

## A bibliometric analysis of the 50 most cited articles on Parkinson's disease

Most cited articles on Parkinson's disease

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### Abstract

**Aim:** Parkinson's disease is a chronic progressive degenerative disease that restricts people's daily life activities and impairs their quality of life. The aim of this study was to evaluate the features of the most cited articles on Parkinson's disease in the literature.

**Material and Methods:** In the study, a bibliometric analysis of articles in the field of Parkinson's disease indexed in the Thomson ISI Web of Science® was performed. The publications that received the most citations were listed by writing "Parkinson's disease" as a keyword with the "topic" option in the search criteria. The publications cover the years 1991-2015 and include only articles in the English language. In the research, the first 50 articles that received the most citations out of 62861 articles meeting these criteria were examined.

**Results:** The total number of citations of the first 50 articles with the highest number of citations was 92903 (minimum 1040 - maximum 6578). The most cited publication year was 1998 (8 publications), and the most cited source country was the United States of America. The journals in which the most cited articles were published were the "New England Journal of Medicine" and "Science".

**Discussion:** In the study, the most cited publications were identified in order to guide authors dealing with Parkinson's disease. The most common research topics on Parkinson's disease were laboratory studies.

### Keywords

Parkinson's disease; Bibliometric analysis; Citation

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## Introduction

Parkinson's disease (PD) is the most common cause of parkinsonism and is the most common clinical picture among movement disorders after essential tremor. Although PD generally presents with motor system symptoms (resting tremor, bradykinesia, imbalance, rigidity, etc.), besides these, it is a complex disease in which non-motor (autonomic, depression, anxiety, such as behavioral, cognitive and sensory) symptoms are common [1,2].

Variation in the symptoms of PD sometimes makes diagnosis difficult in the early period of the disease and causes a delay in treatment. PD usually occurs in middle and advanced ages, starts at the age of 50-60 years on average, and progresses for approximately 10-20 years. Although different results have been obtained in studies conducted in different countries, it is known that the annual incidence of parkinsonism is between 4.5-21/100000 [3,4]. The prevalence of PD in Eskisehir, Turkey, was reported to be 11/100000 [5].

Many articles are published every year on PD, which is a very important field of neurology, and these publications are used and cited by other scientists. The number of citations of an article shows how many times that article has been cited in other scientific articles. It is an important parameter that shows how much attention this article has attracted [6]. However, in order to measure the impact of an article with the help of the number of citations, it is necessary to wait for a certain time after the article is published.

With the help of bibliometric analysis, all research on a subject can be scientifically reviewed [7]. Many features of the research made can be determined with the bibliometric analysis. The country in which the studies were conducted, the journals in which they were published in and their authors can be determined. In the Web of Science Core Collection, more than 20,000 peer-reviewed, high-quality scientific journals, books, articles that are globally accepted, archived and create a very large database for bibliometric analysis (Web of Science 2020. Available at: <http://www.webofknowledge.com>). PD, which we see frequently in neurology, limits the quality of life and creates an important economic burden on the healthcare system. This is why the analysis of research on PD is valuable. The aim of this study was to analyze the 50 most cited articles on PD in the literature and to identify the most interesting scientific topics in recent years.

## Material and Methods

In our study, a search was made using the topic option with the keyword "Parkinson's disease" in the search section of the Web of Science database. Only articles with PD as the main research subject and written in English were included in the study. All articles were reviewed by a neurologist, and those without the main topic of PD were excluded. A bibliometric analysis of indexed articles about PD has been performed.

Selected publications were analyzed and attributed to one of six subgroups according to the research area (clinical, animal study, treatment, genetics, laboratory, review). The publication year of the articles, the name of the first author, the country and the institution of the first author were evaluated in the study.

This study was conducted in accordance with the ethical standards of the institutional and/or national research committee and the Helsinki Declaration of 1964 and subsequent amendments until 2004.

## Data Analysis

A search in the ISI Web of Science database was performed on July 11, 2020 by writing "Parkinson's disease" in the search section. Fifty articles with the highest number of citations selected according to inclusion criteria were evaluated among 62,861 articles.

Each of the selected articles was reviewed and the data of article, including the title, journal, publication year and country of origin of the first author were extracted. After the data were digitalized and organized, they were analyzed using the SPSS 26.0 package statistics program. The results were expressed as frequency and percentage in discrete variables, mean, standard deviation, minimum and maximum values in continuous variables. To evaluate the relative impact of an article, the citation density (number of citations/years since publication) was calculated.

