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Scientometric analysis on scholarly communications of National Institute of Mental Health and Neurosciences (NIMHANS), India

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Abstract:

The study investigated the research publications of the National Institute of Mental Health and Neurosciences (NIMHANS) during the period 2009-2018 as reflected in Web of Science database. The results show that 1694 papers were published and gained 20158 citations. The average number of citations per paper identified is 11.89%. Neuroscience Neurology, Psychiatry, and Surgery are the most preferred domains to publish the articles. The global collaboration of NIMHANS is mostly with the USA, England, and Australia. The degree of collaboration is 0.99. The researchers of NIMHANS prefer to publish their papers in Indian journals. Lotka's law was tested to measure the scientific productivity of authors. Further, the study analyzed the author's productivity, predominant authors, institutional collaboration, impact factor and highly cited papers.

Keywords: NIMHANS, Scientometrics, Authorship Pattern, Citations, Lotka's Law

Introduction:

Neuroscience is the scientific study of the nervous system and a multidisciplinary subject in science, categorized into the branches of cellular, molecular biology, anatomy and physiology. A few macro and micro levels of quantitative studies of neuroscience research literature in India has been carried out in the past. This study confined to analyze the micro-level of the research performance of NIMHANS. Scientometrics is the tool to study the quantitative and qualitative aspects of research productivity.

The National Institute of Mental Health and Neuro Sciences (NIMHANS) is a multidisciplinary institute for patient care and academic pursuit in the field of mental health and neurosciences which is situated in Bangalore, India. The institute was originated in 1847 when Bangalore Lunatic Asylum was founded. The institute has become "Deemed University" in 1994 by UGC. NIMHANS has been conferred as "Institute of National Importance" in 2012¹.

The research domains have been divided into three major categories namely, Basic Science Research, Behavioral Science and Neuro Science Research. The institute gets funds from national agencies such as DBT, DST, ICMR, CSIR, NIH, (USA) and MRC (UK). It has separate publication division and publishes books, teaching materials, technical reports for academic purposes. Since the institute had originated in the 18th century, it has heritage museum to highlight the history of NIMHANS. The institute has a modernized library and information center, which holds a vast collection of print and online resources in the field of mental health and neurosciences.

Related Work:

Anilkumar, Nishtha² (2014), analyzed the research trends of PRL for the period 1997-2006. The data has been taken from their annual reports of the institute. The research studied 1318 papers published in journals. The author studied the publication by division wise of the institute which has six divisions in PRL. The study summarized that the thrust area of PRL research was atmospheric dynamic and meteorology with 114 papers followed by Solar Physics with 82 articles, hydrology and glaciology with 70 papers, and so on. A very less number of documents were published in the area of Condensed Matter with 12 papers during the period. Theoretical Physics division has scored more number of papers; the reason could be more number of faculty and students. Further, high number of publications was directly correlated with more number of journals subscribed by the institute.

Hasan, N. and Singh, M.,³ (2015) studied the Research output of the top five IITs during the period 2009-2013. The study analyzed the publications of India with a global level, and the Indian share is of 215,019 (2.72%) out of 7,894,639 publications as recorded in the Web of Science database. The IITs' share was 9.32% out of 215,019 papers of Indian contribution. IIT Kharagpur with 5271 papers, is the highest among five IIT's followed by IIT Madras, IIT Bombay, IIT Delhi and IIT Kanpur. IIT Bombay has received more number of citations i.e. 6.7 per article and IIT Bombay and IIT Madras got highest H-Index i.e. 45. USA was the top country collaborating with all the IIT's. IIT Bombay with BARC was the first and IIT Delhi, Kanpur, Kharagpur and Madras with CSIR were the first.

Visakhi, P., and Gupta, R.,⁴ (2013) carried out a scientometric study of IISER, Mohali for the period 2008-2012. The study used the Scopus database to collect the data. IISER, Mohali has published 186 papers and confined that annual average growth rate of publications was 44.98%. They calculated the average citation per article for a three-year citation window, and it was 3.40 during the period. The country's collaboration was high with the USA (20.43%) study followed by Germany and Spain. The institute has mostly collaborated with Max Planck Institute of Chemistry, Mainz, Germany etc. IISER, Mohali has also worked with Punjab University, Chandigarh (21papers) IIT, Kanpur (19) papers, and Guru Nanak Dev University, Amritsar (12papers) in India.

