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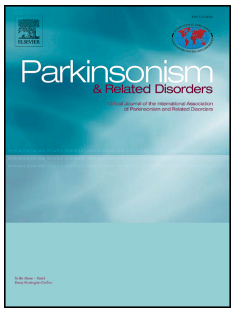

Parkinson's disease: Evolution of the scientific literature from 1983 to 2017 by countries and journals

C. Robert, C.S. Wilson, R.B. Lipton, C.-D. Arreto

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Parkinson's disease:

Evolution of the scientific literature from 1983 to 2017 by countries and journals

Robert C.[1,2]*; Wilson C.S.[3]; Lipton R.B.[4]; Arreto C.-D.[2,5]

1* Université Paris Descartes, Paris, France,

2 Gliaxone; Saint Germain Sous Doue, France

3 Formerly at: School of Information Systems, Technology and Management, University of New South Wales, UNSW Sydney, 2052 Australia;

4 Department of Neurology, Albert Einstein College of Medicine, Bronx, NY, USA;

5 Université Paris Descartes, Faculté de Chirurgie Dentaire, Hôpital Bretonneau, HUPNVS, AP-HP, Paris, France

*Corresponding author: ROBERT Claude

GLIAXONE

30 rue de la Fontaine

77 169 Saint Germain Sous Doue

France

Email : clauderobert99@yahoo.fr

Abstract

This study charts the evolution of the scientific literature on Parkinson's disease (PD) from 1983-2017 to inform communities of scientists, physicians, patients, caregivers and politicians concerned with PD. Articles published in journals indexed in the *Science Citation Index-Expanded* database of the *Web of Science* were retrieved and analyzed in seven five-year periods: 1983-1987, 1988-1992, 1993-1997, 1998-2002, 2003-2007, 2008-2012 and 2013-2017. Over 35 years the number of research papers on PD increased 33-fold: 885 papers in 1983-1987 to 29,972 in 2013-2017. At the same time the number of countries contributing to PD research increased from 37 to 131. The USA was the most prolific country throughout, followed by several European (UK, Germany, Italy and France) and English-speaking (Canada and Australia) countries. By 2003, several Asian countries (China, South Korea, India and Turkey) emerged with rapid increases in publications related to PD. By 2013-2017, China surpassed all but the USA to rank 2nd globally in productivity. Despite an increase from 4 to 22 African countries publishing PD research from 1983-2017, most were either unproductive or contributed ≤ 5 papers in each five-year period. There has also been a 12-fold increase in the number of journals (232 to 2,824) containing papers on PD. In 2013-2017 three PD-focused journals (*Parkinsonism & Related Disorders*, *Movement Disorders* and *Journal of Parkinson's Disease*) contained 6.8% of all PD papers while a large majority (82.5%) of journals published ≤ 10 papers. This quantitative study complements the numerous extant qualitative reviews to provide a global perspective on PD research.

Keywords: Parkinson's Disease, Bibliometrics, Publication Growth, Journal Analysis, Country Productivity

1. Introduction

During the last two decades, the scientific publishing activity on Parkinson's disease (PD) increased tremendously, well beyond that of the global scientific literature (Fig. 1). This literature growth accompanies the important scientific progress made in PD, along with the growing interest among researchers and clinicians. PD is now the world's second most common neurodegenerative disorder, affecting more than six million people worldwide. The 2016 global health metrics show that Parkinson's disease contributes 3.2 million disability-adjusted life-years (DALY) and is responsible for 706 thousand YLD, years lived with disability [1,2]. Based on the two metrics, PD ranked 6th among neurologic disorders. On the occasion of the 200th anniversary of Shaking Palsy, a comprehensive review paper on the past, present, and future of Parkinson's disease prepared by over three dozen prominent researchers was published recently [3].

In the past decade, several studies have tried to quantify various aspects of the PD scientific literature, for example: citation analysis of either highly-cited PD papers [4-5] or highly-cited PD research authors [6]; bibliometric profile of deep brain stimulation [7]; bibliometric impact of neurosurgical research [8,9]; highly-cited works in essential tremor and dystonia [10,11]; bibliometric analysis of movement disorder [12]; bibliometric analysis of stem cell transplantation [13]; and bibliometric study of neuroscience research from 2006 to 2015 [14].

A global bibliometric analysis of the PD field from 1991-2006 showed increasing international collaboration among researchers and demonstrated that author-provided keyword analysis was a novel approach to research trends in PD [15]. Gupta and Bala [16] provide India's research output of PD papers for 10 years (2002-2011) and note that there are no other PD scientific literature studies which focusses on specific countries or regions.

To enhance the extant body of research briefly mentioned above, we studied the evolution of the PD scientific literature over the last 35 years (1983-2017). Our investigation focuses on the geographical distribution of the PD research activity, and on the scientific journals publishing PD

research. We reviewed publications from 1983-2017 grouped in five-year periods: 1983-1987, 1988-1992, 1993-1997, 1998-2002, 2003-2007, 2008-2012 and 2013-2017.

2. Material and Methods

The data were collected in August 2018 from the *Science Citation Index-Expanded* (SCI-E) of the *Web of Science* (WoS). Publications dated from 1983-2017 were considered for analyses based on the following criteria:

- All publications designated as 'articles'; containing Parkinson* in their titles, abstracts or keywords where the asterisk retrieves 'Parkinson' and all extended variants; but *excluding* publications on 'Wolff-Parkinson-White'.

Articles retrieved were then analysed in seven five-year periods from 1983-1987 to 2013-2017 and the following parameters were considered:

- The number of articles authored by researchers in each country – articles issued from more than one country were assigned equally to each contributing country.
- The top-10 most prolific journals.

Impact Factors (IFs) for 2017 were collected through the Thomson Scientific *Journal Citation Reports*. Articles originating from England, Scotland, Wales and Northern Ireland were assigned to the United Kingdom (UK), and the European Union (EU) were the official member States (Countries) registered during each of the seven five-year periods.