## Results

Fifty articles selected for the study were divided into six subgroups according to their content, classified as clinical studies, animal studies, treatment (medical and surgical), genetic studies, laboratory studies (molecular and cell biology, neuropathology) and reviews. There were 3 review articles, 3 animal studies, 4 clinical studies, 8 articles on treatment (3 surgical studies, 5 medical studies), 12 genetic studies, 20 laboratory studies (6 cellular and molecular biology studies, 14 neuropathology studies) (Table 1). The 10 most cited papers according to citation density are shown in Table 2.

The total number of citations for the 50 selected articles was 92903, and the number of citations per article was  $1858.1 \pm 1136.9$  (min. 1040 – max. 6578). The citation number of 13 articles was higher than 2000.

When analyzed according to 6 subgroups, the number of citations per article was  $1456.3 \pm 431.1$  (min. 1052 – max. 1910) for clinical studies,  $1522.8 \pm 576.0$  (min. 1172 – max. 2376) for animal studies,  $1328.4 \pm 263.4$  (min. 1040 – max. 1871) for treatment studies,  $1734.4 \pm 716.1$  (min. 1064 – max. 3382) for genetic studies,  $2285.1 \pm 1598.3$  (min. 1071 – max. 6578) for laboratory studies,  $1767.0 \pm 367.2$  (min. 1361 – max. 2076) for reviews.

The most cited article was titled 'Accuracy of clinical diagnosis of idiopathic Parkinson's disease - a clinicopathological study of 100 cases' by Hughes A.J. published in the 'Journal Of Neurology Neurosurgery and Psychiatry' in 1992 (total citations: 6578). The least cited article was titled 'The Sydney multicenter study of Parkinson's disease: the inevitability of dementia at 20 years' by Hely M.A, published in the "Movement Disorders" journal in 1992 (total citations: 1052).

The last article was published by Kalia, LV in the 'Lancet' journal in 2015, and titled 'Parkinson's disease'.

## Genetic studies

One of the studies was on autosomal recessive juvenile parkinsonism (AR-JP), one was about the Ala30Pro mutation, one was about PINK1 (PTEN-induced kinase 1) gene mutation,

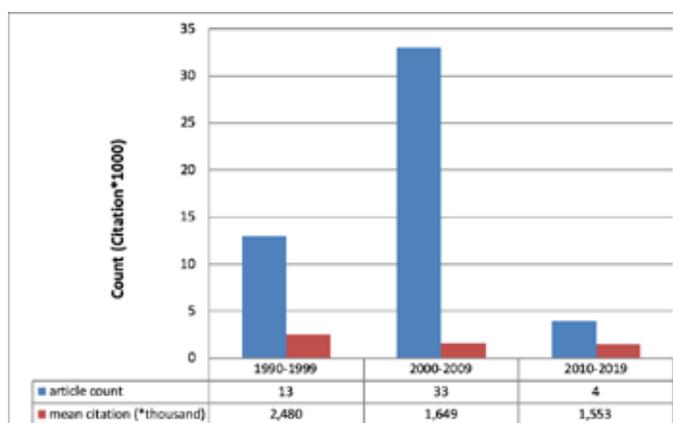
**Table 1.** Publications with the highest number of citations on Parkinson's disease

