Research article

Dysphagia in Parkinson's disease: A bibliometric and visualization analysis from 2002 to 2022

Weiming Sun [a,b,c,**,1], Keqi Wan [a,c,1], Shilin Li [a,c], Guojian Shen [a,c], Xiangli Dong [c,d], Guohua Yu [a,c], Zhen Feng [a,b,e], Chafeng Zheng [a,c,*]

[a] *Department of Rehabilitation Medicine, The First Affiliated Hospital, Jiangxi Medical College, Nanchang University, Nanchang, 330006, China*
[b] *Postdoctoral Innovation Practice Base, The First Affiliated Hospital, Jiangxi Medical College, Nanchang University, Nanchang, 330006, China*
[c] *The First Clinical Medical College, Jiangxi Medical College, Nanchang University, Nanchang, 330031, China*
[d] *Department of Psychosomatic Medicine, The Second Affiliated Hospital, Jiangxi Medical College, Nanchang University, Nanchang, 330006, China*
[e] *Rehabilitation Hospital, Jiangxi Medical College, Nanchang University, Nanchang, 330006, China*

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ABSTRACT

Background: Dysphagia, or difficulty swallowing, is a prevalent complication of Parkinson's disease (PD), which can significantly impair quality of life. Despite the numerous studies on dysphagia in PD published in various journals, there remains a dearth of bibliometric analysis within this domain. This study thus aims to examine the global patterns of research on dysphagia after PD over the past 20 years, employing a visual analysis.
Material and methods: This investigation aimed to gather pertinent publications concerning dysphagia in PD from the SCI-Expanded database of the Web of Science Core Collection (WoSCC), covering the period from 2002 to 2022. To dissect and visually represent the collated corpus, we harnessed the capacities of CiteSpace, VOSviewer and R software for meticulous bibliometric scrutiny.
Results: The bibliometric study encompassed a total of 692 publications. Within the scope of autocratic nations, the USA emerged as the leading country in the quantity of research outputs. The University of Florida stood out as the most prolific academic entity, with Troche MS being the foremost author, contributing to 21 publications. The journal "Dysphagia" featured as the prime venue for publication. Key trending terms identified over the last 20 years include "Parkinson's disease," "dysphagia," "oropharyngeal dysphagia," and "prevalence."
Conclusion: Bibliometric analysis on dysphagia in PD offers a detailed overview of the development of scholarly publications, enabling scholars to grasp the current state of research within their field. It also serves as a benchmark for shaping future research directions.

* Corresponding author. Department of Rehabilitation Medicine, The First Affiliated Hospital, Jiangxi Medical College, Nanchang University, Nanchang, 330006, China.
** Corresponding author. Department of Rehabilitation Medicine, The First Affiliated Hospital, Jiangxi Medical College, Nanchang University, Nanchang, 330006, China.
E-mail addresses: sunweiming@email.ncu.edu.cn (W. Sun), rehabilitation_z@126.com (C. Zheng).
[1] These authors have contributed equally to this work and share the first authorship.

1. Background

Parkinson's disease (PD) stands as the second-most prevalent neurodegenerative condition globally, trailing only Alzheimer's disease [1]. Current estimates indicate that there are 6.1 million patients with PD worldwide, and it will continue to rise as life expectancy increases across the globe [2].

Dysphagia ranks among the predominant complications encountered by individuals with PD. These issues can affect any phase of the swallowing process—oral, pharyngeal, or esophageal—and tend to manifest across all stages of the illness [3]. The causes of swallowing difficulties in people with PD are not entirely understood, but what is known suggests it's a very complex issue with a lot of variability from one patient to another. Studies have pointed out that this might have something to do with a decrease in the activity of dopamine in certain areas, as well as issues with the nerves and muscles that could be related to the disease [4]. PD pathology can significantly disrupt central nervous system operations, which in turn can impact the gastrointestinal system, including the esophagus and stomach. These disturbances are frequently linked to the development of dysphagia or related swallowing disorders [5].

It is worth noting that the impact of dysphagia on individuals with PD is notably detrimental, influencing patient outcomes. Early dysphagia detection rates in PD are disconcertingly low, hindering prompt treatment [6]. This condition also leads to significant health issues such as weight loss, dehydration, and malnutrition. Moreover, it limits social interaction, considerably diminishing the patients' quality of life (QoL) [7]. Furthermore, dysphagia-related aspiration pneumonia remains a primary reason for hospital admissions among PD patients [8,9], often leading to serious health complications and potentially fatal outcomes [10].

Because of the high incidence and serious consequences, an ever-increasing cohort of researchers has conducted studies on dysphagia in PD. While some researchers have attempted to summarize the specific advances in diagnosis and treatment [11,12], there remains a conspicuous gap in comprehensively and quantificationally concluding the research development in this domain. Therefore, this hinders a meticulous exploration, identification, and analysis of the current trends in this field. In pursuit of filling recognized research voids, this investigation leverages bibliometric techniques and visualization tools to quantitatively review and depict the body of literature surrounding PD and associated swallowing disorders from 2002 to 2022, with the objective of outlining prevailing trends and forecasting upcoming research pathways.

As statistical science progresses, bibliometric analysis has become increasingly prevalent in examining current scientific research results and analysing emerging trends. Through visualized networks and in-depth evaluations, researchers can discern publishing trends, anticipate future developments, and pinpoint hot topics within specific areas of study [13]. To address identified research gaps, this study employed bibliometric analysis and visual network techniques to quantitatively assess and visualize the literature on PD-related swallowing disorders, with the objective of outlining prevailing trends and forecasting upcoming research pathways. To our knowledge, it's the inaugural comprehensive bibliometric review focused on this topic, intending to guide both research and clinical approaches. This analysis assists researchers in pinpointing field hotspots and aids clinicians in shaping evidence-based intervention strategies.

