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Review Article

Measuring the growth and trends of neurology research output during 2012-2021

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ABSTRACT

This paper describes scientometric study of the Neurology research in global as per the number of publications indexed in the Web of Science database. During the study period (2012-2021) a total of 12639 publications were published in the field of Neurology. The average number of publications published was 1263.9 and the highest numbers of publications (1741) were published in the year 2021. Neurology research researchers have contributed more in the form of journal articles. Anonymous is the most productive author with 155 (1.23%) publications followed by Matsumoto N with 63 (0.50%) publications. The average productivity per author for the period 2012 to 2021 is 0.26 and the degree of collaboration is C = 0.85. USA topped the list with highest share 4232 (33.48%) of publications. England ranked second with 1345 (10.64%) share of publications followed by Germany 1088 (8.61%) share of publications. 12,423 global institutions involved in the Neurology research. Among these top 12 institutions 9 are from USA, 2 are from UK and one from Canada. The scientific literature on neurology is spread over 1664 different web of science indexed journals.

1. Introduction

Neurology is a branch of medicine dealing with disorders of the nervous system. Neurology deals with the diagnosis and treatment of all categories of conditions and disease involving the central and peripheral nervous system including their coverings, blood vessels, and all effector tissue, such as muscle. Neurological practice relies heavily on the field of neuroscience, which is the scientific study of the nervous system. Neurology implies the branch of medicine pertaining to the study and treatment of disorders of the nervous system. The nervous system is a complex, sophisticated system that regulates and coordinates body activities. Neurology has been at the heart of the Chiropractic profession since its very beginning. But it is only in recent years that advances in clinical neuroscience have allowed us to understand how our treatments affect the nervous system; and how this effect can help us to restore and preserve good structure and function within the musculoskeletal system.[1]

Scientometric analysis is the quantitative study of a subject growth by using bibliometric indicators and statistical tools and techniques. It throws light on the pattern of growth of individual to the respective subject literature, inter-relationship among different branches of knowledge, productivity, authorship pattern, degree of collaboration, pattern of collection building, and their use. Gradually the Scientometric studies are attaining the status of inter-disciplinary in nature. This is clear from the scientometric evidence from 2012 to 2021, the number of publications was increased from 1046 to 1204. There is a significant increase in the literature ttherefore the present study aims to know the growth and development of publications in the field of neurology.

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2. Review of Literature

Review of literature plays a significant role of any research study.

Wang et al[2] carried out a visual analysis of global health research from the perspective of scientific output characteristics, scientific research cooperation networks, keywords, and highly cited literature based on the 14,692 document data retrieved from the Web of Science from 1996 to 2019. The results show that scholars' interest in global health research is increasing, especially after the outbreak of SARS. The USA, England, Canada, Australia, and China have the most prominent contributions to global health research. Significant authors, high-impact journals, and core institutions were also identified. Chaman Sab[3] examined 29153 publications in medical research, the present study deals with the Assessment of Indian medicine research output as reflected in Web of Science (WOS) database for the period 2009 to 2018 for identifying the research output in the field of medical literature. It also provides a comparative evaluation and performance of different types of scientometric indicators, such as the number of publications, the number of citations, relative growth, doubling time, activity index, and collaboration from India.

Karthikeyan[4] examined the overall production of scientific articles in Neuroscience research during the period 1986-2015 in worldwide. The study finds that the total number of publications is between 100 and 1000 per year for the first fifteen years of study i.e. 1986-2000, more than 1000 but below 1500 during 2001 and 2004 and more than 3000 for the further study period 2005-2015. Gautam, Vinod Kumar[5] focused on the growth of neuroscience research in India and its impact on scholarly world. A total of 4812 data was collected from the Scopus database for the period of 2004-2018. Analysis of the data revealed a considerable increase in the Annual Growth Rate in neuroscience research with a 10.52% CAGR for the entire period. Relative Growth Rate (RGR) was increasing with minor fluctuations i.e. growth in Neuroscience research is not an exponential ratio rather than it is the arithmetic ratio and Doubling Time is similar to RGR. Author Shukla, D. is the most productive author contributing 42 articles.

