Journal of Public Health
https://doi.org/10.1007/s10389-024-02308-w

REVIEW ARTICLE

Economic burden of Parkinson's disease and research trends: a bibliometric analysis

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Received: 25 January 2024 / Accepted: 25 May 2024

Abstract

Background Parkinson's disease (PD) is a neurodegenerative disorder associated with a range of motor and non-motor symptom leading to progressive disability that significantly impacts on health related-quality of life (HRQoL) and imposes a substantial economic burden. The overall trend and impact of research production on the economic burden of PD have not yet been documented. In this study, the objective is to describe, map and analyse the evolution and trend of research on the economic burden in PD. Therefore, the initial research questions were: (1) what are the main research keywords on costs in the field of Parkinson's disease? and (2) how do an author's studies on the economic burden and costs of Parkinson's disease influence scientific production?

Methods The data used were retrieved from the Web of Science over the past 25 years, from 1997 to 2022. A bibliometric analysis was performed on the basis of the number of articles, citations, published journals, authors, countries scientific production and keywords plus.

Results A total of 140 articles that met the criteria were collected and analysed, covering 736 authors, 41 journals and 34 countries. The most productive country was the United States of America (80.71%) and, among the journals, the Movement Disorders journal was the one with the largest growth ($n=27$). According to the thematic map, the terms "quality of life", "impact" and "illness" were considered as having a high level of centrality, a moderate density and a high frequency. In addition, the terms "quality-of-life", "impact" and illness were the most relevant words.

Conclusions This study provides an overview of global research trends on the economic burden of PD.

Keywords Bibliometric analysis · Economic burden · Parkinson's disease · Quality of life

Introduction

Parkinson's disease (PD) is a neurodegenerative disorder that mainly affects people over the age of 60 (de Lau and Breteler 2006). The global prevalence of PD was over 6 million between 1990 and 2016 and is expected to double in the next generation owing to the aging population and longer life expectancy (Ray Dorsey et al. 2018). PD is associated with a range of motor and non-motor symptoms that lead to progressive disability and severe complications, factors that have a significant impact on HRQoL (Kadastik-Eerme et al. 2015; Martinez-Martin et al. 2011a, b; Rosqvist et al. 2021; Sanchez-Luengos et al. 2022; van Uem et al. 2016) and increase symptom burden (Armstrong and Okun 2020). These symptoms and their treatments enforce a significant burden not only for patients but also for caregivers by reducing HRQoL Corallo et al. 2017; Grün et al. 2016; Kruse et al. 2021), as well as for society as a whole (financially,

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Published online: 15 June 2024

socially or psychologically (Bovolenta et al. 2017) and for the healthcare system (Dodel et al. 2021). The rising trend in the global burden of PD indicates that PD is a growing challenge for global health (Ou et al. 2021) and the burden on society is also likely to increase owing to the rising prevalence of the disease combined with population aging (Bohingamu Mudiyanselage et al. 2017). Thus, from an economic perspective, total costs will therefore increase with the progression and severity of the disease. In advanced stages of the disease, independent predictors of total costs are disease duration and age, with disease duration being the main independent predictor of direct costs and age being the independent predictor of indirect costs. Motor symptoms, cognitive impairment and pain are main predictors of costs (Afentou et al. 2019; Bohingamu Mudiyanselage et al. 2017; Kruse et al. 2021; Martínez-Martin et al. 2015). In the United Kingdom (UK), the average costs attributable to PD rose from USD 3716 per patient (approx. €3480) in the first year to USD 6021 per patient in year 10 (approx. €5640) (Weir et al. 2018). In the United States of America (USA), the economic burden of PD exceeds USD14.4 billion or €13.5 billion (approx. USD22,800 – €21,313—per patient) (Kowal et al. 2013). In Spain, the total cost of PD per patient increased over time, from €2082.17 per trimester in year 1 to €4008.60 per trimester in year 4 (Martínez-Martin et al. 2015). In Portugal, a study by Reese and colleagues (Reese et al. 2011) examined the costs of home care, indirect costs, hospital and outpatient care and quality of life. The total costs per patient during one semester amounted to €2717 (Reese et al. 2011).

PD research and research into the economic burden of PD has also been developed in many fields worldwide and has generated a large body of research literature. However, the overall trend and impact of research production on the economic burden of PD topic has not yet been documented.

Bibliometric analysis is a tool that measures the literature's influence and production on a specific topic from a quantitative point of view (Aria et al. 2020). Various indicators are used, such as impact factor, h-index, number of citations, most important keywords and others. Although there are many areas in which bibliometric analysis has been used extensively, there are few studies in the health literature, very few on PD (Chen et al. 2022; Liu et al. 2023, 2022) and, to the best of the authors' knowledge, none dealing with the economic burden of PD.