Noruzi, A., Abdekhoda, M.,⁵ (2013) studied the research output of Iraqi-Kurdistan universities using the Scopus database for the period 1970-2012. The study analyzed 459 papers published by the universities. Their results show that the most favored journals were Eastern Mediterranean

Health Journal and Journal of Chinese Clinical Medicine, etc. The study found that 237 (52%) publications out of 459 have international collaboration and 60% of publications were not cited. Finally, the study suggested that Iraqi-Kurdistan universities should establish repositories at the regional and institutional levels so as to increase the impact of the research.

Suresh, N., and Thauskodi, S.,⁶ (2019) explored the research productivity of ICAR-IIHR, Bangalore for the period 1989-2018 using the Web of Science database for collecting the data. The study identified 1095 research publications. Document type “Journal article” is the highest with 90.13%. IIHR researchers mostly preferred to publish their work in Indian journals. USA has gained top position for collaboration with IIHR.

Senthil Kumar, N., Radhakrishnan, N., Hadimani, Nagesh, Prabahar, P.,⁷ (2018) have investigated the research performance of CSIR-CECRI, Karaikudi for the period 2010-2015 and retrieved 650 articles using Web of Science database. The highest number of publications was noticed in the year of 2011 with 131 papers. South Korea was the top country to have collaborated with CECRI by its contribution with 36 (5.5%) followed by the USA with 17 (2.62%) and Japan with 16 (2.46%). The study analyzed year-wise publications, document type, subject-wise distributions, highly cited articles and most favored authors as well.

Kumar, Satish⁸(2018) evaluated the research productivity of ARIES, Nainital. The study focused on 574 research papers which were published during 2001-2015 using the Web of Science data. 510 research publications were found to be refereed papers out of 574 and the remaining were conferences, symposiums and bulletins etc. Further, the study analyzed active authors, citations, H-index and collaborating institutions.

Priya, Saravanan and Radhakrishnan, Natarajan.,¹⁰ (2018) explored the study of global research trends in entomology. A total of 1671 records were downloaded from the web of science database. The study analyzed the relative growth rate, doubling time, authorship pattern, keyword distribution, etc. The authors’ collaboration is 0.97. The output of the study shows that highest number of articles published in the year 2016 with 394 (23.6%) and the lowest articles was published in the year 2012 with 270 (16.2%). USA was the top country to publish articles in the field of entomology followed by South Korea, Peoples R China. India stands in the sixth position with 90 (5.4%) during the period 2012-2016.

Objectives of the Study:

- To describe the authorship pattern and degree of collaboration
- To figure out the most preferred journals for publications

- To visualize co-authorship network using VOSviewer
- To test the Lotka's Law of Scientific Productivity

Methodology:

The study was carried out using the database Web of Science and the data were downloaded for the period 2009-2018. Advanced search as “Organization Enhanced OG=National Institute of Mental Health & Neurosciences-India AND PY=2009-2018” was used to download the records. The results found that totally 2984 publications were retrieved and further refined with “Article” only option with the records 1694 articles taken into the study and other document types like “Editorial material, proceedings paper, biographical item, meeting abstract, review, correction, book chapter, and the letter” were not taken for analysis. The data were downloaded from the database on 26th June. 2019. MS-Excel was also used to analyze the data.

In addition, National and International level assessment with the neuroscience research literature published during the period was considered. To get the national level data, Advance search as “TS=Neuro* AND CU=INDIA and the year range 2009-2018 was applied. For International level data were Advance search as “TS=Neuro* and the period 2009-2018” was given to retrieve suitable records. Further, the data were refined with the document type “Article” only option for the study.

Analysis and Discussion:

Neuroscience Research in India and Abroad:

The study analyzed the literature of neuroscience research at the National and International levels. India stands in the 15th position during the period. Table 1. displays the top 15 countries in the neuroscience research publications. It is evident that the USA is the leading country in the neuroscience research with 36.087%, followed by Peoples R China with 11.395%, Germany with 9.017% so on. Table.2.shows the year-wise publications of the National and international levels.