Sivasami[6] discussed on Scientometric analysis of research on neurophysiology, the data have been accessed from the Scopus database. A total of 1366 records were retrieved from the Scopus database, the year-wise analysis shows neurophysiology research publications an increasing and decreasing trend. In the document type-wise research publications on neurophysiology, the article has the first position with 506 publications, among the top twenty authors, De Paola, L. has the first place with 1.61 percent contributions on neurophysiology research, collaborative contributions are more, single authors' contributions are very least. Alhibshi[7] analyzed the Neurosciences research productivity in the Kingdom of Saudi Arabia (KSA) from 2013-2018 based on the Scopus database. Saudi Arabia is ranked 39th in publishing neuroscientific research worldwide. The number of yearly published articles has increased from 123 to 332 during the time between 2013 and 2018. King Saud University & King Abdul Aziz University & their corresponding regions namely the Western and Central regions are the major contributors to publications. Neuroscientists working in Saudi Arabia collaborate with scientists from all over the world. The top 10 preferred journals are international.[8–12]

3. Objectives for the Study

The present study has following objectives as enumerated bellow:

1. Year wise growth of publications
2. Most prolific authors
3. Highly productive countries
4. Most productive institutes
5. Most preferred source titles and
6. High productive subject areas

4. Materials and Methods

Web of Science bibliographic database was used to harvest the bibliographical details of referred research publications on neurology in topic field. The Web of Science database allows us to refine the results in terms of publication years, countries, institutes, authors, subjects and source titles. The Time Span was used from 2012 to 2021. Total 12,639 research publications were retrieved with this search syntax for research analysis.

5. Data Analysis and Interpretations

5.1. Form of publications

Neurology research has been published in different forms of publications in the world. Out of the 12639 published papers, 9364 (74.09%) were Journal articles followed by Review articles with 1607 (12.71%), Editorial materials with 1210 (9.57%), Letters with 298 (2.3.6%) and the remaining forms are less than 1% of the publications. This is interesting to note that, the study neurology research researchers have contributed more in the form of journal articles.

5.2. Relative growth rate (RGR)

The Relative Growth Rate (RGR) is the increase in number of articles or pages per unit of time. This definition derived from the definition of relative growth rates in the study of growth analysis in the neurology research. The mean relative growth rate (R) over the specific period of interval can be calculated from the following equation.

Table 1: Form of publications

S.No.	Title	Articles	Percentage
1	Articles	9364	74.09
2	Review articles	1607	12.71
3	Editorial materials	1210	9.57
4	Letters	298	2.36
5	Book reviews	49	0.39
6	Biographical-Items	43	0.34
7	Corrections	39	0.31
8	News Items	17	0.13
9	Reprints	7	0.05
10	Poetry	2	0.02
11	Retractions	2	0.02
12	Retracted publications	1	0.01
Total		12639	100.00

Relative growth rate (RGR)

1 - $2R_{=}$Log W_2 – Log W_1/ T_2-T_1

Whereas

1-2 ^{R}- mean relative growth rate over the specific period of interval

Log_e W_1 - log of initial number of articles

Log_e W_2 - log of final number of articles after a specific period of interval

T_2-T_1- the unit difference between the initial time and the final time

The year can be taken here as the unit of time. The RGR for articles is hereby calculated.

Therefore

1-2) can represent the mean relative growth rate per unit of articles per unit of year over a specific period of interval.

1-2/ T-T

5.2.1. Doubling time (DT)

There exists a direct equivalence between the relative growth rate and the doubling time. If the number of articles or pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and end of this period must be logarithm of the number 2. If natural logarithm is used this difference has a value of 0.693. Thus, the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the formula.

Doubling Time (DT) = 0.693/R

Therefore,

Doubling time for articles Dt (a)= 0.693/1-2)

A total of 12639 publications were published during 2012-2021. The average number of publications per year was 1263.9. The highest publications (1741) were in 2021 and the lowest publications (1046) was 2017. It was observed that there was a fluctuation trend of publications during 2012-2021.