Therefore, in order to increase knowledge in the field of management and to analyse published scientific literature, a bibliometric analysis was carried out with the objective of describing, mapping and analysing the evolution and trend of research on economic burden of PD. To this end, the following initial questions were asked: *RQ1: What are the main research keywords on costs in the field of Parkinson's disease? RQ2: How do an author's studies on the economic burden and costs of Parkinson's disease influence scientific production?*

Methodology

Data collection and search strategy

The data used was retrieved from the Web of Science (WOS) database from Clarivate Analytics. This database was searched for relevant literature on the economic burden of PD over the past 25 years, from the date of the first article, 1997, to 2022. The literature search was conducted in May 2023. The search strategy was developed by querying the term *Parkinson's disease AND (Economic Burden OR Costs)* as topics in the WOS database.

Study selection and data extraction

After the initial data collection, the screening process was carried out as summarized in Fig. 1, with successive review and refinement of the research protocol.

Regarding the eligibility criteria for this study, articles that addressed the relationship between economic burden and PD were included. In turn, articles were excluded if they were off-topic and/or did not answer the questions that were on the agenda in this present work were excluded. In addition, papers were pre-selected based on reading their abstracts. The pre-selected articles were then assessed on the basis of the following inclusion criteria:

1) Research literature only with content about PD;
2) Literature type is limited to "articles" and "anticipated access articles";
3) Articles in English language;
4) Only categories and research areas of Clinical Neurology; Neuroscience; Health Care Sciences Services; Multidisciplinary Sciences; Health Policy Services; Neurosciences; Neurology; Health Care Science Services; Business Economics and Management were used.

On the basis of the title and abstract, 386 scientific studies were extracted. Of these, 140 met the inclusion criteria, were selected and analysed in May 2023, according to the objective of presenting a bibliometric study on the influence/relationship of the economic burden of PD. All available results were exported as a plain text file from the WOS database, including citation information, bibliographic information, abstracts and keywords. Clarivate's EndNote Web was used to eliminate duplicate publications and to manage the database.