2. Material and Methods

2.1. Data collection

For its comprehensive coverage and credibility, Web of Science Core Collection (WoSCC) was selected as the primary source for obtaining global academic information for the bibliometric analysis in this study [14]. In this study, all published literature on dysphagia in PD was extracted from the SCI-Expanded database, covering the period from October 1, 2002 to October 1, 2022. The database was updated as of March 4, 2023, guaranteeing that the data pool for this study is both contemporary and representative of the most recent scholarly contributions to this domain. The Advanced Search function of the database was employed for literature retrieval, the searching terms can be seen in Supplementaries, and the screening process is as Supplementary Fig. 1. During the search process, the inclusion and exclusion criteria were established.

Inclusion criteria: (1) participants needed a Parkinson's disease diagnosis; (2) research specifically addressed swallowing disorders; (3) The article type was limited to original articles or reviews; (4) The articles written in English language were considered.

Exclusion criteria: (1) The articles that did not pertain to dysphagia in Parkinson's disease were excluded; (2) Non-article formats, such as letters, were excluded; (3) Articles written in languages other than English were excluded.

With this search strategy, relevant studies were found and reviewed according to the title and abstract by two independent evaluators (WMS and KQW), to include only those that met the eligibility criteria of the study.

2.2. Bibliometric analysis and visualization

The preliminary data collection from WoSCC was transferred to Microsoft Excel 2016 for organization, then examined using CiteSpace (version 6.1.R6), VOSviewer (version 1.6.19), and the "bibliometrix" R package. These tools facilitated the co-occurrence analysis and helped visualize the collaborative networks among authors, institutions, nations, and keywords [15].

CiteSpace is a software tool widely used in bibliometrics to visualize trends and patterns in research areas [16,17]. By utilizing various dynamic network analysis techniques, CiteSpace can accurately determine a particular scientific field's critical studies, hot research topics, tendencies, and frontiers [18,19]. Via CiteSpace, we conducted a cluster analysis of relevant co-cited references and identified the co-cited references with the strongest burst intensity. The burst intensity, calculated by CiteSpace, is based on the mapping function between the knowledge domain, conceptualized as the research frontier, and its intellectual base [20]. The settings

for this analysis in CiteSpace were specified to cover October 2002 to October 2022, dividing the period into annual segments.

VOSviewer, which enables the creation and analysis of bibliometric networks, can extract various types of bibliographic networks from bibliographic databases [21]. Importantly, VOSviewer can be downloaded and can be used freely for any purpose. Via VOSviewer, we created a co-occurrence network of relevant countries, authors, and keywords.

The Naples University in Italy has developed an open-source R package called Bibliometrix to conduct in-depth bibliometric and scientometric analyses. It is an accessible tool that can be used by anyone who requires it [21]. A global distribution network of scholarly articles concerning dysphagia in PD was constructed using bibliometrics in this investigation.

3. Results

3.1. Overall performance of global literature

692 papers satisfied the designated retrieval criteria, as shown in Supplementary Fig. 1. The yearly publication count is illustrated in Fig. 1, whereby the overall trend exhibits a consistent, gradual increase from 2002 to 2020, before plateauing in recent years. These 692 articles have garnered a staggering total of 19,297 citations, indicating an average of 35.64 citations per article.

3.2. Analysis of leading journal, countries/regions, institutions and authors

Literature on dysphagia in PD research has been dispersed across 260 journals, with the leading 15 outlined in Supplementary Table 1. With the highest number of contributions (63 papers), the journal "Dysphagia" leads, followed by "Parkinsonism & Related Disorders" (52 articles) and "Movement Disorders" (45 articles).

As for Countries/Regions, the USA stood at the forefront with 219 papers, followed by Germany with 83 papers, and England with 73 publications. Supplementary Table 2 elaborates on this data. These contributions were analyzed to construct a collaborative network among nations as shown in Fig. 2.

Fig. 3 offers a visual representation of the 15 most prominent institutions, with University of Florida (36 papers), Columbia University (21 papers) and University of Wisconsin System (20 papers). More details are provided in Supplementary Table 3.

As seen in Fig. 4, the author's collaboration network and author citations of dysphagia in PD were screened. In terms of frequencies, Troche, Michelle S. (21 papers), Warnecke, Tobias (18 papers) and Okun, Michael S. (17 papers) emerged as the most prolific authors over the past several decades. In terms of citation influence, Okun, Michael S. (824 co-citations), Troche, Michelle S. (576 co-citations), and Warnecke, Tobias (568 co-citations) occupied the top spots, indicating their substantial academic influence. For further specifics, see Supplementary Table 4.

3.3. Analysis of Co-cited references and burst references

Table 1 enumerates the ten most-cited papers from the set of 692 we identified. The leading paper (67 citations)by Inga Suttrup and the team presented a detailed examination of the epidemiology, underlying physiological changes, diagnostic protocols, and treatment options for dysphagia in PD [4]. Subsequent research (42 citations) led by Christina Pflug et al. outlined the widespread nature of dysphagia in individuals with Parkinson's disease, noting critical symptoms such as penetration and aspiration [3]. In another study (42 citations), J G Kalf and co-authors provided an analysis of the rate of occurrence of dysphagia among those suffering from Parkinson's disease [22]. From the contents of the above several studies, it can be seen that the epidemiology of dysphagia in PD is still the focus of scholars.