The year wise relative growth rate is found to be in the range of -0.01 to 0.20. It has been observed from Table 2 and figure 2 that RGR is fluctuation trend from 2013 (-0.20) to 2020 (0.20). The doubling time was also fluctuation trend from 2013 (-3.46) to 2016 (13.86).

5.3. Identification of most prolific authors

A total number of 4,489 authors were identified from the 12,639 published bibliographic research articles. The authors having 30 or more publications during the study period are given in Table 3. Anonymous is the most productive author with 155 (1.23%) publications followed by Matsumoto N with 63 (0.50%) publications, Okumura, A with 59 (0.47%) publications, Saito Y with 39 (0.37%) publications, Sasaki M with 46 (0.36%) publications, Yamamoto T with 43 (0.34%) publications, and Saitsu H with 42 (0.33%) publications. Total of 51,689 authors are contributed entire research output of the study period.

5.4. Author's productivity

In a study of author productivity, a large number of authors were classified according to the number of articles they had published during a certain period. To calculate Author productivity a formula has been applied. The formula is mathematically represented as below:

Average Author per Paper = No. of Authors/No. of Papers

Productivity per Author = No. of Papers/No. of Authors

It is one of the productivity of the total authors involved in contributing the research productivity. But the contribution of individual authors can't measured in these methods of measurements. Table 4 depicts the data pertaining to author productivity and average author per paper. It is revealed from the table no. 4 that the average number of authors per articles is 4.01 for 12639 articles published between the periods 2012 to 2021.

The average productivity per author for the period 2012 to 2021 is 0.26. It is also clear from above table that for the years 2012, 2019 and for the years 2016, 2017 years are

Table 2: Relative growth rate (RGR) and Doubling time (DT) of publications

Year	No. of Publications	Percentage	W1	W2	RGR	DT
2012	1442	11.41	-	7.27	-	-
2013	1177	9.31	7.27	7.07	-0.20	-3.46
2014	1069	8.46	7.07	6.97	-0.10	-6.93
2015	1132	8.96	6.97	7.03	0.06	11.55
2016	1184	9.37	7.03	7.08	0.05	13.86
2017	1046	8.28	7.08	6.95	-0.07	-9.90
2018	1204	9.53	6.95	7.09	0.14	4.95
2019	1193	9.44	7.09	7.08	-0.01	-6.93
2020	1451	11.48	7.08	7.28	0.20	3.46
2021	1741	13.77	7.28	7.46	0.18	3.85

Table 3: Identification of most prolific authors

S.No.	Author	No. of publications	Percentage
1	Anonymous	155	1.23 %
2	Matsumoto N	63	0.50 %
3	Okumura A	59	0.47 %
4	Saito Y	47	0.37 %
5	Sasaki M	46	0.36 %
6	Yamamoto T	43	0.34 %
7	Saitsu H	42	0.33 %
8	Takahashi Y	37	0.29 %
8	Sugai K	36	0.28 %
10	Gronseth G S	34	0.28 %
11	Maegaki Y	33	0.26 %
12	Osaka H	32	0.25 %
13	Haginoya K	31	0.24 %
14	Kobayashi K	31	0.24 %
15	Saito T	31	0.24 %
16	Nakagawa E	30	0.24 %
17	Yamagata T	30	0.24 %

Table 4: Author productivity

Year	No of Authors	No of Articles	Average Author Per Paper	Productivity per Author
2012	6351	1442	4.40	0.23
2013	4392	1177	3.73	0.27
2014	3194	1069	2.99	0.33
2015	3963	1132	3.50	0.28
2016	4105	1184	3.47	0.29
2017	3648	1046	3.49	0.29
2018	4686	1204	3.89	0.26
2019	5236	1193	4.39	0.23
2020	7548	1451	5.20	0.19
2021	8746	1741	5.02	0.20

equal average productivity per author is recorded i.e., 0.23 and 0.29 respectively.