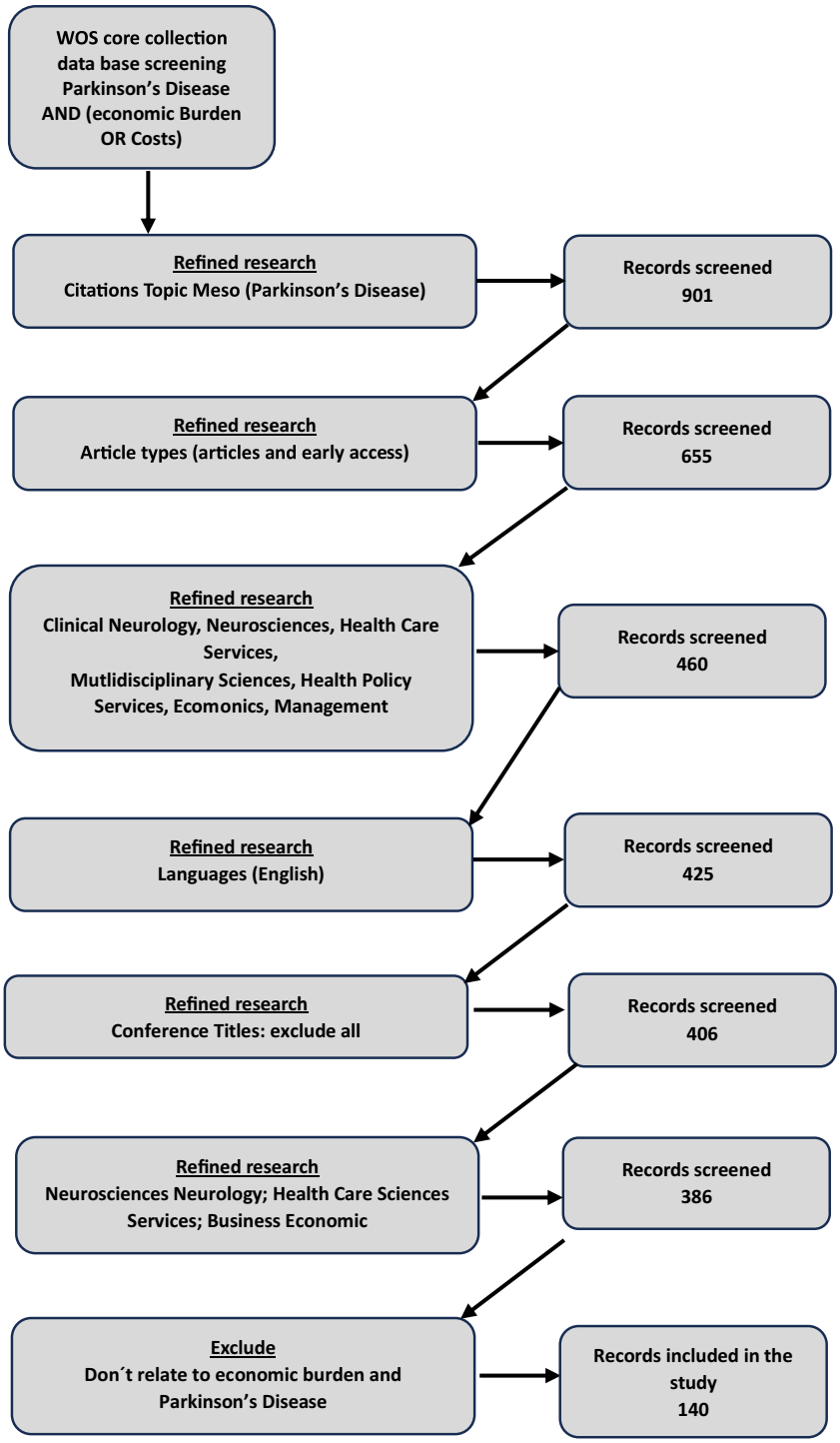

Fig. 1 Research protocol diagram

Bibliometric analysis

The R package Bibliometrix 3.1.4 in the version Biblioshiny (Aria and Cuccurullo 2017) which is based on the R software (version 4.1.2) was used for science mapping. Science mapping allows the study and global visualization of scientific knowledge from a statistical perspective through three knowledge structures (conceptual, social and intellectual). This study was created with the domain in mind, i.e. sources, authors and documents, as well as different metrics, such as Bradford's Law, Lotka's Law or h-index, which provide objective and measurable data to understand the evolution of the scientific field (Cuccurullo et al. 2016). In addition, this work was done on one of the knowledge structures, conceptual, to identify the leading topics and trends in science (Aria and Cuccurullo 2017).

Results

Countries

Table 1 shows the countries scientific production, based on the affiliations of all authors of each article, of the documents analysed in this work. The 140 articles analysed here came from 34 countries, of which 58.8% were from European countries, whereas 20.6% were from Asia, and 11.8% from the USA. However, the most productive country was the USA with 113 (80.7%) articles, followed by the UK with 87 (62.1%) articles and Germany with 73 (52.1%) articles.

Table 1 Countries scientific production

Country	Number of articles	Percentage (%)
USA	113	80.7
UK	87	62.1
Germany	73	52.1
Netherlands	55	39.3
Sweden	44	31.4
Spain	31	22.1
Australia	30	21.4
Canada	27	19.3
Norway	23	16.4
South Korea	16	11.4
Singapore	15	10.7
Japan	11	7.9
China	10	7.1
France	9	6.4
Czech Republic	8	5.7
Italy	8	5.7
Denmark	7	5
Finland	7	5
Luxembourg	7	5
Austria	6	4.3
Israel	6	4.3
India	5	3.6
Belgium	4	2.9
Colombia	4	2.9
Portugal	4	2.9
Estonia	2	1.4
Kenya	2	1.4
Philippines	2	1.4
Russia	2	1.4
Brazil	1	0.7
Greece	1	0.7
Iceland	1	0.7
Ireland	1	0.7
Switzerland	1	0.7

UK United Kingdom, *USA* United States of America

The countries that contributed the least were Brazil, Greece, Iceland, Ireland and Switzerland with 0.7%.

Authors and affiliations

The articles included in this study were written by 736 researchers. Furthermore, the average number of co-authors per article was 6.69. A total of three articles (2.1%) were written by a single author, while a total of 137 articles (97.9%) were written by multiple authors. Furthermore, the analysis of the articles revealed that the 10 most relevant authors for the topic in question were the authors described in Table 2. This table shows the h-index – a common metric for evaluating the scientific merit – the year of publication of the articles and number of articles published. As described, Oertel Wolfgang and Dodel Richard had the highest h-index among the 736 authors and were also the most prolific authors with the largest number of publications and citations. More specifically, Oertel Wolfgang had an h-index of 11, 13 publications and 587 citations. On the other hand, Dodel Richard had an h-index of 10, also 13 publications and 505 citations. It is noteworthy that Dodel Richard also appears in the top 10 most relevant authors under a different name, Dodel RC. Dodel RC has an h-index of 4, 5 publications and 216 citations.

It is worth noting that it is also important to understand the connection of these authors with affiliated organizations in the production of scientific knowledge (Supplementary material 1), as these institutions help in the dissemination and expansion of knowledge. The four most relevant institutions affiliated with the authors of the selected studies are Radboud University Nijmegen with 20 articles as the most relevant institution, followed by University of Marburg with 17 articles and both King's College London and University of Bonn with 11 articles each.

Table 2 Top 10 authors

Authors	h-Index	Year of first publication	Number of publications	Number of citations
Oertel WH	11	1998	13	587
Dodel R	10	2005	13	505
Bloem BR	7	2010	8	388
Von Campenhausen S	7	2005	7	364
Winter Y	6	2009	7	252
Balzer-Geldsetzer M	5	2010	5	170
Munneke M	5	2010	5	286
Reese JP	5	2009	5	228
Siebert U	5	2003	5	274
Dodel RC	4	1998	5	216

Journals

The most productive journals on economic burden in PD are listed in Table 3. As can be seen, the top three journals are Movement Disorders (27), Parkinsonism & Related Disorders (13) and Pharmacoeconomics (13). Most of the journals are included in one or two categories, with Clinical Neurology and Neurosciences being the top two. This suggests that these categories exerted a major influence on the economic burden of PD and that it is a specific field. Lancet Neurology has the highest impact factor (48.0) and Movement Disorders has the highest number of citations (1995) with 27 articles published on this topic.