3. Results

Evolution of the number of Parkinson's disease publications

During the period 1983-2017, the number of research papers on Parkinson's disease increased 33-fold – 885 papers in 1983-1987 to 29,972 in 2013-2017 – while the total publications of the WoS only increased 3-fold for the same two periods – 2,228,138 and 6,662,203 papers (Fig. 1).

Evolution of countries publishing on Parkinson's disease

From 1983 to 2017, the number of countries participating in basic and clinical research on Parkinson's disease increased continually: 37 for 1983-1987, 52 for 1988-1992, 69 for 1993-1997, 80 for 1998-2002, 95 for 2003-2007, 105 for 2002-2007 and 131 countries for 2013-2017 (See supplementary data). During the 35 years analyzed the USA ranked first in each of the five-year periods from 279 to 9,365 articles. Some of the industrialized countries (UK, Germany, Italy, France and Canada) ranked after the USA. At the same time China and India made significant headway: in 2013-2017, China ranked 2nd with 3,986 papers, and India 14th with 913 papers. The percentages of countries publishing ≥10 papers have been increasing each decade: 37.8% for 1983-1987, 50.72% for 1993-1997, 53.12% for 2003-2007 and 54.96% for 2013-2017. In each five-year period the EU member countries have been increasingly more productive with the difference (vis-à-vis the USA) being greatest in 2013-2017 (12,412 vs. 9,365 papers); however, from 1983 to 2017, the EU has expanded from 10 to 28 members.

Evolution of journals publishing on Parkinson's disease

From 1983-2017, the number of journals publishing papers about Parkinson's disease increased 12-fold: 232 journals for 1983-1987 to 2,824 for 2013-2017 (Fig.2). Additionally, the number of journals publishing >50 PD papers in each five-year period increased dramatically from zero journal in 1983-1987 to 104 journals in 2013-2017; conversely, the number of journals

publishing fewer than 6 PD papers increased 10-fold during the same periods: 198 in 1983-1987 and 2,041 in 2013-2017 (Fig. 3).

The top-10 most productive journals on Parkinson's disease research in each of the seven time periods are presented in Table 1. The first period (1983-1987) has mostly general neurology and neuroscience journals. However, by the last period (2013-2017) three PD journals (*Parkinsonism & Related Disorders*, *Movement Disorders* and *Journal of Parkinson's Disease*) were ranked in the top-10 journals publishing 6.8% (n=2,059) of all papers in PD. In 2013-2017 the top-10 concentrated 19.3% of all the papers while 72.0% of the 2,834 journals published ≤5 papers on PD. Additionally, the IFs of the top-10 journals ranged from 2.1 for *Neuroscience Letters* to 8.3 for *Movement Disorders*. Eight of the top-10 journals were classified as *Clinical Neurology* and/or *Neurosciences* in the WoS categories and the two broad science journals (*Plos One* and *Scientific Reports*) in *Multidisciplinary Sciences*.

4. Discussion

The major results of the present study are: an 33-fold increase in the number of publications from 1983-1987 to 2013-2017; a 12-fold increase in the number of journals publishing on Parkinson's disease; the spread and distribution of papers among publishing countries from 37 in 1983-1987 to 131 in 2013-2017; and the recent inclusion of China among the top-10 most productive countries.

4.1. Limitations of the study

Our study has several limitations common to all bibliometric studies. Selecting papers with the word-stem 'Parkinson' in the titles/abstracts/keywords was chosen as we concluded that *if* the article is about Parkinson's disease but the word-stem 'Parkinson' is not in the title due to word-count limitation, *then* 'Parkinson' would appear in either the abstract and/or the keywords. The restriction to the document-type, 'article' (research papers), ensures that our dataset represents research results on PD in (mostly) journals, but also in some conference proceedings and book series containing research papers. Each science literature 'mega-database' has advantages and drawbacks [17]; however the *Web of Science* remains the database generally chosen for bibliometric analysis – especially for studies spanning many decades and requiring reasonably accurate e-data. With these choices, we think that the inherent bias accompanying our approach and retrieval strategy is reduced, and that the data collected are sufficiently representative to give readers a realistic view of the scientific research literature on PD.

To check our approach, we briefly compared our country ranking results with that of *Expertscape* (http://expertscape.com/) – a database derived from publications (2007-2018) indexed in *PubMed* (https://www.ncbi.nlm.nih.gov/pubmed/). *Expertscape* ranks people, countries and institutions by their expertise in more than 26,000 biomedical topics including 'Parkinson Disease'.

A comparison made with our last two five-year periods (2008-2012 and 2013-2017) showed that the top-20 country rankings are similar except for China (ranked lower) and Israel (ranked higher) in *Expertscape*. The overall result of the comparison provides more similarities than differences; however, detailed explanations are difficult to make since *Expertscape* is not designed for data retrieval or manipulation; rather it uses *PubMed* indexed publications to facilitate the identification and location of medical experts worldwide in various subject areas.

4.2. Evolution of productive countries/territories

USA. During the 30+ year period, the USA continuously led in the production of papers in PD research: from about 31% to 39% of the publications in each of the five -year periods. In 1997 US President Clinton signed the Morris K. Udall Parkinson's Disease Research Act into law and shortly thereafter the National Institute of Neurological Disorders and Stroke (NINDS) established the first Morris K. Udall Center of Excellence in Parkinson's Disease Research. The overarching goal is to establish a network of Centers that work collaboratively as well as independently to define the causes of and discover improved treatments for PD. In 2017, there were eight Udall Centers across the United States.