Title	First author	Country of the first author	Publication year	Title of the journal	Number of citations
Accuracy of clinical-diagnosis of idiopathic Parkinsons-disease - a clinicopathological study of 100 cases	Hughes, A.J.	England	1992	Journal of Neurology Neurosurgery and Psychiatry	6578
Mutation in the alpha-synuclein gene identified in families with Parkinson's disease	Polymeropoulos, M.H.	USA	1997	Science	5367
Staging of brain pathology related to sporadic Parkinson's disease	Braak, H.	Germany	2003	Neurobiology of Aging	4945
Mutations in the parkin gene cause autosomal recessive juvenile parkinsonism	Kitada, T.	Japan	1998	Nature	3382
Parkinson's disease: mechanisms and models	Dauer, W.T.	USA	2003	Neuron	3103
Consensus guidelines for the clinical and pathologic diagnosis of dementia with Lewy bodies (DLB): report of the consortium on dlb international workshop	Mckeith, I.	England	1996	Neurology	2962
Ala30pro mutation in the gene encoding alpha-synuclein in Parkinson's disease	Kruger, R.	Luxembourg	1998	Nature Genetics	2827
Alpha-synuclein locus triplication causes Parkinson's disease	Singleton, A.B.	USA	2003	Science	2801
Chronic systemic pesticide exposure reproduces features of Parkinson's disease	Betarbet, R.	USA	2000	Nature Neuroscience	2376
Parkin is recruited selectively to impaired mitochondria and promotes their autophagy	Narendra, D.P.	USA	2008	Journal of Cell Biology	2155
Parkinson's disease: clinical features and diagnosis	Jankovic, J.	USA	2008	Journal of Neurology Neurosurgery and Psychiatry	2076
Aging and Parkinsons-disease - substantia-nigra regional selectivity	Fearnley, J.M.	England	1991	Brain	2064
Hereditary early-onset Parkinson's disease caused by mutations in pink1	Valente, E.M.	Italy	2004	Science	2042
Movement disorder society-sponsored revision of the unified Parkinson's disease rating scale (MDS-UPDRS): scale presentation and clinimetric testing results	Goetz, C.G.	USA	2008	Movement Disorders	1910
Alpha-synuclein in filamentous inclusions of Lewy bodies from Parkinson's disease and dementia with Lewy bodies	Spillantini, M.G.	England	1998	Proceedings of The National Academy of Sciences of The United States of America	1892
Systematic review of levodopa dose equivalency reporting in Parkinson's disease	Tomlinson, C.I.	England	2010	Movement Disorders	1871
Epidemiology of Parkinson's disease	De lau, I.M. L.	Netherlands	2006	Lancet Neurology	1864
Mutations in lrrk2 cause autosomal-dominant Parkinsonism with pleomorphic pathology	Zimprich, A.	Austria	2004	Neuron	1808
Mutations in the dj-1 gene associated with autosomal recessive early-onset Parkinsonism	Bonifati, V.	Netherlands	2003	Science	1764
Transplantation of embryonic dopamine neurons for severe Parkinson's disease.	Freed, C.R.	USA	2011	New England Journal of Medicine	1582
Cloning of the gene containing mutations that cause park8-linked Parkinson's disease	Paisan-ruiz, C.	USA	2004	Neuron	1535
A randomized trial of deep-brain stimulation for Parkinson's disease	Deuschl, G.	Germany	2006	New England Journal of Medicine	1491
Pink1/parkin-mediated mitophagy is dependent on vdac1 and p62/sqstm1	Geisler, S.	Germany	2010	Nature Cell Biology	1482
Parkinson's disease - first of two parts	Lang, A.E.	Canada	1998	New England Journal of Medicine	1453
Stages in the development of Parkinson's disease-related pathology	Braak, H.	Germany	2001	Cell and Tissue Research	1433
A drosophila model of Parkinson's disease	Feany, M.B.	USA	2000	Nature	1431
Clinical diagnostic criteria for dementia associated with Parkinson's disease	Emre, M.	Turkey	2007	Movement Disorders	1407
Five-year follow-up of bilateral stimulation of the subthalamic nucleus in advanced Parkinson's disease	Krack, P.	Switzerland	2003	New England Journal of Medicine	1379
Dopaminergic loss and inclusion body formation in alpha-synuclein mice: implications for neurodegenerative disorders	Maslah, E.	USA	2000	Science	1366
Non-motor symptoms of Parkinson's disease: diagnosis and management	Ray Chaudhuri, K.	England	2006	Lancet Neurology	1361
Oxidative stress in Parkinson's disease	Jenner, P.	England	2003	Annals of Neurology	1361
Parkinson's disease	Kalia, L.V.	Canada	2015	Lancet	1279
Electrical stimulation of the subthalamic nucleus in advanced Parkinson's disease	Limousin, P.	England	1998	New England Journal of Medicine	1257
Alpha-synuclein locus duplication as a cause of familial Parkinson's disease	Chartier-harlin, M.C.	France	2004	Lancet	1247
Parkinson's disease	Lees, A.J.	England	2009	Lancet	1231
Molecular pathways of neurodegeneration in Parkinson's disease	Dawson, T.M.	USA	2003	Science	1224
Dopamine neurons derived from embryonic stem cells function in an animal model of Parkinson's disease	Kim, J.H.	South Korea	2002	Nature	1177
Mice lacking alpha-synuclein display functional deficits in the nigrostriatal dopamine system	Abeliovich, A.	USA	2000	Neuron	1172
Genome-wide association study reveals genetic risk underlying Parkinson's disease	Simon-sanchez, J.	Germany	2009	Nature Genetics	1171
The ubiquitin pathway in Parkinson's disease	Leroy, E.	USA	1998	Nature	1171
Acceleration of oligomerization, not fibrillization, is a shared property of both alpha-synuclein mutations linked to early-onset Parkinson's disease: implications for pathogenesis and therapy	Conway, K.A.	USA	2000	Proceedings of The National Academy of Sciences of The United States of America	1155
Aggregation of alpha-synuclein in Lewy bodies of sporadic Parkinson's disease and dementia with Lewy bodies	Baba, M.	Japan	1998	American Journal of Pathology	1143