The annual growth rate of published articles was 57%. As shown in Fig. 2, the analysis of journal production over time revealed that the number of articles published in the three main journals mentioned has increased in recent years. Furthermore, Movement Disorders is the journal with the highest growth, followed by Parkinsonism & Related Disorders and Pharmacoeconomics.

Citations

The 140 articles were published in 41 different scientific journals, with an average citation rate of 37.97 per article. The most cited articles are listed in Table 4. The first is from Kowal and colleagues (Kowal et al. 2013) with 447 citations and the second is from Huse and colleagues (Huse et al. 2005) with 225 citations. Both articles estimate the economic burden of PD in the USA and the third article by Findley and colleagues (Findley et al. 2003) with 170 citations, also estimates the economic burden of PD but in the UK. These three top articles were published in the most prolific journal on the subject, Movement Disorders.

Thematic map and co-occurrence network

Figure 3 presents a thematic map in which each of the circles represents a cluster of research topics. In this map, the X-axis represents centrality, which measures the intensity of the links between the clusters – clusters with numerous and stronger links mean that they denote a set of research problems that are considered crucial by the scientific community. Density, on the other hand, is plotted on the Y-axis and measures the degree of development, i.e. the strength of the links that exist between the words that make up the cluster. Stronger links mean that the research problems form a coherent and integrated cluster. Therefore, this map classifies a research topic into four quadrants based on these two values, each representing a specific topic module. The thematic map is interpreted by analysing where the keyword or research topic is located. Moreover, the size of the circle represents the size of the cluster, i.e. the number of research topics/keywords it contains. Large circles represent research

Table 3 Top 20 journals with the most published literature on economic burden in PD

Journals	Number of articles	Number of citations	JCR categories	IF
Movement Disorders	27	1995	Clinical Neurology	8.6
Parkinsonism & Related Disorders	13	688	Clinical Neurology	4.1
Pharmacoeconomics	13	571	Health Policy & Services; Economics	4.4
American Journal of Managed Care	7	392	Health Policy & Services	3.2
European Journal of Neurology	7	329	Neurosciences; Clinical Neurology	5.1
Journal of Medical Economics	7	59	Health Care Sciences & Services; Medicine, General & Internal	2.4
Acta Neurologica Scandinavica	6	93	Clinical Neurology	3.5
BMC Neurology	6	79	Clinical Neurology	2.6
Journal of Parkinsons Disease	5	48	Neurosciences	5.2
Journal of Neurology	4	100	Clinical Neurology	6.0
Movement Disorders Clinical Practice	4	21	Clinical Neurology	4.0
Parkinsons Disease	4	59	Clinical Neurology	3.2
Journal of the Neurological Sciences	3	97	Neurosciences; Clinical Neurology	4.4
Lancet Neurology	3	250	Clinical Neurology	48.0
BMC Health Services Research	2	29	Health Care Sciences & Services	2.8
CNS Drugs	2	36	Pharmacology & Pharmacy; Clinical Neurology; Psychiatry	6.0
Frontiers in Neurology	2	5	Neurosciences; Clinical Neurology	3.4
Journal of Clinical Neuroscience	2	11	Neurosciences; Clinical Neurology	2.0