During the last decade, the financial contribution of the NIH to Parkinson’s disease research had increased about 11% from $152 million in 2008 to $169 million in 2017 (https://report.nih.gov/categorical_spending.aspx). Approximately 77% of the financial support for PD research is provided by industry, the US Federal Government, and various US-based foundations such as the Michael J. Fox Foundation for Parkinson’s Disease Research.

Other major contributions of US scientists to PD include the introduction of progressive stages (1 through 5) of deterioration of motor function in PD [18];the serendipitous discovery in the early 1980s that MPTP (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) induces a Parkinson’s like

illness [19]; the description of the first genetic aberration linked to Parkinson's disease at the National Human Genome Research Institute of the NIH [20] later opening the way to important investigation on PD in the field of genetics; and the important progress in deep brain stimulation therapy at Emory University in Atlanta, Georgia [21], to name but a few.

Finally, in 2012 under the auspices of the *National Institute of Neurological Diseases and Stroke*, the USA launched the *Parkinson's Disease Biomarkers Program* (PDBP) aimed at discovering PD biomarkers for use in phase II and III clinical trials [22]. The PDBP was developed in the context of the Harvard Biomarker Study, the *Michael J. Fox Foundation Parkinson's Progression Markers Initiative* (PPMI), and the *Michael J. Fox Foundation BioFIND Project* [23].

China. Evidence has shown that Parkinson's disease was well known to medical scholars in China as early as 425 BC [24]. In the modern occidental literature, the early scientific publications of China on PD were minimal (<10 papers/year); however, by 2000 it increased rapidly and China ranked 2nd (after the USA) in the 2013-2017 period with 3,986 publications (see supplementary data).

The rapid literature growth of China is also illustrated by the successive publication of three versions of guidelines for the management of PD in China in 2006, 2009 and 2014 by the *Chinese Parkinson's Disease and Movement Disorder Society*. Prior to 2006 there was a "lack of standardization for the management of PD in different regions and among different physicians, leading to different treatment levels in different regions and different physicians." [25]

At the level of PD research, our observation corroborates the trends presented recently by the *National Natural Science Foundation of China*: the exponential growth since 2006 in the numbers of projects and research funding and from 2000 in the numbers of PD publications in *PubMed* [26]. In 2011 Shanghai hosted the XIX *World Congress on Parkinson's Disease and*

Related Disorders. China's phenomenal scientific literature growth suggests that the "cross-over" between first and second positions of the USA and China is fast approaching around 2020-2025 [27].

Knowing that the projected number of individuals over age 50 with Parkinson disease will rise to nearly five million by 2030 [28], and that a recent study revealed the considerable economic burden accompanying this disease [29], the important efforts engaged by China, the most populous country of the world, in the battle against Parkinson's disease deserve to be noticed and supported.

Finally, since the early 2000s academics have been supported by government incentives to encourage publications in Western (English) journals so that Chinese research can reach a broader audience worldwide [30,31]. China has greatly improved its research productivity on neurodegenerative diseases and between 2009-2013 it showed an impressive compound annual growth rate (11.6%) of articles in Brain and Neurosciences; it was only 2.9% for USA, and 3.6% for the EU-41 [32].

UK. For two centuries the UK has contributed to the growing body of knowledge of PD [33] and in the past 35 years, was second only to the USA in publications except for 2003-2007, 2008-2012, and 2013-2017 when it ranked third (see supplementary data). In the last three decades the UK increased its productivity nearly 25-fold: from 122 papers in 1983-1987 to 2,983 in 2013-2017.

The importance of the UK can be further illustrated by two examples: first is the fact that a UK researcher was a co-founder of the *Movement Disorder Society* in 1985 and its journal *Movement Disorders* in 1986; the second example is the UK contribution to the introduction of apomorphine to treat advanced complications of PD [34], and the development (since 1987) of the *Queen Square Brain Bank for Neurological Disorders* (which aims to provide the highest-possible quality of brain tissue for neuropathological studies and for scientific research in the UK and worldwide. Additionally, the first formal diagnostic criteria proposed for PD was issued by The *UK Parkinson's Disease Society Brain Bank* [35].

Germany. Germany's leading position (see supplementary data) is in accordance with a recent study which ranked Germany among the top-3 most productive neuroscience countries [14]. Germany has always been at the forefront of PD research; this is illustrated by the works of a German group who hypothesized 15 years ago that the disease process begins in the digestive tract and in the brain's center of smell [36]. From 2001 to 2004 a German researcher coordinated the *European Network of Research, Diagnosis and Therapy in Parkinson's Disease.* Finally, Germany hosted two congresses of the *International Parkinson and Movement Disorder Society*: 1992 in Munich, and 2017 in Berlin.

Italy. From 1983-2002, Italy ranked between 6th and 7th among countries publishing PD research; however, from 2003-2017 it was among the top-5 most productive countries. Italy's scientific publishing on PD increased more than that of the worldwide literature: nearly 52-fold versus 34-fold (see supplementary data). This might be the consequence of Italy's long and active participation in neurological and neuroscience research [37,38]. Other examples of Italy's leading position are: the organization in 2004 of the *International Congress on Parkinson's Disease and Movement Disorders* and in 2015 the 21st *WFN-organized congresses on Parkinson's Disease and Related Disorders* in Milano; organized by the International Association of Parkinsonism and Related Disorders (IAPRD); and the number of projects on PD research listed in an EU-JPND report on the "mapping of Italian research excellence in neurodegenerative diseases" (http://apre.it/media/38899/mappatura.pdf).

Canada. Canada continues to be among the top-7 most prolific countries on PD research (see supplementary data) through, *inter alia*, its involvement in building the PD community by the

founding in 1995 of the journal *Parkinsonism & Related Disorders*. Additionally, Canada hosted the first WFN-organized congresses on Parkinson's Disease and Related Disorders in Montreal in 1959, and more recently (2011 in Toronto, and 2017 in Vancouver), two congresses of the International Parkinson and Movement Disorder Society, and the 3rd World Parkinson Congress in Montreal in 2013.