By carrot or by stick: cognitive reinforcement learning in Parkinsonism	Frank, M.J.	USA	2004	Science	1134
A five-year study of the incidence of dyskinesia in patients with early Parkinson's disease who were treated with ropinirole or levodopa	Rascol, O.	France	2000	New England Journal of Medicine	1079
Drosophila pink1 is required for mitochondrial function and interacts genetically with parkin	Clark, I.E.	USA	2006	Nature	1089
Accelerated in vitro fibril formation by a mutant alpha-synuclein linked to early-onset Parkinson disease	Conway, K.A.	USA	1998	Nature Medicine	1079
Neuropathology of Parkinson's disease	Forno, L.S.	USA	1996	Journal of Neuropathology and Experimental Neurology	1071
Mitochondrial dysfunction in drosophila pink1 mutants is complemented by parkin	Park, J.	South Korea	2006	Nature	1064
Deep-brain stimulation of the subthalamic nucleus or the pars interna of the globus pallidus in Parkinson's disease.	Obeso, J.A.	Spain	2001	New England Journal of Medicine	1040
The Sydney multicenter study of Parkinson's disease: the inevitability of dementia at 20 years	Hely, M.A.	Australia	1992	Movement Disorders	1052

**Table 2.** Top 10 Highest Citation Density Papers

Rank	Title	Citation density
1	Braak H, Del Tredici K, Rüb U, de Vos RAI, Jansen Steur ENH, Braak E. Staging of brain pathology related to sporadic Parkinson's disease. <i>Neurobiol Aging</i> . 2003;24(2):197-211.	290,9
2	Kalia LV, Lang AE. Parkinson's disease. <i>Lancet</i> . 2015; 29;386(9996):896-912.	255,8
3	Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. <i>J Neurol Neurosurg Psychiatry</i> . 1992;55(3):181-4.	234,9
4	Polymeropoulos MH, Lavedan C, Leroy E, Ide SE, Dehejia A, Dutra A, et al. Mutation in the alpha-synuclein gene identified in families with Parkinson's disease. <i>Science</i> . 1997 27;276(5321):2045-7.	233,3
5	Tomlinson CL, Stowe R, Patel S, Rick C, Gray R, Clarke CE. Systematic review of levodopa dose equivalency reporting in Parkinson's disease. <i>Mov Disord</i> . 2010;25(15):2649-53.	187,1
6	Dauer W, Przedborski S. Parkinson's disease: mechanisms and models. <i>Neuron</i> . 2003;39(6):889-909.	182,5
7	Narendra D, Tanaka A, Suen D, Youle RJ. Parkin is recruited selectively to impaired mitochondria and promotes their autophagy. <i>J Cell Biol</i> . 2008;183(5):795-803.	179,6
8	Freed CR, Greene PR, Breeze RE, Tsai WY, DuMouchel W, Kao R, et al. Transplantation of embryonic dopamine neurons for severe Parkinson's disease. <i>N Engl J Med</i> . 2001;344(10):710-9.	175,8
9	Jankovic J. Parkinson's disease: clinical features and diagnosis. <i>J Neurol Neurosurg Psychiatry</i> . 2008;79(4):368-76.	173,0
10	Singleton AB, Farrer M, Johnson J, Singleton A, Hague S, Kachergus J, et al. Alpha-Synuclein locus triplication causes Parkinson's disease. <i>Science</i> . 2003;302(5646):841.	164,8



**Figure 1.** Number of publications and average number of citations per decade

one was about DJ-1 (PARK7) gene mutation, three were about alpha-synuclein gene mutation, one was about LRRK2 (leucine rich repeat kinase 2) variant as risk factors in Parkinson's patients, two were related to the pink1 and parkin gene, and two were related to the PARK 8 gene mutation.

**Animal studies**

In one of the studies, cytoplasmic inclusions containing ubiquitin and alpha-synuclein were examined in nigral neurons in rats treated with rotenone, in one alpha-synuclein in transgenic mice and in the last one, locomotor findings were investigated in mice negative for alpha-synuclein.

**Laboratory studies**

A total of 20 articles were divided into cellular and molecular biology and neuropathology studies.

It was observed that 10 out of 14 studies on neuropathology were articles on Lewy bodies alpha-synucleinopathy, 1 on striatonigral degeneration, 1 on complex I activity, oxidative stress and alpha-synuclein aggregation, 1 on the ubiquitin pathway, and 1 on hyaline inclusions and neurofilaments.