Table.1. Top 15 Countries in Neuroscience Research

Rank	Countries/Regions	Records	% of 627158
1	USA	226320	36.087%
2	PEOPLES R CHINA	71466	11.395%
3	GERMANY	56551	9.017%
4	ENGLAND	44926	7.163%
5	JAPAN	41636	6.639%
6	ITALY	36714	5.854%
7	CANADA	33894	5.404%
8	FRANCE	31615	5.041%

9	SPAIN	23734	3.784%
10	AUSTRALIA	23251	3.707%
11	SOUTH KOREA	20655	3.293%
12	NETHERLANDS	19255	3.07%
13	BRAZIL	17109	2.728%
14	SWITZERLAND	15151	2.416%
15	INDIA	14153	2.257%

Table.2.Year-wise publications of National and International levels

Year	National	%	International	%
2009	921	6.51%	51888	8.27%
2010	1048	7.41%	54735	8.73%
2011	1140	8.06%	56543	9.01%
2012	1198	4.47%	60836	9.70%
2013	1326	9.37%	63233	10.08%
2014	1546	10.92%	64160	10.23%
2015	1487	10.51%	66348	10.58%
2016	1716	12.13%	67726	10.80%
2017	1821	12.87%	69665	11.11%
2018	1950	13.78%	72024	11.49%
Total	14153	100%	627158	100%

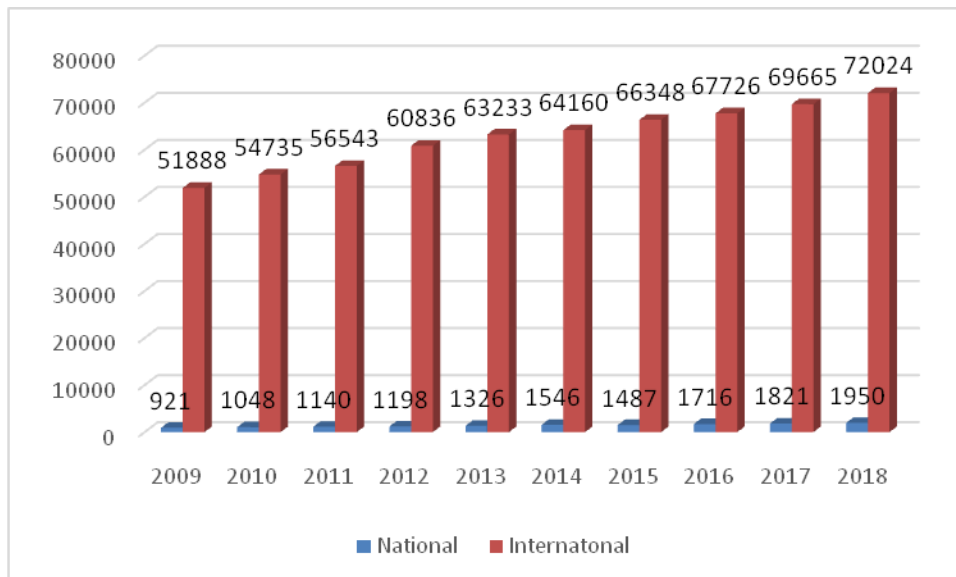


Fig.1.The graph shows Year-wise publications of National and International level on Neuroscience.

Document Type:

The study has analyzed the document-wise publications of NIMHANS during the period 2009-2018. The table 3 proves that out of 2985 publications, the maximum number of publications i.e. 1694 (56.73%) which are research papers and 192(6.43%) publications are “Editorial material, 12 (0.40%) are Proceedings paper, 466 (15.61%) are Meeting abstract, 186 are (6.23%) are Review, and 429 (14.37%) are Letters.

Table.3: Document-wise Distribution

Document Type	No. of document	Percentage
Article	1694	56.73%
Editorial Material	192	6.43%
Proceedings Paper	12	0.40%
Biographical Item	8	0.26%
Meeting Abstract	466	15.61%
Review	186	6.23%
Correction	10	0.33%
Book Chapter	2	0.06%
Letter	429	14.37%
Total	2985	100%

Table 4 shows the year-wise publications of NIMHANS from 2009-2018 and it is proved that 1694 articles were published and received 20158 citations. TLCS (Total Local Citation Score) is 1026, and TGCS (Total Global Citation Score) is 19312. The highest number of articles i.e. 241(14.235%) appeared in the year 2017 and the lowest articles i.e. 114(6.734%) appeared in the year 2011. The average number of articles published per year is 169.3.