We utilized the CiteSpace clustering function to cluster the co-citation literature and generated a Fig. 5 visual map. Through cluster analysis, we separated the collected literature into 24 distinct clusters, which were found to be closely interconnected and
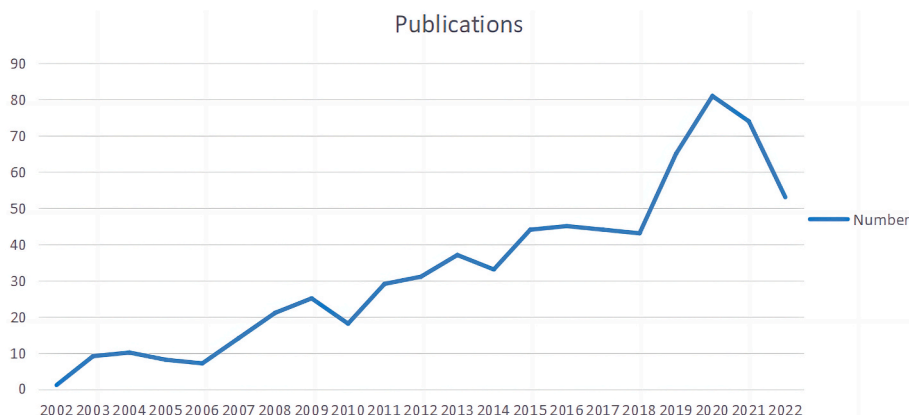

Fig. 1. | Depicts the yearly trends in Parkinson's dysphagia research publications. The data for 2022 is not complete.
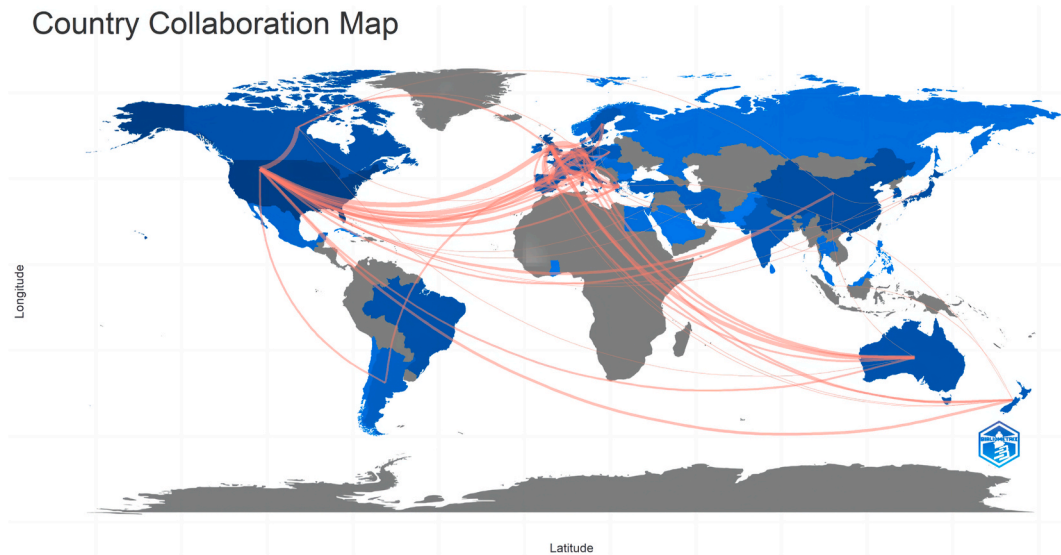
Country Collaboration Map

Fig. 2. | Country/region collaboration map. Deeper blues signal more extensive collaboration, with thicker lines indicating stronger collaborative ties.
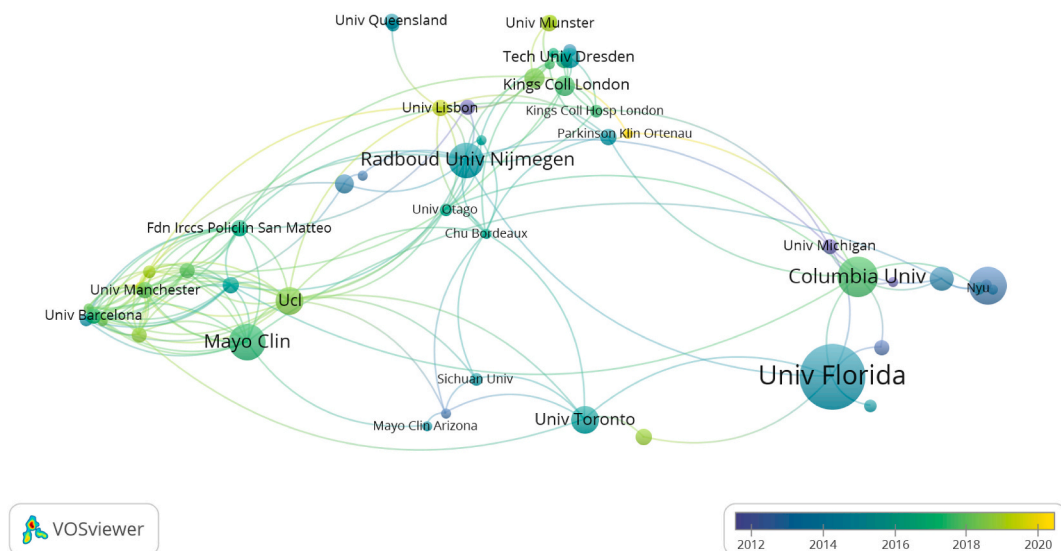

Fig. 3. | Institution collaboration map. The size of each institution's font corresponds with its publication count. Line thickness illustrates levels of collaborative efforts among institutions in PD dysphagia research; colors within the circle indicate different periods. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

collaborative in specific domains. The cluster of research on "aging" had previously garnered greater focus, but lately, researchers have shifted their focus towards "aspiration," "gastrointestinal," and "multiple system atrophy." The foremost cluster was named #0 ″aspiration″, followed by #1 ″caudal zona incerta″, #2 ″swallowing″, and #3 ″swallowing disorder″. Other significant groups, such as the "gastrointestinal," "gastrointestinal symptoms," "multiple system atrophy," and "aging" clusters, may have reflected a transition point in research.

The literature cited over the past three years has been visually mapped and clustered into 11 groups using CiteSpace's cluster analysis, as depicted in Fig. 6. The most prominent cluster was focused on Parkinson's disease (#0), followed by oropharyngeal dysphagia (#1), drooling (#2), and constipation (#3). Other noteworthy clusters included motor speech disorders, telerehabilitation, progressive supranuclear palsy, and rat. Combined with the findings from Fig. 5, it is evident that while the aging cluster has been extensively studied, recent research has shifted towards aspiration, gastrointestinal issues, and multiple system atrophy.