Africa. African countries contributing to PD research ranged from 4 (1983-1987) to 22 (2013-2017). A recent review on neuroscience in Africa likewise noted the increase of African countries involved in neurological research [39]. Despite this increase, the low involvement of PD research in Africa is still worrying due to: WHO's recent report showing that Africa is lagging behind most of the rest of the world concerning medical, scientific and therapeutic equipment for neurodegenerative diseases [40]; an epidemiological review of neurodegenerative diseases in Sub-Saharan countries that found only 20 publications in *PubMed* from 7 of the 48 sub-Saharan countries [41]; and the rapidly increasing population and incidences of diseases in Africa. It is hoped that Africa, with the help of the international community, will do all it can to increase its involvement in PD research.

EU. The productivity of the EU countries ranged from 36.4% to 43.9% of the overall scientific literature on PD and in 2013-2017 all of the 28 EU-members contributed publications (see supplementary data). Investment of EU institutions in PD research is illustrated by a rapid increase of the number of projects linked to PD and listed in the successive Framework Programmes (FP) for Research and Technological Development: <10 for each of the first four FPs from 1984 to 1998, and then an increase from 35 for FP5 (1998-2002) to 86 for the last FP7 (2007-2013). FP8 is known as Horizon 2020 from 2014 to 2020 (https://data.europa.eu/euodp/en/data/dataset?q=cordis&ext_boolean=akk&sort=views_total+desc).

Recent examples of the EU investment in Horizon 2020 are two projects: (1) *Magnetic Diagnostic Assay for Neurodegenerative Diseases* (MADIA) aimed at detecting biomarkers specifically associated to Alzheimer's and Parkinson's diseases, funded for €3.9 Million for three years (2017-2019) involving five EU-members: Czech Republic, Germany, Italy, Spain and the UK (https://cordis.europa.eu/project/rcn/206197_en.html). (2) The *EU-Joint Programme-Neurodegenerative Disease Research*, launched in 2010 "to increase coordinated investment between participating countries in research aimed at finding causes, developing cures, and identifying appropriate ways to care for those with neurodegenerative diseases" including Parkinson's disease (www.neurodegenerationresearch.eu). Additionally, the *European Parkinson Disease Association* (http://www.epda.eu.com) launched in 1992, includes 22 EU-member states, plus the Faroe Islands, Israel, Norway, Switzerland and Ukraine; it plays an important role in the PD community of politicians, pharmacological industries, scientists, physicians and patients.

Other countries. Even though other countries are not as productive as the six countries detailed above, their contributions must not be overlooked. For example, in 1979, the first graft of fetal ventral mesencephalic tissue in the rat 6-OHDA lesion model was made by a Swedish team, followed ten years later by the first implantation of a fetal-derived dopamine neuroblast in a human [42]. Another example is provided by the pioneering work of a French team at the end of the 1980s; they introduced high-frequency stimulation of the ventralis intermedius nucleus of the thalamus to replace thalamotomy in the treatment of tremor [43,44]. Their research opened a new avenue for PD therapeutics and its importance in the scientific publishing community is shown through various rankings [4,9].

Another important actor in PD research is Japan, who, with more than 6,000 PD articles published during the 35 years studied, provided important contribution such as the first identification of mutations in the *parkin* gene in 1998 in Japanese patients with autosomal recessive juvenile parkinsonism

[45] and more recently, the development of the world's first clinical trial using iPS (induced pluripotent stem) cells on Parkinson's disease at Kyoto university; and finally hosting the 10th Congress the *International Parkinson and Movement Disorder Society* in Kyoto in 2006.

Although South Korea and India were negligible contributors of PD research papers in 1983-1987, their productivities started increasing in the last four periods starting in 1998-2002. By 2013-2017 South Korea ranked 10th and India 14th (see supplementary data). PD research in South Korea has been boosted by the *Brain Research Promotion Act* of 1998 and further stimulated by the Korean Brain Initiative project launched in 2016; its goal is "centered on deciphering the brain functions and mechanisms that mediate the integration and control of brain functions that underlie decision-making." With this project encouraging global collaboration in neuroscience-focused projects [46], we should see South Korea among the top countries in PD research. Corresponding to the creation of *India's Parkinson's Disease and Movement Disorders Society* in 2001, the recent progression of India's PD research output was noted by Gupta and Bala (2013)[16]. In a recent review paper Surathi and his colleagues indicate that "the Indian population may differ from the rest of the world in the context of PD, be it epidemiology or genetics or response to treatment. … further research needs to be encouraged to understand the disease in Indian patients better, as all the results cannot be extrapolated from the Western literature to this heterogeneous Indian population" [47], especially as India's population will most likely exceed that of China by 2022 (http://money.cnn.com/2015/07/30/news/economy/india-china-population/index.html).

Finally, it is important to note that every country/territory publishing research papers on PD contributes to the progression of research and that the total contribution pushes the timeline further forward for the development of better treatments and a (possible) cure for Parkinson's Disease.

4.3. Parkinson's Disease Journals

During the last 35 years, the landscape of scientific journals publishing articles related to fundamental or clinical research on Parkinson's disease has increased greatly (Table 1, Figure 4). In 1983-1987 the WoS universe of journals publishing PD research was restricted to 232 journals; however, by 2013-2017 there were 2,824 journals. Nearly 30% of these journals were indexed in the *Clinical Neurology* and/or *Neuroscience* WoS categories and concentrated 62% of the PD articles; furthermore, the top-10 most productive journals (all in general neurological- or neuroscience-focused journals) concentrated 38.5% of the 885 PD articles in 1983-1987. The percentage of neurological journals in the categories, *Clinical Neurology* and *Neurosciences*, within the total *SCI-Expanded* database that were targeted by PD researchers in 1983-1987 was moderately low (41.0%), but had increased to 67.9% for the recent period, 2013-2017.