Table.4 Year-wise Publications of NIMHANS

Year	Total Publications	%	TLCS	TGCS
2009	117	6.911%	163	2280
2010	138	8.151%	166	2167
2011	114	6.734%	111	2839
2012	126	7.442%	118	1979
2013	159	9.392%	85	1960
2014	180	10.632%	112	3381
2015	174	10.278%	97	1424
2016	206	12.109%	87	1335

2017	241	14.235%	78	1244
2018	239	14.117%	9	523
Total	1694	100%	1026	19132

Year-wise Publications and Citations:

Fig.2.indicates the year-wise publications and citations received on NIMHANS publications. The academics of NIMHANS published 1694 articles during the period 2009-2018 and received 20158 citations. The highest numbers of citations i.e. 3493 were received in the year 2014 and the lowest number of citations 532 was received in the year 2018. The average number of citations per article is 11.89.

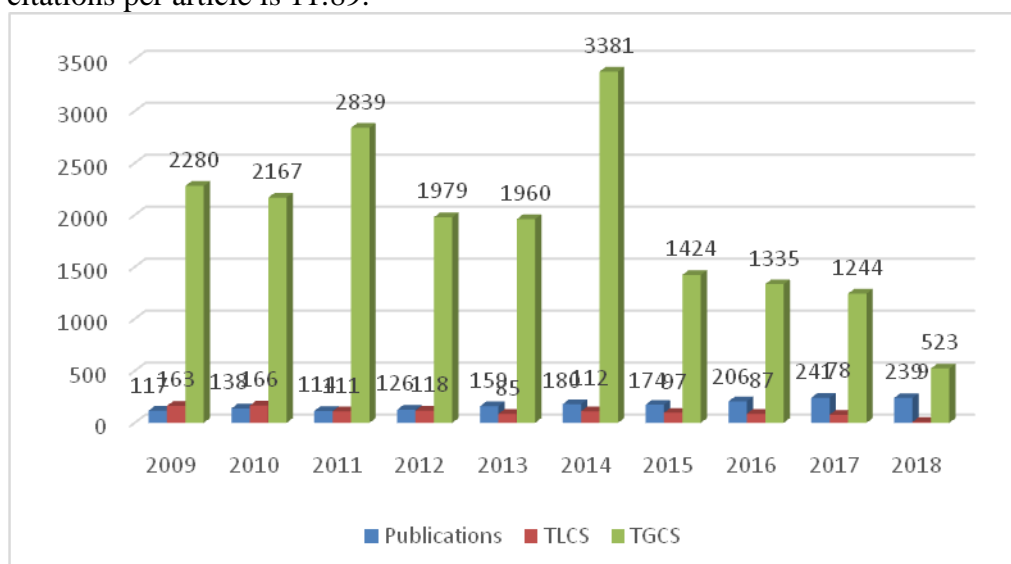


Table 5: Authorship Pattern

S.No.	Authorship Pattern	Number
1	Single Authored Article	72
2	Multi Authored Article	19782
3	Total Publications	1694
4	Total Authors	19854

Subramanyam, K.,¹¹(1983) defined a formula to calculate the Degree of Collaboration and it is expressed as:

$$\text{Degree of Collaboration (DC)} = \frac{Nm}{Nm+Ns}$$

Where,

Nm = No. of Multi-authored publications.

Ns = No. of single-authored publications.

$$(DC) = 19782/19782+72$$

$$(DC)=0.99$$

Hence, the Degree of Collaboration for the period 2009-2018 is 0.99.

Author Productivity:

Yoshikane, F.,[et al.]¹² (2009) given a formula to calculate Average Author Per Paper (AAPP) and Productivity Per Author (PPA), which is defined as below:

$$\text{Average Author Per Paper} = \text{No. of Authors/No. of Papers}$$

$$\text{Productivity Per Author} = \text{No. of Papers/No. of Authors}$$

In all 19854 authors (each author is given one count for each published paper) have contributed 1694 articles during the study period. The average author per paper is 11.72 for 1694 articles. The average productivity per author is 0.08.