5.4.1. Degree of Collaboration

The degree of collaboration is defined as the ratio of the number of collaborative research articles to the total number of research articles in the subject during a certain period of time. The formula suggested by Subramanyam (1983) is used. It is expressed as

$$C = \frac{N_m}{N_m + Ns}$$

Where, C is the degree of collaboration in a discipline. N_m is the number of multiauthored research papers in the discipline published during a year. N_s is the number of single authored papers in the discipline published during the same year.

The authorship pattern was analysed to determine the percentage of single and multiple authors. Table 5 presents the single and multiple authors productivity pattern on yearly basis. There were 10719 (84.81%) multi authored and only 1920 (15.19%) single authored publications. The productivity patterns on the neurology publications are much contributed by the multiple authors than the single author since 2012 to 2021.

The degree of collaboration is determined by using this formula based on this study, the degree of collaboration C = 0.85. i.e, 85 percents of collaborative author's articles is published in this study. The degree of collaboration in producing research output on neurology research has shown a fluctuating trend.

5.5. Highly productive countries

H gives highly productivity countries ((≥200 publications) in Neurology research. In all there were146 countries that have at least one publication in the research field of Neurology. USA topped the list with highest share 4232 (33.48%) of publications. England ranked second with 1345 (10.64%) share of publications followed by Germany 1088 (8.61%) share of publications, Japan with 1080 (8.54%) share of publications, Italy with 956 (7.56%) share of publications, Canada with 788 (6.23%) share of publications, France with 677 (5.36%) share of publications, China with 652 (5.16%) share of publications, Netherlands with 528 (4.18%) share of publications and Australia with 485 (3.84%) share of publications respectively.

5.6. Highly productive institutes

Table 7 presents the institutions that have contributed more than 150 publications during 2012-2021. There were 12,423 global institutions involved in the Neurology research. Among these top 12 institutions 9 are from USA, 2 are from UK and one from Canada. Mayo Clinic, USA topped the list with 331 (2.62%) publications followed by Harvard Medical School, USA with 255 (2.02%) publications, UCL Institute of Neurology, UK with 222 (1.76%) publications, Massachusetts General Hospital, USA with 206 (1.63%) publications, University of California San Francisco, USA with 205 (1.62%) publications, University of Toronto, Canada with 195 (1.54%) publications, Johns Hopkins University, USA with 194 (1.53%) publications, University of Pennsylvania, USA with 183 (1.45%) publications and University of California Los Angeles, USA with 174 (1.38%) publications.

5.7. Most preferred source titles

HHH provides the leading journals each with number of publications and impact factor. The scientific literature onneurology is spread over 1664 different web of science source journals. It reveals that Neurology the list with the highest number of publications 1619 (12.81%) and the impact factor is 9.901, followed by Brain Development with a share of 1400 (7.39%) publications and the impact factor is 2.272. European Journal of Pediatric Neurology occupies the third position with 1144 (9.05%) publications and the impact factor is 3.692. The fourth highest source title is Epilepsy and Behavior with 235 (1.86%) publications and the impact factor is 3.337, Journal of the Neurological Sciences with 153 (1.21%) publications and the impact factor is 4.553 and European Journal of Neurology with 146 (1.16%) publications and the impact factor is 6.089.

5.8. High productivity subject areas

The scientific literature on neurology is spread over 91 different subjects. Table 9 shows high productivity subjects which are contributing more than 100 articles. It is found that Neurosciences Neurology has highest number of articles with 7129 (56.40%) followed by Behavioral Sciences contributing 5119 (40.50%) articles. Pediatrics occupies the third position with 1819 (14.39%) articles. The fourth highest articles belonged to the subject Research Experimental Medicine with 798 (6.31%), General Internal Medicine with 628 (4.97%) and Health Care Sciences Services with 622 (4.92%) articles respectively.[13–15]

6. Conclusions

The current scientometric study shows that a total of 12639 articles on neurology research were published in the web of science database during 2012 to 2021. The average number of publications per year was 1263.9. Since 2021, the number of publications related to this field has grown rapidly. There was a fluctuation trend of publication during the study period. The topmost research active institution was the Mayo Clinic, USA topped the list with 331 (2.62%) publications followed by Harvard Medical School, USA with 255 (2.02%) publications and the USA has a significant