Fig. 7 displays a list of the top 20 references with the highest burst intensity, arranged chronologically. Among them, the study [23] conducted by Claire Takizawa et al., published in Dysphagia in 2016, exhibited the strongest burstiness (strength = 19.67) between
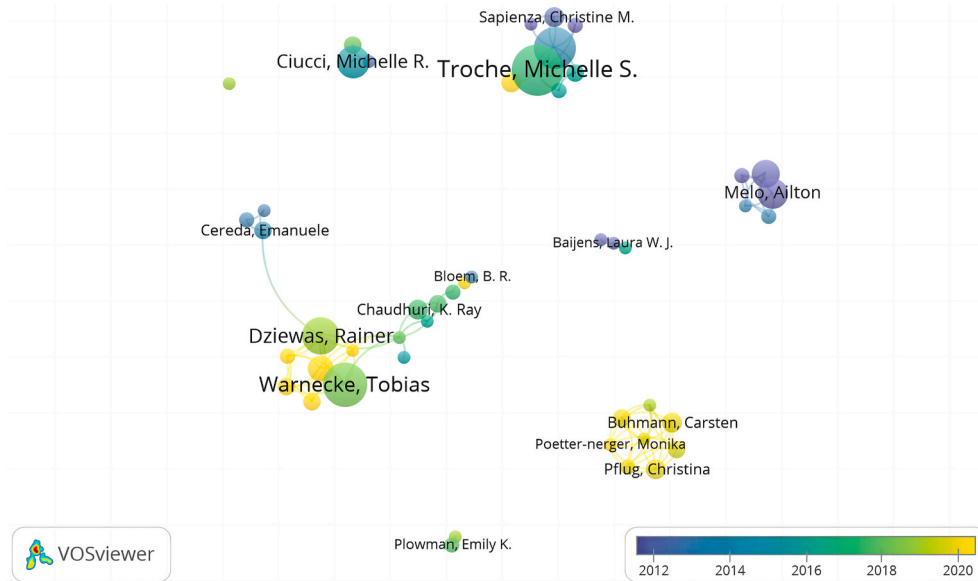
Fig. 4. | Author collaboration map. The size of each author's font correlates with their publication numbers. Line thickness shows the intensity of collaboration among authors involved in PD dysphagia research; varying colors represent different timeframes. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 1
| Top 10 cso-cited references related to dysphagia in Parkinson's disease.

Ranking	Author	Source Title	Cited	Year	DOI
1st	Suttrup I	DYSPHAGIA	67	2016	10.1007/s00455-015-9671-9
2nd	Pflug C	DYSPHAGIA	42	2018	10.1007/s00455-017-9831-1
3rd	Kalf JG	PARKINSONISM RELAT D	42	2012	10.1016/j.parkreldis.2011.11.006
4th	Fasano A	LANCET NEUROL	35	2015	10.1016/S1474-4422(15)00007-1
5th	Warnecke T	PARKINSONISM RELAT D	26	2016	10.1016/j.parkreldis.2016.04.034
6th	Takizawa C	DYSPHAGIA	24	2016	10.1007/s00455-016-9695-9
7th	Cereda E	PARKINSONISM RELAT D	21	2014	10.1016/j.parkreldis.2014.09.031
8th	Plowman-Prine EK	MOVEMENT DISORD	20	2009	10.1002/mds.22617
9th	Baijens LWJ	DYSPHAGIA	19	2009	10.1007/s00455-008-9180-1
10th	van Hooren MRA	PARKINSONISM RELAT D	18	2014	10.1016/j.parkreldis.2014.03.026

2018 and 2022. The research team performed a comprehensive assessment of the complications associated with dysphagia across various diseases, while also delivering an endorsement and urging for additional dysphagia research.

3.4. Analysis of keywords and hotspots

The collaboration network of dysphagia in PD encompasses a total of 2622 keywords, as depicted in Fig. 8. An analysis of the citations reveals that "dysphagia" is the most frequently referenced keyword, indicating its significance as a hotspot for dysphagia in the context of PD. Additionally, "dysphagia," "oropharyngeal dysphagia," and "prevalence" are also recurrently cited as key terms within the period spanning from 2002 to 2022 pertaining to dysphagia in PD.

A network diagram was constructed to illustrate clusters of keywords (as shown in Supplementary Fig. 2), with each node representing a significant keyword as identified by Citespace. The top ten keyword clusters were #0 deglutition disorders, #1 alpha synuclein pathology, #2 disease duration, #3 botulinum toxin, #4 pneumonia, #5 deep brain stimulation, #6 multiple system atrophy, #7 Parkinsons disease, #8 drug-induced dysphagia and #9 hla dr.

The analysis of information on the keyword "transform" from 2002 to 2022 reveals a fluctuation in its frequency over time. This observation indicates a shift in the research focus over the years, as depicted in Supplementary Fig. 3.