The current PD "journal-universe" has changed markedly perhaps due to the growing and expanding interests of the political, medical and scientific communities. In 2013-2017 the PD research articles were scattered over 2,824 different journals from which only 373 (13.2%) were in the *Clinical Neurology* and/or *Neurosciences* WoS categories; however, these journals contained over half (51.5%) of all the PD papers.

Another important development is the appearance of several journals dedicated to PD: *Movement Disorders* launched in 1986; *Parkinsonism & Related Disorders* in 1995; *Parkinson's Disease* in 2010; and *Journal of Parkinson's Disease* in 2011. These four journals concentrated 6.8% of the 2013-2017 papers (n=29,972) on PD.

An interesting fact to note is that in the periods, 2008-2012 and 2013-2017, there were two multidisciplinary science journals (*PLOS One* and *Scientific Reports*) among the top-10 most productive journals on PD research (Table 1). This could be explained in several ways: *PLOS One* and *Scientific Reports* are mega-journals [48], publishing several thousand papers a year while the other top-10 journals only publish several hundred, thus providing more opportunity for researchers to publish in those journals; PD researchers may want to expose their work to a wider audience in a

general journal read by both specialists and generalists; PD became a 'hot-topic' from about 2010 onwards (https://www.natureasia.com/en/nature/hot-topics/) and thus spurred general research interest; and finally, both *PLOS One* and *Scientific Reports* are open access journals reporting research outputs online "that are free of all restrictions on access … and free of many restrictions on use …" (https://en.wikipedia.org/wiki/Open_access).

Other newcomers that appeared among the journals publishing PD research during the recent decades are "Special Issues" in which advancements in a specific subfield of Parkinson's disease are aggregated; these are not regular issues dedicated to 'hot topics' or particular themes. A quick search revealed that, with the exclusion of the four PD-focused journals mentioned above, more than a dozen Special Issues focusing on PD were indexed in the WoS during the last decade. As expected, most of them were journals mainly associated with the WoS categories *Clinical Neurology* and/or *Neurosciences*: for example, the *Journal of Neurochemistry* [49] or *Neuroscience Bulletin* [50]; others were associated with non-Neurological/Neuroscience journals such as *Biomolecules* [51] or the *IEEE Journal of Biomedical and Health Informatics* [52] – thus illustrating the spreading of interest in PD among the wider medical and scientific community.

The evolution of the Top-10 most productive journals can be explained in two ways: first, the simultaneous appearance of PD-focused journals and Mega-Omics journals (*PLOS One* and *Scientific Reports*) that considerably reduced the number of Neurological/Neuroscience journals in the rankings; second, the "effect-size" phenomenon where the more articles a journal publishes the more likely that PD papers will appear in the journal (e.g. in 2013-2017 *Neuroscience Letters*, *Journal of Neuroscience*, and *Neuroscience* published more than 3,500 articles while *Brain Research*, the *Journal of Neurochemistry*, and *Neurology* published fewer than 2,600 articles, and still fewer than 1,000 articles for *Annals of Neurology*). Hence, the shift from emblematic neurological journals such as *Neurology* (ranked 10th in 2013-2017), *Brain Research* (19th), or *Annals of Neurology* (56th), must not be interpreted as a lack of interest for PD research papers, but

more a consequence of the increase in research on PD and consequently the evolution of a broader "journal-universe".

The importance of PD research can also be seen through its strong presence in prestigious journals. For example, in 2013-2017, 152 papers related to PD research were published in four multidisciplinary journals (*Nature*, *Nature Communications*, *The Lancet* and *Science*) with IFs >12. Additionally, PD scientific literature is also present in prestigious Neurological/Neuroscience journals such as *Neuron* (48 articles), The *Lancet Neurology* (46) and *Nature Neuroscience* (21); and in biomedical journals such as *Cell Stem Cell* (9 articles), *Nature Medicine* (7) and *Nature Genetics* (7). The number of PD papers in prestigious journals has continuously increased; however, the progression greatly varies from one journal to another: some journals (*Nature*, *The Lancet*, *Science* or *The New England Journal of Medicine*) progress slowly, while others have increased dramatically (4 PD papers in the *PNAS* for 1983-1987 then 154 for 2013-2017; 11 papers in *Nature Communications* for 2008-2012 then 96 for 2013-2017; 7 papers in *Nature Neuroscience* for 1998-2002 then 22 for 2013-2017. A deeper analysis of this heterogeneous behaviour is beyond the scope this study; however, the presence of prestigious journals for PD publications is important as it dramatically contributes to the spread of ideas and development of PD into the general scientific community. This is illustrated by the fact that more than one third of the top-100 most cited works in PD were published in three prestigious journals: *Nature*, *The New England Journal of Medicine*, and *Science* [4,5].

Not surprisingly, the striking growth of scientific publications on PD observed these last decades is not an evolution restricted to just this disease; other neurological diseases such as Multiple Sclerosis and Dementia have also followed similar trajectories (Fig. 1). If the main contributing countries in term of number of publications remains stable over decades, the case of China deserves to be noted as its progression seems to be delayed according to the neurological disorder considered: a highly delayed take-off for Multiple Sclerosis [53], a medium take-off for

Cephalalgia [54]. China has indeed achieved a rapid integration among the major actors in scientific research of neurodegenerative diseases [55]. However, as there is a great disparity in the range of years studied and in the methodologies employed in the various studies on PD, an integrated project dedicated to this topic should provide interesting information about the evolution of the scientific publishing community on neurodegenerative and other neurological diseases at this time.