JCR categories–categories in journal citation reports, IF–impact factor

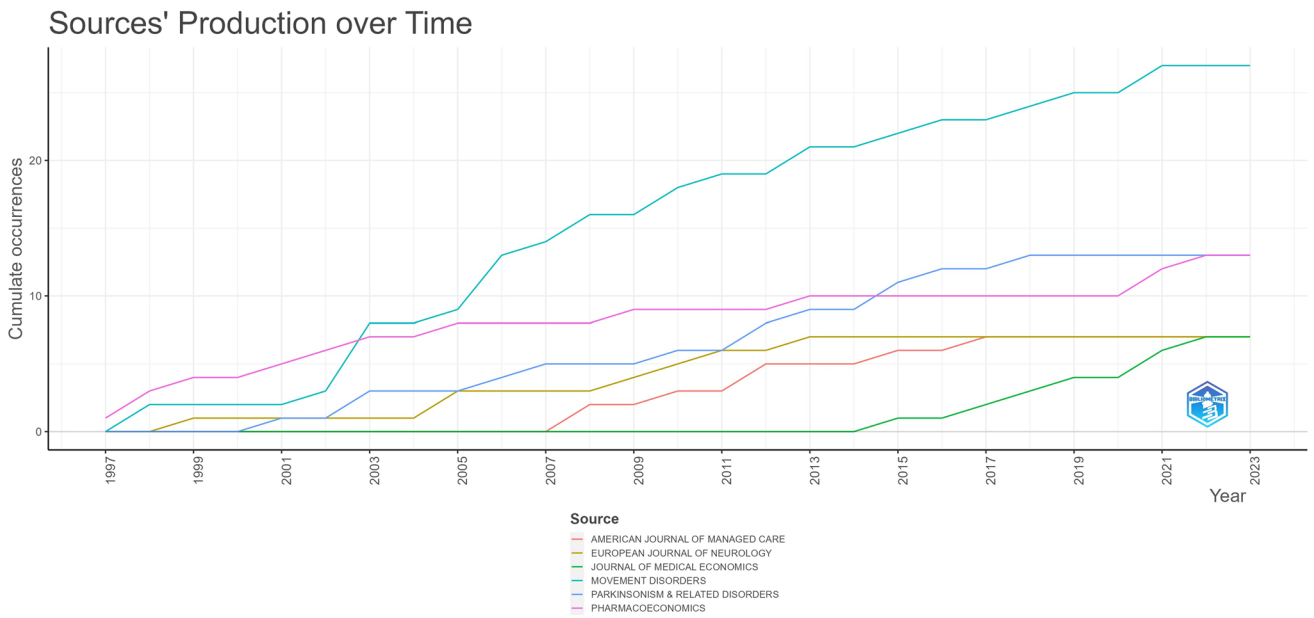

Fig. 2 Journals production over time

Table 4 Most global cited documents on economic burden in PD

Articles	Journal	Number of citations	Number of citations per year
Kowal SL, 2013	Movement Disorders	447	40.6
Huse DM, 2005	Movement Disorders	225	11.8
Findley L, 2003	Movement Disorders	170	8.1
Yang WY, 2020	NPJ Parkinsons Disease	159	39.8
Weintraub D, 2008	American journal of Managed Care	156	9.8
Pechevis M, 2005	European Journal of Neurology	153	8.1
Findley LJ, 2007	Parkinsonism & Related Disorders	134	7.9
Martinez-Martin P, 2008	Movement Disorders	129	8.1
Spottke AE, 2005	Pharmacoeconomics	119	6.3
Keranen T, 2003	Parkinsonism & Related Disorders	116	5.5

topics of greater importance and small circles for research topics of lesser importance.

The results show that there are two clusters with high centrality and density in the first quadrant, "double-blind, safety, long-term" and "therapy, bromocriptine, multicentred". These clusters focus on items related to PD and are the topic of motor research.

In the second quadrant there is a cluster with high density that represents niche themes "balance, index, physiotherapy, performance", while the third quadrant consists mainly of three clusters representing emerging or declining themes: "metanalysis", "fall" and "disability".

The fourth quadrant consists of three clusters with low density, but high centrality, i.e. the basic themes: "entacapone, health, United States"; "dementia, depression, diagnosis" and "validation, disease, questionnaire". Finally, the cluster "quality-of-life, impact, illness" that is located between the first and fourth quadrant has a high level of centrality and moderate density but has the largest cluster frequency given its size.

The map of co-occurrence of themes analyses in a complex way the themes of the studies that occur simultaneously between the authors and is included in supplementary material 2. The map shows that the most frequently occurring themes are "quality of life", "impact" and "illness".

Keywords

To answer the first question of the study – *"What are the main keywords regarding cost research in the area of*