4. Discussion

Dysphagia is commonly observed in patients with PD [24]. By conducting a bibliometric analysis, we summarize the work of prominent scholars and research groups in this field. This study encompasses 692 research papers obtained from WoSCC and marks the initial utilization of bibliometric and visual techniques with dysphagia in PD.
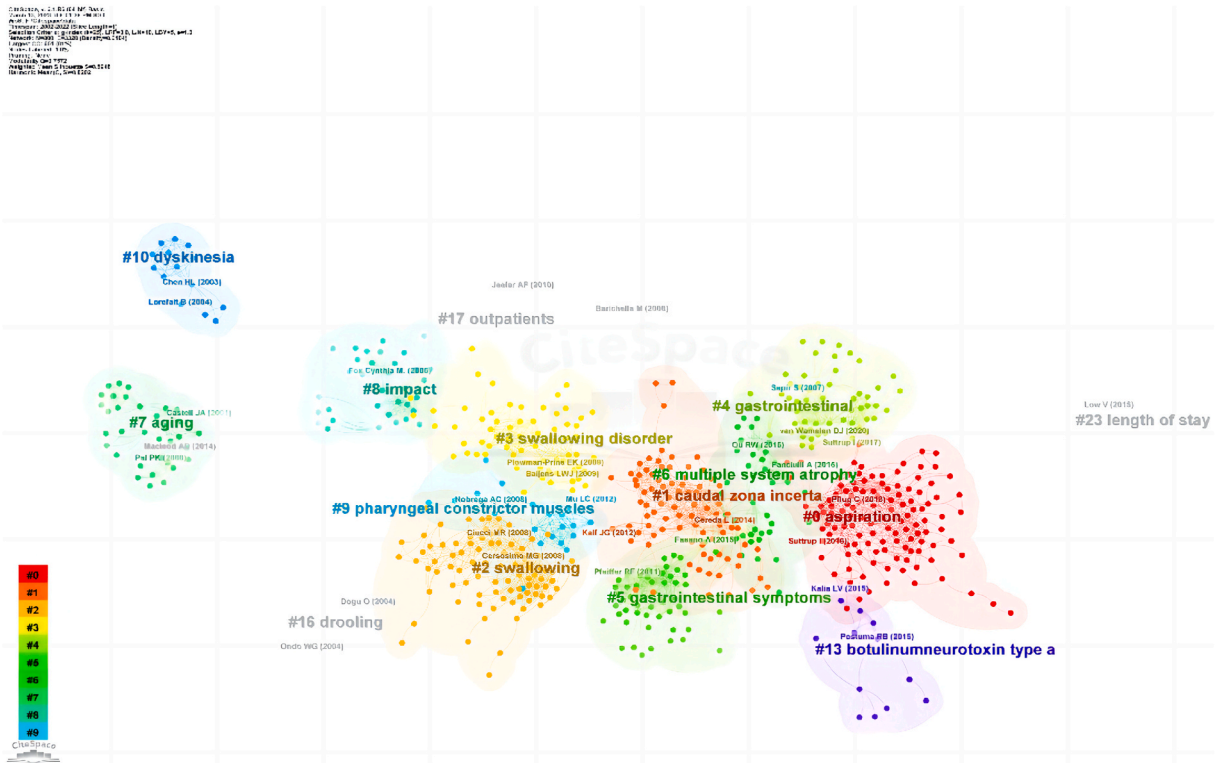
Fig. 5. | The network of co-cited reference clusters (2002–2022). Each color represents a cluster. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

4.1. Trend overview of the development of dysphagia in PD

As depicted in the illustrated graphs, there has been a significant surge in published works between October 1, 2002 and October 1, 2022, except for 2021. This revealed that the demand for this area of study is undergoing a period of expansion.

According to an analysis of national contributions, approximately 56 countries have published research papers on dysphagia in PD. The USA stood out as the primary contributing country with 219 published works in this domain. The four leading nations in this research arena were developed countries situated predominantly in Europe and America, where a large number of researchers interested in this field and adequate funding for scientific research may have contributed to their research output. However, of the top 10 nations, only Japan, China, and South Korea hail from Asia, and these countries had comparatively fewer publications, despite Asia being home to approximately 60 % of the global population [25]. Reduction in publications for the last two years may be due to the outbreak of the global COVID-19 pandemic. This has led to a general slowdown in scientific progress, including research into PD and its associated symptoms, such as dysphagia. Additionally, during the pandemic, scientific resources and funding were likely prioritized for COVID-19 research and its implications, resulting in diminished investment in other medical research areas. Consequently, this shift may have directly impacted the volume of literature on dysphagia associated with PD, observed as a decrease over the past two years. As the situation with the pandemic gradually comes under control, it is expected that literature output in this research field will return to normal levels progressively.

Investigation in the realm of PD typically received support from national science foundations and leading international pharmaceutical corporations. This suggests that scientific and technological research in this field is given significant attention at the national level. The related research was primarily published centrally in a few journals, with dysphagia being the most prolific publisher, followed by Parkinsonism & Related Disorders, Movement Disorders, and the Journal of Parkinson's Disease, among others. Furthermore, an average citation rate of 33.98 per paper reflects the international standing and impact of researchers in this arena, suggesting that the research produced is not only high-caliber but also embodies critical scientific discoveries.