5. Conclusion

During the past 35 years, PD research has dramatically evolved: PD scientific literature increased 33-fold from 1983-1987 to 2013-2017; the number of countries publishing grew from 37 in 1983-1987 to 123 in 2013-2017, accompanied with a rapid emergence of China during the last decade and a slow progression of African countries; and a 12-fold increase in the number of journals publishing PD research, accompanied by an important change in the landscape of journals with the progressive appearance of new publishing vectors such as Mega journals, Special Issues, or journals specifically dedicated to PD. As the world population continues to grow and age, accompanied by a growing economic and social cost of neurodegenerative diseases, the recent advances in the understanding of PD, and the scientific progresses in various fields (Genetics, Surgery, Neuroimaging, Drug delivery, Nanotechnology, Technology, Medical Devices) are all contributing factors for researchers, physicians, decision-makers and politicians to continue and increase their efforts to keep PD patients hopeful of a cure in the future.

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Table 2. Top most productive journals in Parkinson research during the seven periods: 1983-1987, 1988-1992, 1993-1997, 1998-2002, 2003-2007, 2008-2012 and 2013-2017

1983-1987

Source title	*# publications*	*% of 885*	*WoS category*
Journal of Neurology Neurosurgery and Psychiatry	48	5.4	Clinical Neurology; Psychiatry; Surgery
Neurology	47	5.3	Clinical Neurology
Canadian Journal of Neurological Sciences	46	5.1	Clinical Neurology
Annals of Neurology	41	4.6	Clinical Neurology; Neurosciences
Acta Neurologica Scandinavica	38	4.3	Clinical Neurology
Archives of Neurology	30	3.4	Clinical Neurology
Journal of Neural Transmission	30	3.4	Clinical Neurology; Neurosciences
Brain	25	2.8	Clinical Neurology; Neurosciences
European Neurology	19	2.1	Clinical Neurology; Neurosciences
Neuroscience Letters	17	1.9	Neurosciences

1988-1992

Source title	*# publications*	*% of 2979*	*WoS category*
Neurology	176	5.9	Clinical Neurology
Journal of Neurology Neurosurgery and Psychiatry	104	3.5	Clinical Neurology; Psychiatry; Surgery
Annals of Neurology	92	3.0	Clinical Neurology; Neurosciences
Brain Research	84	2.8	Neurosciences
Movement Disorders	84	2.8	Clinical Neurology
Acta Neurologica Scandinavica	81	2.7	Clinical Neurology; Psychiatry; Surgery
Archives of Neurology	73	2.4	Clinical Neurology
Brain	63	2.1	Clinical Neurology; Neurosciences
Journal of Neurochemistry	54	1.8	Biochemistry & Molecular Biology; Neurosciences
Neuroscience Letters	54	1.8	Neurosciences
Journal of Neural Transmission Parkinson Diseases and Dementia Section	53	1.8	Clinical Neurology
Journal of Neurological Sciences	53	1.8	Clinical Neurology; Neurosciences

1993-1997

Source title	*# publications*	*% of 7003*	*WoS category*
Neurology	329	4.7	Clinical Neurology
Movement Disorders	279	4.0	Clinical Neurology
Brain Research	219	3.1	Neurosciences
Neuroscience Letters	155	2.2	Neurosciences
Journal of Neural Transmission Supplement	148	2.1	Neurosciences
Annals of Neurology	138	2.0	Clinical Neurology; Neurosciences
Experimental Neurology	138	2.0	Neurosciences
Neuroscience	137	2.0	Neurosciences
Journal of Neurochemistry	129	1.8	Biochemistry & Molecular Biology; Neurosciences
Journal of the Neurological Sciences	124	1.8	Clinical Neurology; Neurosciences

1998-2002

Source title	*# publications*	*% of 10741*	*WoS category*
Movement Disorders	624	5.8	Clinical Neurology
Neurology	429	4.0	Clinical Neurology
Brain Research	292	2.7	Neurosciences
Experimental Neurology	225	2.1	Neurosciences
Neuroscience Letters	225	2.1	Neurosciences
Journal of Neurochemistry	222	2.0	Biochemistry & Molecular Biology; Neurosciences
Annals of Neurology	198	1.8	Clinical Neurology; Neurosciences
Journal of Neurology Neurosurgery and Psychiatry	196	1.8	Clinical Neurology; Psychiatry; Surgery
Journal of Neural Transmission	187	1.7	Clinical Neurology; Neurosciences
Journal of Neuroscience	170	1.6	Neurosciences

2003-2007

Source title	*# publications*	*% of 15741*	*WoS category*
Movement Disorders	1006	6.4	Clinical Neurology
Neurology	418	2.6	Clinical Neurology
Parkinsonism Related Disorders	387	2.5	Clinical Neurology
Neuroscience Letters	329	2.0	Neurosciences
Brain Research	315	2.0	Neurosciences
Journal of Neurochemistry	313	2.0	Biochemistry & Molecular Biology; Neurosciences
Journal of Neuroscience	276	1.7	Neurosciences
Experimental Neurology	251	1.6	Neurosciences
Journal of Biological Chemistry	239	1.5	Biochemistry & Molecular Biology
Journal of Neurology Neurosurgery and Psychiatry	218	1.4	Clinical Neurology; Psychiatry; Surgery

2008-2012

Source title	*# publications*	*% of 22057*	*WoS category*
Movement Disorders	1108	5.0	Clinical Neurology
Plos One	599	2.7	Multidisciplinary Sciences
Parkinsonism Related Disorders	565	2.6	Clinical Neurology
Neuroscience Letters	382	1.7	Neurosciences
Journal of Neuroscience	330	1.5	Neurosciences
Journal of Neurochemistry	320	1.5	Biochemistry & Molecular Biology; Neurosciences
Brain Research	290	1.3	Neurosciences
Neurology	284	1.3	Clinical Neurology
Journal of the Neurological Sciences	272	1.2	Clinical Neurology; Neurosciences
Neuroscience	258	1.2	Neurosciences

2013-2017

Source title	*# publications*	*% of 29972*	*WoS category*
Plos One	1335	4.5	Multidisciplinary Sciences
Parkinsonism Related Disorders	881	2.9	Clinical Neurology
Movement Disorders	870	2.9	Clinical Neurology
Scientific Reports	549	1.8	Multidisciplinary Sciences
Neuroscience Letters	339	1.1	Neurosciences
Journal of the Neurological Sciences	322	1.0	Clinical Neurology; Neurosciences
Journal of Parkinson's Disease	308	1.0	Neurosciences
Neurobiology of Aging	307	1.0	Geriatrics & Gerontology; Neurosciences
Journal of Neuroscience	295	1.0	Neurosciences
Neuroscience	288	1.0	Neurosciences
Neurology	288	1.0	Clinical Neurology

Figure 1.