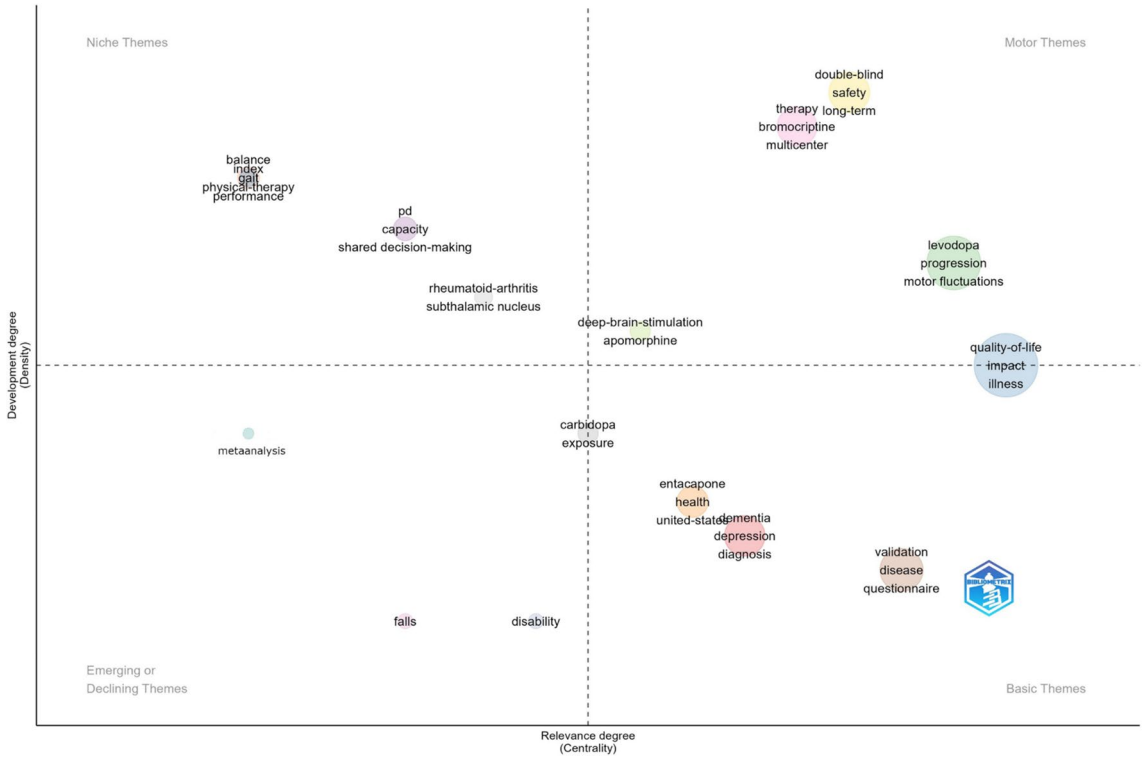

Fig. 3 Thematic map

Parkinson's disease? – the results show that the authors wrote 140 articles with more than 320 keywords. The most important words are listed in Table 5. The words are presented in order of relevance, with "quality of life" as the most relevant, with 49 (35%) occurrences, and "economic burden" ranked 6th position out of 25 words, with 18 (12.9%) occurrences. The use of keywords plus in bibliometric analysis is more effective to investigate the knowledge structure in scientific fields as they offer several advantages due to their large number of concepts and broad meaning (Zhang et al. 2016).

Figure 4 displays a word cloud to help to quickly understand the most relevant terms, such as "quality-of-life", "impact" and "illness".

Lotka's Law and Bradford's Law

The results of the bibliometric analysis for the question—*"How do an author's studies on the economic burden and costs of Parkinson's disease influence scientific production?"* – can be seen in Tables 6 and 7, which show the results of the bibliometric analysis based on Lotka's Law (Lotka 1926) and Bradford's Law (Bradford 1934), applied to the sample of the present work, supporting the interpretation of question 2 of the study.

Lotka's inverse square law of scientific productivity, also known as Lotka's law, determines the productivity of authors within specific research areas and is used to assess the frequency with which authors publish articles (Coile 1977; Potter 1981). The more articles published, the less frequent the authors who write these publications become. As in this research analysis, more than 80% of the authors (629) published one article, while only 3% of them (2) published 13 articles. Table 7 presents the results of the Bradford's Law.

According to Bradford's Law, the first articles on a new topic are submitted to a small selection of suitable journals. If these articles are accepted, these journals attract further articles as the subject area develops (Brookes 1969). This phenomenon is known as the "mechanism of success generating success". If other journals publish their first articles on the topic at the same time and the topic continues to develop, a core of journals will eventually emerge that corresponds to the most prolific journals in terms of articles on that topic. Our research has shown that Movement Disorders, Parkinsonism & Related Disorders and Pharmacoeconomics are the most important sources.

Finally, Fig. 5 shows the average annual scientific production on the topic of the current work, which is essential, as it not only informs us about the current state of scientific production on this very relevant topic but also helps us to understand the distribution over the years. Therefore, Fig. 5

Table 5 Top 25 most relevant words

Words	Occurrences	Percentage (%)
quality-of-life	49	35
impact	31	22.1
illness	24	17.1
prevalence	24	17.1
cohort	20	14.3
economic burden	18	12.9
burden	17	12.1
care	16	11.4
mortality	16	11.4
severity	16	11.4
levodopa	14	10
progression	13	9.3
symptoms	13	9.3
dementia	12	8.6
motor fluctuations	12	8.6
people	12	8.6
double-blind	11	7.9
economic-impact	11	7.9
nonmotor symptoms	11	7.9
cost-effectiveness	10	7.1
costs	9	6.4
epidemiology	9	6.4
therapy	9	6.4
validation	9	6.4
deep brain-stimulation	8	5.7

presents a line with an oscillating pattern of fluctuations, however, with a peak of 15 published articles showing the highest production on this topic in 2021, followed by a slow decline in 2022 with 10 published articles. This shows a growing interest in this topic.

Discussion

This study presents a bibliometric analysis of the economic burden of PD through a comprehensive literature search to provide some evidence of publications growth trends, geographical distribution, research trends and other related bibliometric indicators, as well as to provide objective and reliable analyses in this field. This study has also provided answers to the two research questions.

Oertel Wolfgang and Dodel Richard had the highest h-index and were also the most prolific authors with the highest number of publications and citations. A large number of these articles were published in collaboration between the two authors. Dodel Richard also publishes under other names (Dodel RC) which is why his articles appear separately and have a different h-index, number of publications and citations. The h-index for each author do not exactly match those in the WOS database, as in this article we only consider the h-index based on the articles included in this study. The authors studied here have published other articles in other areas that are included in their h-index.