Among 6 studies on cellular and molecular biology, 2 were related to mitochondrial dysfunction and oxidative stress, 1 to free oxygen radicals and oxidative stress, 2 to embryonic stem cells, 1 to mitochondrial damage, ubiquitylation and autophagy.

**Treatment studies**

Three out of 8 studies were related to surgery and 5 were related to medical treatment.

Two of the 5 studies about medical treatment were related to levodopa treatment, 1 to Unified Parkinson's Disease Rating Scale, part III (UPDRS-III) scoring in patients who did not receive treatment, 1 to ropinirole and levodopa treatment, 1 to dopamine therapy and learning.

It was observed that 2 of the 3 surgical treatment studies were related to bilateral stimulation of the subthalamic nucleus, and 1 to deep-brain stimulation.

**Clinical studies**

The studies were related to the evaluation of the MDS-UPDRS scale (1), dementia in Parkinson's patients (1), and non-motor and motor symptoms in the follow-up of treatment response (2)

**Reviews**

There was 1 article on Medline search results for "Parkinson's disease", "diagnosis" and "signs and symptoms"; 1 article was on the treatment of non-motor symptoms, and 1 article was on non-genetic risk factors and prognosis forPD.

The 50 most cited publications were published between 1991 and 2015. It was seen that the year with the most citations was 1998 (8 publications). When analyzed according to decades, 13 publications between 1990-1999 had an average citation number of 2480.5 ± 1751.5 (min. 1071 – max. 6578), 33 publications between 2000-2009 had 1649.8 ± 780.7 (min. 1040 – max. 4945) and 4 publications between 2010 -2019 had

1553.5 ± 246.4 (min. 1279 – max. 1871) (Figure 1).

According to the first author's country, the most cited articles were published in the United States (13, 26%), United Kingdom (9, 18%) and Germany (5, 10%). According to the journals, the most cited articles were published in the New England Journal of Medicine (7, 14%) and Science (7, 14%).

## Discussion

Parkinson's disease differs from other causes of parkinsonism in terms of its pathology, clinical presentation and response to dopaminergic therapy. It is very important to diagnose and treat Parkinson's disease because it has the best response to medical treatment among neurodegenerative diseases. The motor signs of PD are characterized by asymmetric-onset resting tremor, rigidity, bradykinesia, akinesia, and postural abnormalities [8,9]. The gold standard in the diagnosis of PD is still neurological examination. Although PD is diagnosed with motor findings, it is a complex disease that includes motor and nonmotor findings. Due to the wide variety of clinical findings, it can be difficult to diagnose the disease at the initial stage of the disease, which can cause a delay in treatment.

In a study conducted in the Netherlands, it was observed that 26% of Parkinson's patients used inappropriate drugs and 33% had complications [10]. In another study, treatment errors were detected in 39% of Parkinson's patients, and an approximately 5 points worsening in UPDRS scores at discharge was found compared to UPDRS before hospitalization [11].

The fifty most cited articles out of 62,861 on Parkinson's disease were selected for analysis. The total number of citations of the articles was 92903 and ranged from a minimum of 1040 to a maximum of 6578 per article. The year 1998 was in the first place among the publication years of the most cited articles. In terms of citation density, articles published in the 1990s and 2000s were at the forefront.

Laboratory studies were included in the list of 50 articles with the highest number of articles (20) and constituted the most cited group with 2285 citations per article. The largest group of laboratory studies was nephropathology, which showed that this area was more researched, aroused clinical attention, and the effect on researchers was more prominent.

Review articles, the second most frequently cited group. This shows that general knowledge about PD has been used by researchers in a comprehensive way, as well as the results of current researches.

According to the countries of the first authors of most cited articles, the United States of America (USA) was the first. This has revealed that the USA is the leader in the scientific field about Parkinson's disease, with studies that attract more attention.

High citation can give a good estimate of the impact of a journal. The most frequently cited journals were the New England Journal of Medicine (7, 14%) and Science (7, 14%), which showed that these journals are important sources of information about Parkinson's disease.

## Conclusions

Although not a perfect method, citation analysis can largely reflect the impact of articles on a topic. In this study, articles on PD, which has a high prevalence, were examined, and the

number of citations of these publications was evaluated, and the characteristics of the fifty most cited publications were determined and analyzed. Data were presented on issues that have attracted attention and the popular journals about PD. This research will help us understand the evidence base for clinical decision-making in the field of PD.

## Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

## Animal and human rights statement

All procedures performed in this study 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. No animal or human studies were carried out by the authors for this article.

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## Conflict of interest

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