Number of research articles on Parkinson's disease, Dementia and Multiple Sclerosis vs. *SCI-E* (Web of Science): 1983 to 2017

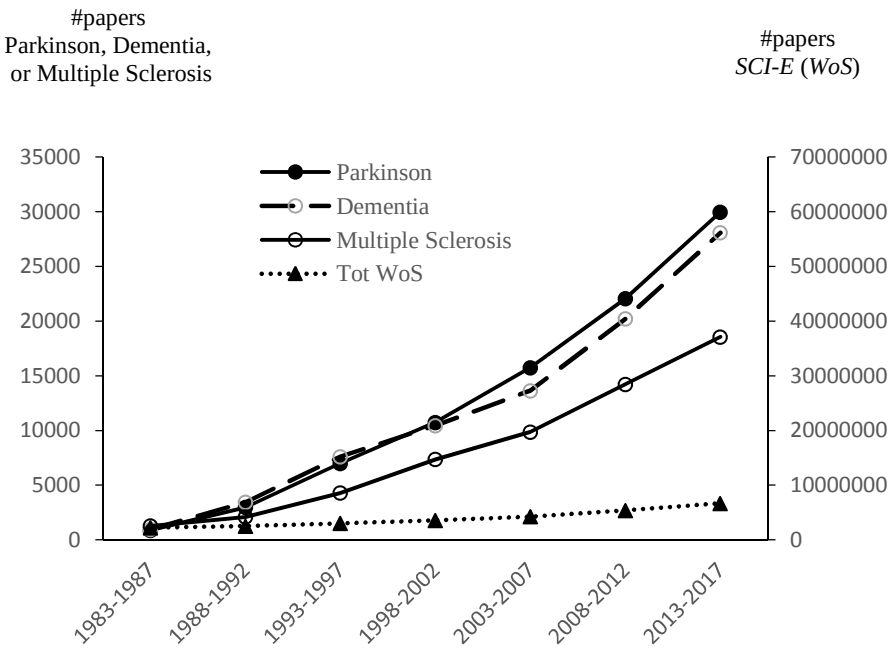


Figure 2.

Number of journals publishing Parkinson's disease research articles

vs. total number of WoS journals: 1983-2017

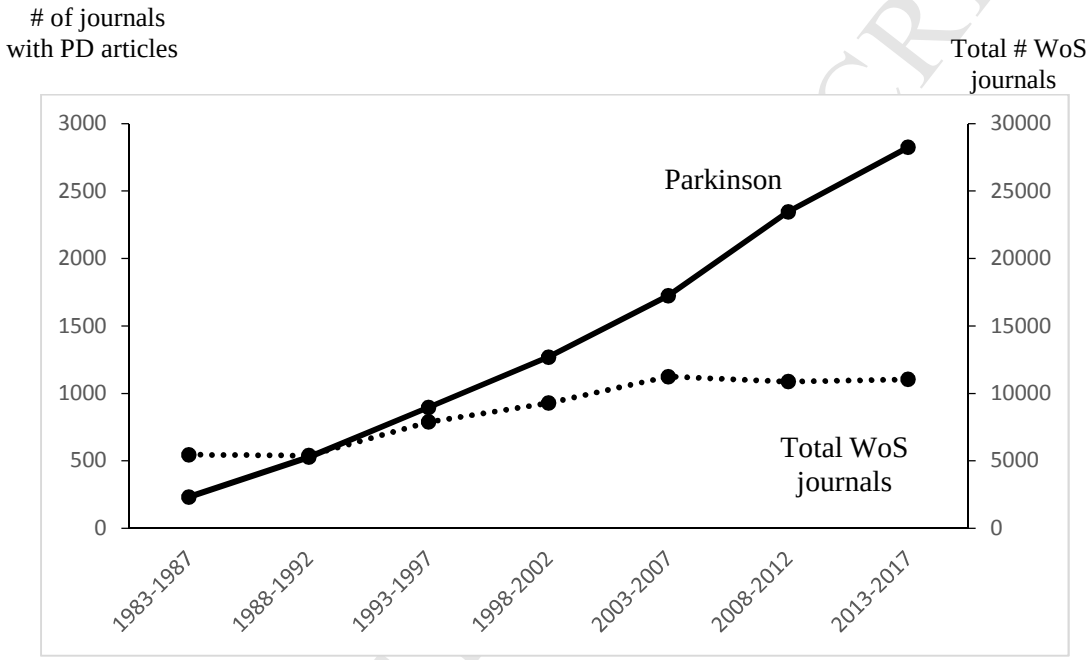


Figure 3.