In general, there is a growing production and interest in the economic burden of PD. The articles show an evolution in the understanding of the disease's impact on the economy and also in the estimated costs of the disease. The two most cited articles are by Kowal and colleagues (Kowal et al. 2013) and Huse and colleagues (Huse et al. 2005), respectively. The latter, and oldest study, estimates that the total cost of PD in the USA could be as high as $23 billion (approx. €21.8 billion) per year, with direct healthcare costs of $10,349 (approx. 9 791) per patient per year (Huse et al. 2005). Another study from 2013 estimates the economic burden of PD in the USA at over $14.4 billion (approx. €13.5 billion) and around USD 22,800 (€21,313€) per patient in 2010, with medical expenses of approximately

Fig. 4 Word cloud

Table 6 Lotka's Law

Documents	Number of authors	Proportion of authors
1	629	0.855
2	75	0.102
3	12	0.016
4	5	0.007
5	7	0.010
6	2	0.003
7	3	0.004
8	1	0.001
13	2	0.003

Table 7 Bradford's Law

Core sources by Bradford's Law	Rank	Frequency	Cumulative frequency
Movement Disorders	1	27	27
Parkinsonism & Related Disorders	2	13	40
Pharmacoeconomics	3	13	53
American Journal of Managed Care	4	7	60
European Journal of Neurology	5	7	67

$14 billion (approx. €13.2 billion) and indirect costs at $6.3 billion (approx. €5.96 billion). Nursing home care is a major contributor to medical costs while reduced employment is one of the major indirect costs of PD (Kowal et al. 2013). In recent years, a study updated cost components of the economic burden of PD in the USA. It estimates that the total cost of PD in 2017 amounted to $51.9 billion (approx. €49.3 billion), including direct medical costs of $25.4 billion (approx. €24.1 billion), and indirect and non-medical costs of 26.5 billion (approx. €25.2 billion). The study predicts that by 2037 there will be over 1.6 million people with PD and the total cost will be over $79 billion (approx. €75.2 billion) (Yang et al. 2020). As a result, the estimated costs of PD have increased considerably over time, with the most recent study showing significantly higher costs than the two previous studies. All three studies highlight the significant economic burden of PD on the USA healthcare system and economy and the last two emphasize the need for interventions to reduce the number of people with PD and slow the progression, in order to reduce the future economic burden of PD. Moreover, the authors use similar keywords in their studies, such as "Parkinson's disease", "economic burden", "health economics", "cost of illness", "resource use" and "disease cost" with the adding of "Parkinson's prevalence" in the study by Kowal and collaborates (Kowal et al. 2013).

The journal Movement Disorders had the highest number of publications since 2006, followed by Parkinsonism & Related Disorders which grew gradually and Pharmacoeconomics. These results indicated that these three journals were the three most popular journals for scholars who studied economic burden in PD. In this sense, it could be said that researchers around the world are more likely to choose Movement Disorders, followed by Parkinsonism & Related Disorders and Pharmacoeconomics to publish their leading-edge results and major recent breakthroughs. This could also mean that the editors of this journal focus more on the economic burden of PD, than the others. Finally, this

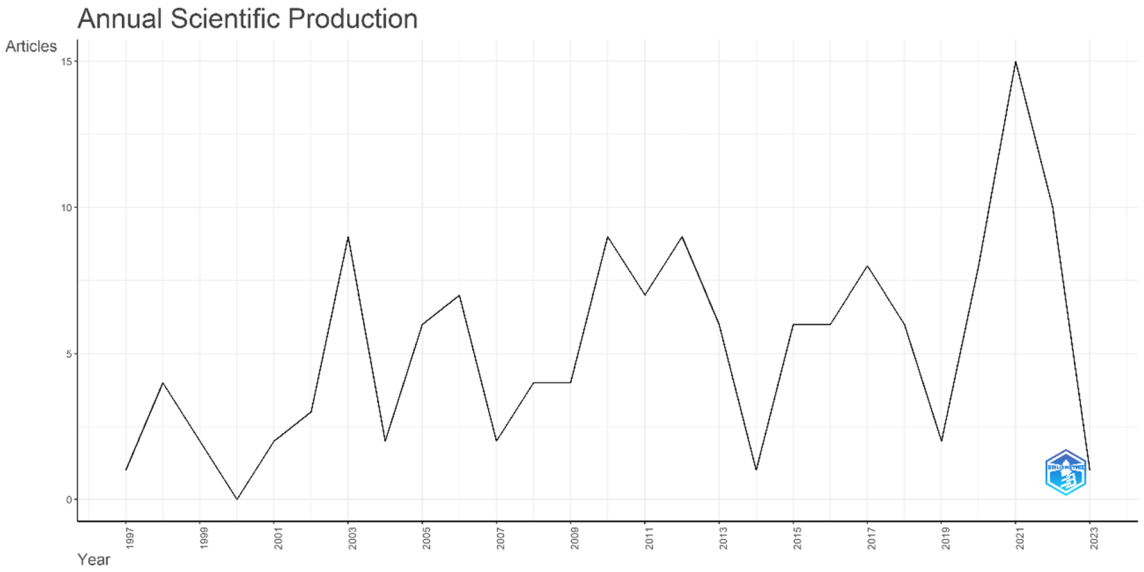

Fig. 5 Annual scientific production

study shows an annual growth rate of 57% in the number of articles published, which indicates a significant growth, and therefore increasing interest in this topic.