As for academic institutions, the University of Florida was the most influential entity (with 36 publications), substantially driving the advancement of research in this area. It had been observed that the research teams operating on a global scale exhibited distinct geographical characteristics, with a predominant presence of teams hailing from American and European entities. Therefore, it is recommended that efforts be made to enhance communication and collaboration with these international research teams to promote the research level of backward areas in this field. Regarding research teams or researchers, Mulhall John P emerged as the most prolific author and researcher in the field.
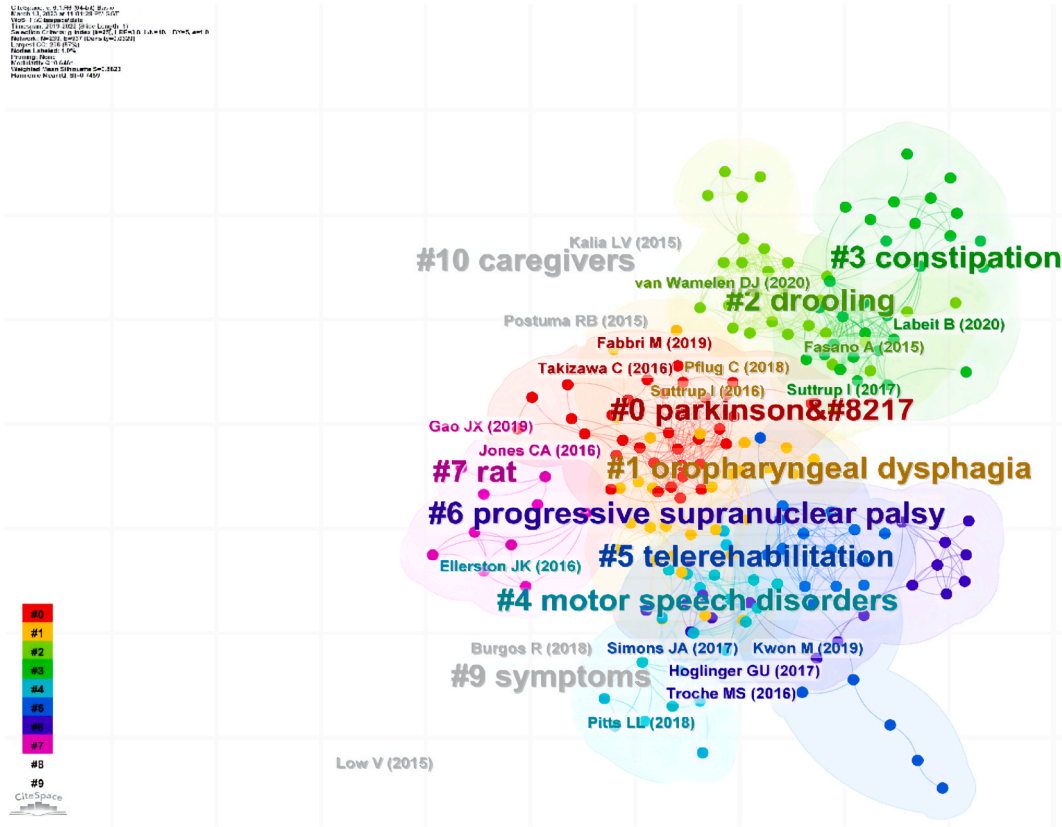
Fig. 6. | The network of co-cited reference clusters (2019–2022). Each color represents a cluster. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Top 20 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	2002 – 2022
Potulska A, 2003, PARKINSONISM RELAT D, V9, P349, DOI 10.1016/S1353-8020(03)00045-2, DOI	2003	6.28	2006	2008	
Miller N, 2006, AGE AGEING, V35, P614, DOI 10.1093/ageing/afl105, DOI	2006	7.87	2007	2011	
Troche MS, 2008, DYSPHAGIA, V23, P26, DOI 10.1007/s00455-007-9090-7, DOI	2008	8.02	2009	2013	
Cersosimo MG, 2008, MOVEMENT DISORD, V23, P1065, DOI 10.1002/mds.22051, DOI	2008	7.07	2009	2013	
Plowman-Prine EK, 2009, MOVEMENT DISORD, V24, P1352, DOI 10.1002/mds.22617, DOI	2009	9.27	2010	2014	
Baijens LWJ, 2009, DYSPHAGIA, V24, P91, DOI 10.1007/s00455-008-9180-1, DOI	2009	8.95	2010	2013	
Miller N, 2009, J NEUROL NEUROSUR PS, V80, P1047, DOI 10.1136/jnnp.2008.157701, DOI	2009	6.93	2010	2014	
Troche MS, 2010, NEUROLOGY, V75, P1912, DOI 10.1212/WNL.0b013e3181fef115, DOI	2010	7.75	2012	2015	
Kalf JG, 2012, PARKINSONISM RELAT D, V18, P311, DOI 10.1016/j.parkreldis.2011.11.006, DOI	2012	17.08	2014	2017	
Cereda E, 2014, PARKINSONISM RELAT D, V20, P1382, DOI 10.1016/j.parkreldis.2014.09.031, DOI	2014	7.78	2015	2019	
Mu LC, 2013, J NEUROPATH EXP NEUR, V72, P614, DOI 10.1097/NEN.0b013e3182965886, DOI	2013	7.03	2015	2018	
Pfeiffer RF, 2011, PARKINSONISM RELAT D, V17, P10, DOI 10.1016/j.parkreldis.2010.08.003, DOI	2011	6.73	2015	2016	
van Hooren MRA, 2014, PARKINSONISM RELAT D, V20, P800, DOI 10.1016/j.parkreldis.2014.03.026, DOI	2014	6.66	2015	2019	
Srivanitchapoom P, 2014, PARKINSONISM RELAT D, V20, P1109, DOI 10.1016/j.parkreldis.2014.08.013, DOI	2014	7.75	2016	2019	
Fasano A, 2015, LANCET NEUROL, V14, P625, DOI 10.1016/S1474-4422(15)00007-1, DOI	2015	11.88	2017	2020	
Suttrup I, 2016, DYSPHAGIA, V31, P24, DOI 10.1007/s00455-015-9671-9, DOI	2016	19.67	2018	2022	
Warnecke T, 2016, PARKINSONISM RELAT D, V28, P100, DOI 10.1016/j.parkreldis.2016.04.034, DOI	2016	9.11	2018	2022	
Takizawa C, 2016, DYSPHAGIA, V31, P434, DOI 10.1007/s00455-016-9695-9, DOI	2016	8.4	2018	2022	
Pflug C, 2018, DYSPHAGIA, V33, P41, DOI 10.1007/s00455-017-9831-1, DOI	2018	14.14	2019	2022	
Hoglinger GU, 2017, MOVEMENT DISORD, V32, P853, DOI 10.1002/mds.26987, DOI	2017	6.07	2019	2022	