Number of journals publishing Parkinson's disease research papers from 1983 to 2017 having: 1-5 papers, 6-25 papers, 26-50 papers, and >50 papers

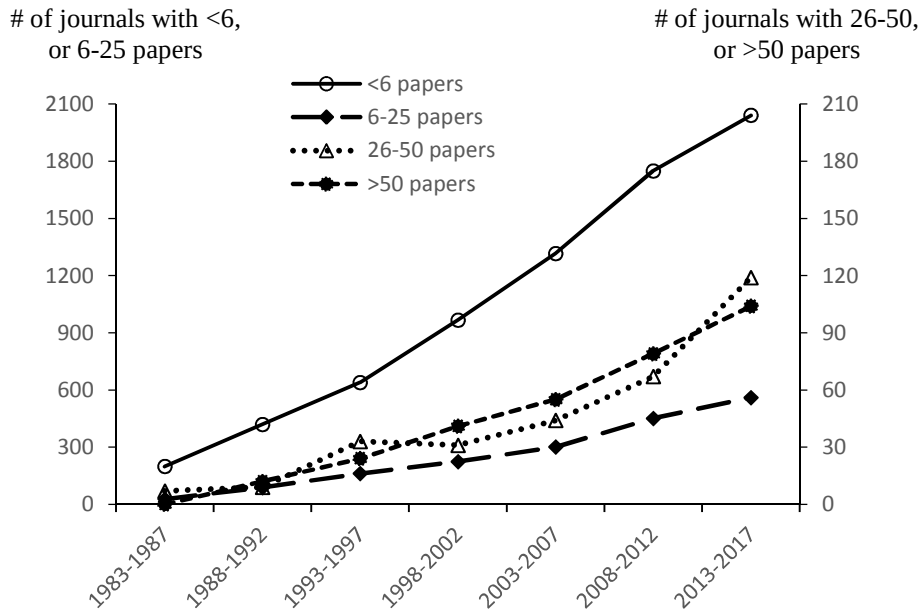
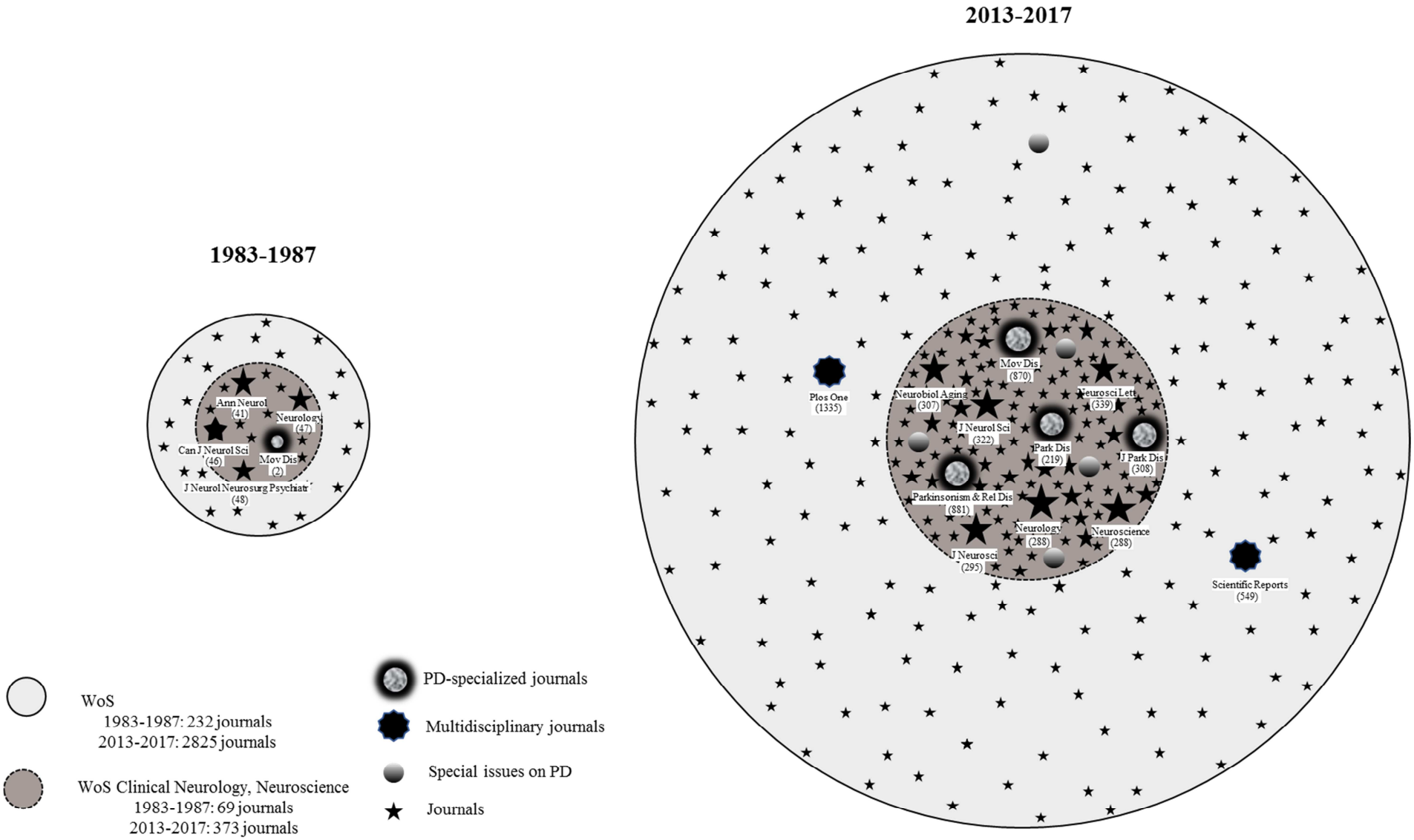


Figure 4. "Journal-universe" publishing Parkinson's disease research articles



***Highlights**

From 1983 to 2017:

- The scientific literature on Parkinson's disease increased 33-fold;
- The number of countries publishing Parkinson's disease papers went from 37 to 131;
- The number of journals publishing Parkinson's disease research increased 12-fold;

Currently:

- The countries contributing the largest percentages of published papers are: USA, China, UK, Germany, Italy, and Canada;
- Ten journals concentrate nearly 19% of the Parkinson's disease literature.