The two most important authors, Dodel R. and Oertel W. are both from the Philipps University of Marburg in Germany, which is second place in the most relevant institution, as well as other authors in the top 10 such as Balzer-Geldsetzer M and Reese JP. Nevertheless, the USA was the most productive country possibly due to the fact that the USA is a larger country with a higher population. Additionally, their interest in producing articles with updated economic data may be greater.

The 140 articles had an average citation rate of 37.97 per article, which can be considered low compared to the average number of citations in the most common scientific fields or categories of the journals in which they were published. For example, the neuroscience category has an average of 187 citations per article, clinical neurology 146, economics 79 and health policy services 53 (Patience et al. 2017). However, if we look more closely at the most cited articles worldwide (Table 4), the top three articles by Kowal and colleagues (Kowal et al. 2013) with 447 citations, Huse and colleagues (Huse et al. 2005) with 225 citations and Findley and colleagues (Findley et al. 2003) with 170 citations, all from the journal Movement Disorders exceed the average number of citations of the scientific field of clinical neurology. These results mean that these articles have high visibility and impact in this scientific field.

The cluster "quality-of-life, impact, illness" has moderate density, a high centrality and a higher cluster frequency. This means that, despite their moderate prominence, the topics represent a set of research problems that are considered crucial and of greater importance by the scientific community.

As for the first question purposed: *The main keywords regarding cost research in the area of Parkinson's Disease*, the results achieved showed that the most frequently used terms were "quality of life" (35%), "impact" (22.14%) and "illness" (17.14%). These results demonstrate that the bibliographic research and the results are in line with the mainstream about PD, namely the impact of the disease on people's quality of life, corroborated in several articles (Kadastik-Eerme et al. 2015; Martinez–Martin et al. 2011a, b; Rosqvist et al. 2021; Sanchez-Luengos et al. 2022; van Uem et al. 2016).

Regarding the second question: *How an author's studies on the economic burden and costs of Parkinson's disease influence scientific production,* the results showed an asymmetric distribution of authors and their scientific productivity (Table 6), where more than 80% of the authors (629) have one published article while only 3% of them (2) have published 13 articles, which is supported by Lotka's Law (Lotka 1926). Also, the results show a main cluster of journals (Table 7) that emerge as core journals on this topic, meaning that they have produced the most relevant scientific output. These journals are Movement Disorders, Parkinsonism & Related Disorders and Pharmacoeconomics. These results are supported by Bradford's Law (Bradford 1934).

Limitations

This research should be viewed as having some limitations. Querying topics retrieved only from the WOS database is the first one as the use of other databases could have enlarged the sample for the analysis. In addition, analysing the data without considering that authors may use different names is a bias that should be recognized. The language chosen for the analysis is another limitation as it may limit the scope of the analysis. Finally, the fact that the countries of origin were not according to the population of the country itself can also be seen as a potential limitation, as it can be assumed that more articles are published in the USA than in smaller countries, such as Portugal.

Conclusion

This bibliographic analysis presents a structured review of the economic burden of PD and contributed to assertively achieve the proposed objectives of this study, by identifying the existing research on this topic, which was extracted using two pre-defined questions at the beginning of this work. With this in mind, we completed the work by answering all relevant questions, and also included additional and supplementary information, such as the origin of the studies, the most relevant authors, articles and journals, as well as data on the annual scientific production of studies, citations and the most important topics. PD remains a chronic condition with growing disability and considerable socioeconomic burden, thus healthcare decision-makers should consider the cost-driving factors of PD and optimize the organization and provision of healthcare for these patients. In this sense, this article pretends to be a basis for future research and to be useful for researchers, academics, or professionals in this field since this is a very important topic. Moreover, this work can be a tool for researchers, and help them to identify influential articles on this topic and core journals in this field to publish.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10389-024-02308-w.

Acknowledgements This paper is partially financed by National Funds provided by FCT- Foundation for Science and Technology through project UIDB/04020/2020 and with DOI https://doi.org/10.54499/UIDB/04020/2020 and through project UIDP/04539/2020.

Authors' contribution Maura Cunha and Lara N. Ferreira had the idea for the article and performed the literature search. Maura Cunha and Helena Almeida performed the data analysis. The first draft of the manuscript was written by Maura Cunha. Lara N. Ferreira and Helena Almeida critically revised the work. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding Open access funding provided by FCT|FCCN (b-on). No funding was received for conducting this study.

Data Availability The data that support the findings of this study are available from the authors upon reasonable request.

Declarations

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

This study was reviewed and approved by the Health Ethics Committee of the Algarve Local Health Unit [Comissão de Ética para a Saúde da Unidade Local de Saúde do Algarve] (references: 232/22; 84/23; 207.23).

Informed consent Not applicable.

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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