Most preferred journals for publication:

It has been identified that 1694 articles published by NIMHANS were scattered in various national and international journals. Table.6 describes the top 15 journals in which NIMHANS researchers mostly preferred to publish their work. The highest numbers of articles were published in the journal "Neurology India" with 90(5.316%) is in 1st position, followed by "Annals of Indian Academy of Neurology" with 81(4.784%) is in 2nd position, "Asian Journal of Psychiatry" with 77(4.371%) is in 3rd position. "Journal of Affective Disorders" with 13(0.768%) is in 15th position. Neurology India has got IF (Impact Factor) of 2.708 (2018) and received the highest number of citation i.e. 646 (35 TLCS and 611 TGSC) amongst the top 15 journals. Out of 15 journals, four journals which published 6.025% papers has highest IF of above 4. Hence, the study proves that NIMHANS researchers mostly prefer to publish their work in national level journals.

Table.6 Most preferred journals

Position	Journal Name	Total	%	IF2018	TLCS	TGCS
1	NEUROLOGY INDIA	90	5.316%	2.708	35	611
2	ANNALS OF INDIAN ACADEMY OF NEUROLOGY	81	4.784%	0.898	22	389
3	ASIAN JOURNAL OF PSYCHIATRY	77	4.371%	1.932	16	184
4	INDIAN JOURNAL OF PSYCHIATRY	74	1.93%	1.122	30	446
5	JOURNAL OF CLINICAL PSYCHIATRY	58	3.426%	4.023	64	390
6	JOURNAL OF THE NEUROLOGICAL	27	1.536%	2.651	16	311

	SCIENCES					
7	JOURNAL OF ECT	26	1.76%	2.280	19	233
8	BRITISH JOURNAL OF NEUROSURGERY	24	1.418%	1.481	0	110
9	PEDIATRIC NEUROSURGERY	20	1.181%	0.783	2	76
10	PSYCHIATRY RESEARCH	18	1.004%	2.208	15	181
11	JOURNAL OF CLINICAL NEUROSCIENCE	17	1.31%	1.593	3	157
12	INDIAN JOURNAL OF MEDICAL RESEARCH	16	0.945%	1.251	16	145
12	PARKINSONISM & RELATED DISORDERS	16	0.945%	4.360	14	235
12	PLOS ONE	16	0.945%	2.776	0	251
13	SCHIZOPHRENIA RESEARCH	15	0.886%	4.569	9	176
14	EPILEPSY RESEARCH	14	0.827%	2.178	18	157
15	JOURNAL OF AFFECTIVE DISORDERS	13	0.768%	4.084	13	182

Highly Prolific Authors of NIMHANS:

Table 7 identified the list of top 15 prolific authors who have contributed papers for NIMHANS. A. Mahadevan has registered for 141 (8.328%) papers which received 2659 citations (TLCS 132 and TGCS 2527) stood in 1st rank followed by S.Sinha who published 133 (7.856%) papers which received 1128 citations (TLCS 85 and TGCS 1043) held in 2nd rank. A.B.Taly has published 116 (6.852%) papers received 1095 citations (TLCS 54 and TGCS 1041) (3rd rank). S.K.Shankar has published 98 (5.789%) papers and received 2589 citations (TLCS 125 and TGCS 2464) (4th rank) and C.Andrade has published 94 (5.552%) papers which received 798 citations (TLCS 86 and TGCS 712) reached 5th rank.

Rank	Author	Number of Papers	%	TLCS	TGCS
1	MAHADEVAN A	141	8.328%	132	2527
2	SINHA S	133	7.856%	85	1043
3	TALY AB	116	6.852%	54	1041
4	SHANKAR SK	98	5.789%	125	2464
5	ANDRADE C	94	5.552%	86	712
6	PAL PK	90	5.316%	51	828
7	SATISHCHANDRA P	86	5.080%	90	1794
8	SAINI J	79	4.666%	27	542
9	GANGADHAR BN	78	4.607%	49	952
10	NALINI A	77	4.548%	99	693
11	VENKATASUBRAMANIAN G	76	4.489%	41	851
12	SANTOSH V	72	4.253%	60	1105