Fig. 7. | Illustrates the top 20 most significant citation bursts in the co-cited reference network.
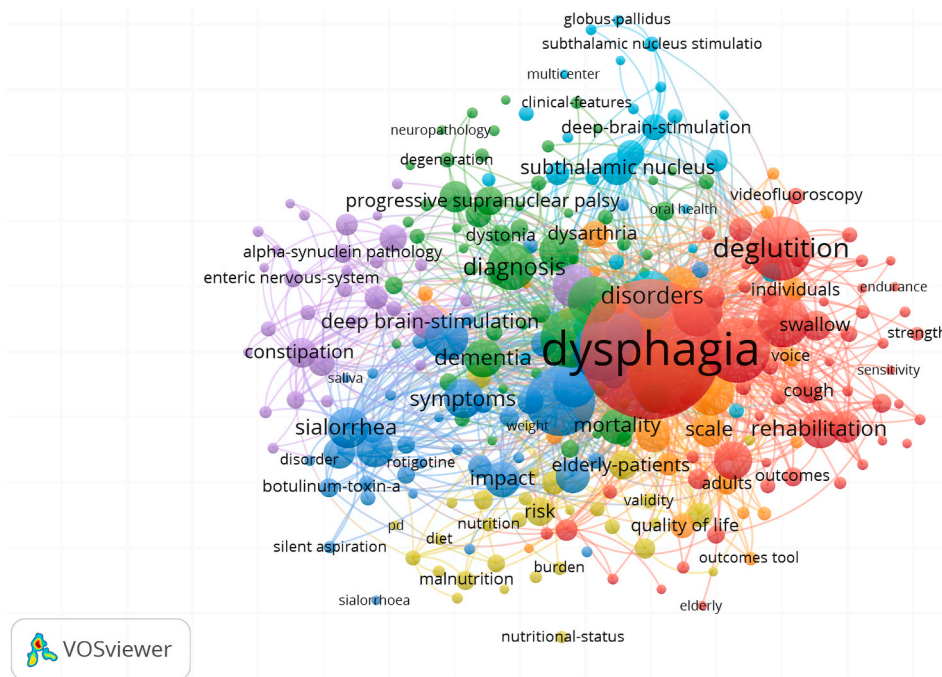
Fig. 8. | keywords collaboration map. The size of the keyword fonts denotes the number of related articles. Line thickness signifies the strength of associations between keywords in PD dysphagia research; uniform color suggests they belong to the same cluster, with brighter tones indicating more active research areas.(For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

4.2. Research hotspots and future trends

The co-occurrence analysis of keywords pointed to 'Parkinson's disease,' 'dysphagia,' 'oropharyngeal dysphagia,' and 'prevalence' as the terms most frequently appearing in parallel, signaling a research concentration on the effects of dysphagia among Parkinson's disease patients. These keywords, occupying central positions within the network, underline the main focal points within this research domain. Our timeline visualization of keyword clusters demonstrates the progression of research themes, transitioning from early investigations on botulinum toxin to more recent topics such as progressive supranuclear palsy. These results show the hot changes in the field of Dysphagia in PD in the past and also point to future research trends, as follows.

(I) Alpha synuclein pathology: Our inquiry found that the cluster related to alpha synuclein pathology encompasses keywords such as "misfolding," "aggregation," "neurodegeneration," and "Lewy bodies," indicating a focus on the alpha synuclein pathology's role in PD development and progression. The increasing frequency of this cluster since 2017 suggests that it is gaining more attention in the field, getting the researchers highly interested [26–28]. This growing interest suggests a key area of research into the molecular mechanisms of alpha-synuclein aggregation and its impact on neural circuits related to swallowing, pointing towards potential novel therapeutic approaches for PD and its symptoms such as dysphagia. The overlap of this cluster with "neurological diseases" and "treatment" indicates active exploration of targeted treatments for alpha-synuclein pathology. Addressing these complexities requires a multidisciplinary approach, integrating neuroscience, biochemistry, pharmacology, and more. In future studies, elucidating the molecular mechanisms driving the aggregation of α -synaptic nuclear proteins and their effects on the neural circuits involved in swallowing offers a promising avenue for revealing new therapeutic targets for the remedies for dysphagia in PD.

(II) Disease duration: Using keyword co-occurrence analysis, our research has divulged that "disease duration" is a pivotal subject in PD research concerning dysphagia. This term is situated within the same cluster as other significant terms like "Parkinson's disease," "dysphagia," "prevalence," and "oropharyngeal dysphagia," indicating that the length of time an individual has had PD is a crucial determinant of dysphagia's onset and progression. Our keyword cluster timeline map suggests that the cluster connected to disease duration has been a consistent subject in PD research since 2014. This implies that scientists recognize the gravity of disease duration in the development and severity of the complication. Dysphagia in PD can manifest at any stage of the sickness, including preclinical and prodromal stages, rather than being limited to the late stages [29]. Initially, swallowing issues in PD are often not noticed because symptoms are not obvious. However, as the disease progresses, patients may face problems like delayed swallowing, breathing in food, regurgitation, leaving food in the mouth, and unusual swallowing motions [30]. The keyword cluster linked to disease duration is not limited to dysphagia, but also encompasses other relevant keywords like "age," "neurodegenerative diseases," and "clinical features." This indicates that researchers are also delving into the impact of disease duration on other clinical features and neurodegenerative diseases that are associated with PD. According to

associated factors study, the occurrence of dysphagia in PD is connected with a longer disease duration, and it contributing to dysphagia may be the result of a combination of factors [31]. Therefore, it is crucial to fully comprehend the dynamic interplay between disease duration and dysphagia to develop an all-sided understanding of the dysfunction. Prospective studies should strive to undertake longitudinal studies that track the changes in swallowing function over time in patients with PD. Such investigations could shed light on the underlying factors contributing to the progressive deterioration of swallowing function, including aging, disease severity, and other clinical factors. The elucidation of these complex and multifaceted processes could pave the way for the development of personalized interventions for dysphagia that consider individual patients' unique disease trajectories.