Table 5: Degree of collaboration

Year	Single Author		Multi Authors		Total	Degree of Collaboration
	No. of Output	Percentage	No. of Output	Percentage		
2012	176	9.17	1266	11.81	1442	0.88
2013	231	12.03	946	8.82	1177	0.80
2014	143	7.45	926	8.64	1069	0.87
2015	197	10.26	935	8.72	1132	0.82
2016	167	8.70	1017	9.49	1184	0.86
2017	89	4.63	957	8.93	1046	0.91
2018	159	8.28	1045	9.75	1204	0.87
2019	281	14.63	912	8.51	1193	0.76
2020	218	11.35	1233	11.50	1451	0.85
2021	259	13.49	1482	13.82	1741	0.85
Total	1920	100.00	10719	100.00	12639	8.47

Table 6: Highly productive countries

S. No.	Country	Total Publications (%)	S. No.	Country	Total Publications (%)
1	USA	4232 (33.48%)	10	Australia	485 (3.84%)
2	England	1345 (10.64%)	11	Turkey	387 (3.06%)
3	Germany	1088 (8.61%)	12	Spain	358 (2.83%)
4	Japan	1080 (8.54%)	13	Switzerland	343 (2.71%)
5	Italy	956 (7.56%)	14	Austria	284 (2.25%)
6	Canada	788 (6.23%)	15	India	251 (1.99%)
7	France	677 (5.36%)	16	South Korea	231 (1.83%)
8	China	652 (5.16%)	17	Belgium	230 (1.82%)
9	Netherlands	528 (4.18%)	18	Sweden	221 (1.75%)

Table 7: Highly productive institutes

S. No.	Institutions	Country	No. of Publications
1	Mayo Clinic	USA	331 (2.62%)
2	Harvard Medical School	USA	255 (2.02%)
3	UCL Institute of Neurology	UK	222 (1.76%)
4	Massachusetts General Hospital	USA	206 (1.63%)
5	University of California San Francisco	USA	205 (1.62%)
6	University of Toronto	Canada	195 (1.54%)
7	Johns Hopkins University	USA	194 (1.53%)
8	University of Pennsylvania	USA	183 (1.45%)
9	University of California Los Angeles	USA	174 (1.38%)
10	Harvard University	USA	164 (1.30%)
11	Washington University	USA	157 (1.24%)
12	Kings College London	UK	154 (1.22%)

Table 8: Sourcetitle of publications

Rank	Source Title	No. of Publications	Percentage	Impact Factor
1	Neurology	1619	12.81	9.901
2	Brain and Development	1400	11.08	2.272
3	European Journal of Pediatric Neurology	1144	9.05	3.692
4	Epilepsy and Behavior	235	1.86	3.337
5	Journal of the Neurological Sciences	153	1.21	4.553
6	European Journal of Neurology	146	1.16	6.089
7	Pediatric Neurology	139	1.10	2.398
8	Nervenarzt	136	1.08	1.214
9	Neurological Sciences	130	1.03	3.830
10	Journal of Child Neurology	128	1.01	1.385

Table 9: High productivity subject areas

S.No.	Subject	No. of Articles	Percentage
1	Neurosciences Neurology	7129	56.40
2	Behavioral Sciences	5119	40.50
3	Pediatrics	1819	14.39
4	Research Experimental Medicine	798	6.31
5	General Internal Medicine	628	4.97
6	Health Care Sciences Services	622	4.92
7	Communication	301	2.38
8	Psychiatry	299	2.37
9	Psychology	296	2.34
10	Toxicology	271	2.14

research output as a country with 4232 publications. Three of the most productive journals are Neurology, Brain and Development and European Journal of Pediatric Neurology. The results of this research showed that Indian author publications was very low. Maybe neurology Indian researchers can use the results of this study to identify their research colleagues around the world and increase the publication productivity.

7. Source of Funding

None.

8. Conflict of Interest

None.

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