS applications. These keywords highlight the relevance of DBS in various medical conditions. Limitations Although this study provides insightful information about the worldwide field of DBS research, some limitations should be noted. First off, depending too much on the Web of Science database runs the risk of bias since it might not include all pertinent papers on the subject. Furthermore, previous or non-traditional contributions may be overlooked as a result of the inclusion criteria, which include removing non-medical papers and concentrating only on studies published after 2000. The fact that the research was limited to English-language publications reduces the generalizability of the results and may cause important insights from non-English literature to be overlooked. A qualitative evaluation of the content and context of the in-

cluded articles is absent from the bibliometric analysis, despite its provision of quantitative trends. Lastly, because contributions from individuals or organizations may not be properly recognized, the collaborative nature of research may not be adequately conveyed.

CONCLUSION

To sum up, this thorough examination of DBS research highlights important patterns and trends between 2000 and 2023. The analysis reveals a notable increase in publications, which peaked in 2020, and a spike in citations that followed, highlighting the field's dynamic progress. Prominent contributions from several nations, establishments, and financial organizations highlight how international DBS research is. The limitations of the study, such as the language and database constraints, point to areas that warrant further investigation. All things considered, these results provide a critical understanding of the wide field of DBS research and lay the groundwork for future inquiries and developments in the field of neuroscience study.

Ethics

As there were no animals or experiments in this study, ethical approval was not required.

Authorship Contributions

These authors contributed equally to this work.

Declaration of competing interest

The authors declare that they have no competing interests

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