(III) Botulinum toxin: Our investigation reveals that the botulinum toxin keyword cluster has been a crucial and perplexing research hotspot in dysphagia related to PD. It is a well-established and efficient treatment option for oropharyngeal dysphagia, and numerous studies have demonstrated its efficacy. The use of botulinum toxin has now expanded to include neurogenic dysphagia. Previous studies have used different doses of botulinum toxin for neurogenic dysphagia, all of which have received some degree of efficacy, and no side effects have been observed [32,33]. The administration of botulinum toxin into the salivary glands has shown efficacy in treating sialorrhea associated with dysphagia in patients with PD [34]. The prevailing evidence supporting its application for PD dysphagia primarily stems from open-label studies, and there is a scarcity of randomized controlled trials offering a high level of evidence [35]. Moreover, the latest studies indicated that the benefits of botulinum toxin treatment may be temporary, and repeated injections may be necessary over time [6]. Therefore, further studies are needed to provide definitive evidence of efficacy.

To fully capitalize on the potential benefits of this therapeutic approach, future research should focus on elucidating the optimal dosing and administration of botulinum toxin for dysphagia, as well as its long-term effects on swallowing function and quality of life. Such investigations would require a multidisciplinary approach that integrates a diverse range of scientific disciplines, including neurology, pharmacology, and gastroenterology. The identification of evidence-based guidelines for botulinum toxin use in managing PD dysphagia would represent a significant advance in the field of PD research, as it would enable clinicians to tailor their treatment strategies with guidelines to customize treatment plans for their patients' specific needs. The potential benefits of such an undertaking are vast and far-reaching, as this advancement could potentially lead to more precise and targeted interventions for dysphagia.

(IV) Deep brain stimulation: Regarding deep brain stimulation (DBS), our research identified an active cluster of keywords associated with this intervention, increasingly recognized in the exploration of PD dysphagia.

DBS, which entails the implantation of electrodes to stir targeted brain regions with electrical impulses, has shown promise for alleviating PD's motor symptoms. The DBS keyword cluster intersects with other pertinent keywords such as "swallowing function," "long-term outcomes," and "subthalamic nucleus," signifying researchers' growing interest in exploring the effects of DBS on dysphagia and the mechanisms by which it may improve swallowing function in individuals with PD. Bursting with perplexing possibilities, this dynamic field of research offers a glimmer of hope for those seeking new therapeutic approaches to manage PD and its dysfunction, including dysphagia. However, there is no consensus on whether deep brain stimulation can be an effective treatment for dysphagia, detailed information regarding the impact of DBS on dysphagia in PD patients is still being investigated [36,37]. Research studies have indicated that subthalamic nucleus stimulation with low-frequency stimulation (i.e., 60Hz) may provide benefits for patients with frozen gait-related swallowing dysfunction. Conversely, high-frequency stimulation's effects on dysphagia are complex. While it may lead to a short-term reduction in aspiration rates, long-term observation is necessary to substantiate this notion [37].

To fully capitalize on this potential, continued research is necessary to find the most suitable candidates for DBS and evaluate the sustained impacts of this treatment on swallowing function in PD patients. Also, future research should strive to elucidate the optimal parameters for deep brain stimulation that can effectively improve swallowing function. Such investigations would require a multidisciplinary approach that integrates a diverse range of scientific disciplines, including neurology, neurosurgery, and biomedical engineering, among others. The identification of evidence-based guidelines for DBS usage in the management of dysphagia in PD would represent a significant advance in PD research, as it would promote the application of neuroregulatory techniques in dysphagia of PD.

(V) Pneumonia: This keyword cluster underscores the paramount importance of preventing pneumonia in patients with dysphagia in PD. To achieve this goal, future research should delve deeper into the intricate mechanisms, risk factors, prognosis, prevention and rehabilitation measures. Such studies would require a comprehensive and multidisciplinary approach that integrates a wide range of scientific disciplines, including respiratory physiology, immunology, and nutrition. Armed with this knowledge, researchers could develop targeted interventions tailored to individual patients' unique needs and characteristics, reducing the incidence of aspiration pneumonia and its associated complications. These measures could include respiratory muscle training, postural adjustments, and dietary modifications etc. The ultimate goal of such an undertaking would be to improve the quality of life for patients with dysphagia in PD, reducing their risk of developing pneumonia and other life-threatening complications.

4.3. Limitation

It is crucial to bear in mind that the analysis presented in this study is predicated solely on articles found within the WoSCC

database, which may not offer a comprehensive representation of the existing literature. Moreover, many of the studies included in this analysis may require follow-up updates, as they tend to cite prior studies on the same cohort. It's worth noting that the research results generated by this study are produced by software algorithms, and thus are subject to potential bias. Machine algorithms, while powerful, are not as astute as the human mind in problem-solving and may not always produce accurate results. Nevertheless, despite these limitations, this study provides valuable discernment into the prevalent trends in PD dysphagia research and serves as a clarion call for further investigation into this pressing and complex issue.

5. Conclusion

By bibliometrics and visual analysis methods, this study summarized the global research trend of PD dysphagia in the past 20 years from the aspects of papers, authors, journals, countries/regions, research topics etc. The United States has emerged as a powerhouse in dysphagia research, producing the most papers. The physiological and pathological mechanism of Dysphagia in PD and treatment methods are the hot trend of future research. This study provides strategic references and points out the direction for future evolution in this domain.

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Data availability statement

Data will be made available on request.

Ethics statement

Review and/or approval by an ethics committee was not needed for this study because the research did not involve experimentation on animals or include human subjects.

Informed consent was not required for this study because the research did not involve experimentation on animals or include human subjects.

CRediT authorship contribution statement

Weiming Sun: Writing – review & editing, Writing – original draft, Project administration, Funding acquisition. **Keqi Wan:** Writing – review & editing, Writing – original draft, Visualization, Data curation, Conceptualization. **Shilin Li:** Writing – original draft, Visualization. **Guojian Shen:** Validation, Formal analysis. **Xiangli Dong:** Software, Methodology. **Guohua Yu:** Writing – review & editing, Data curation. **Zhen Feng:** Writing – review & editing. **Chafeng Zheng:** Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e30191.

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