13	DEVI BI	71	4.194%	14	170
14	THENNARASU K	69	4.076%	58	699
15	THIRTHALLI J	65	3.839%	43	704

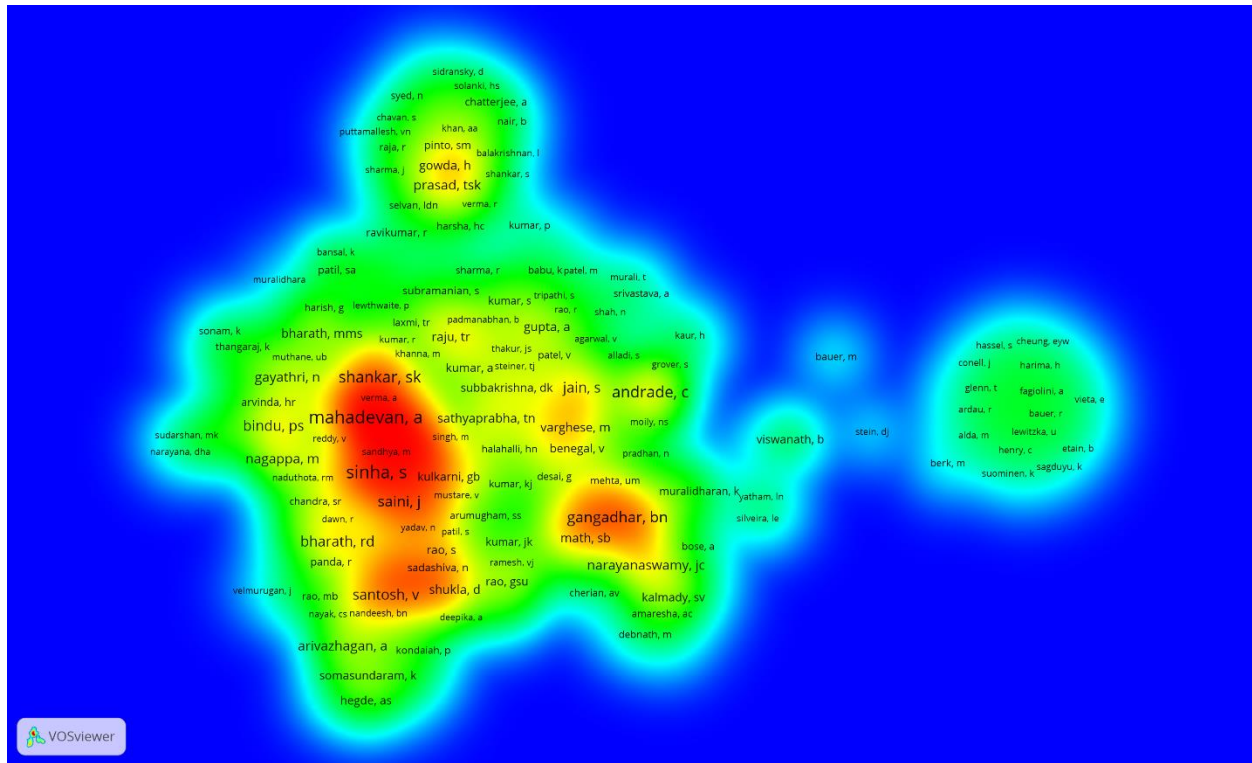


Fig.3.VOSviewer Co-authorship Network Visualization

Subject wise distribution of publications:

Table 8 shows the top 20 subject wise publications of NIMHANS. As per the subject area classified by Web of Science, the academics of NIMHANS mostly preferred to publish their papers in the field of "Neuroscience Neurology" (43.414%) followed by "Psychiatry" (25.340%).

Other prolific subject areas are such as Surgery (7.856%), Biochemistry Molecular Biology (6.143%), Psychology (5.198%), Immunology (4.312%) and similar.

Table 8. Top 20 Subject Areas

Rank	Subject	Records	Percentage
1	NEUROSCIENCES NEUROLOGY	735	43.414 %
2	PSYCHIATRY	429	25.340 %
3	SURGERY	133	7.856 %
4	BIOCHEMISTRY MOLECULAR BIOLOGY	104	6.143 %
5	PSYCHOLOGY	88	5.198 %

6	IMMUNOLOGY	73	4.312 %
7	PEDIATRICS	64	3.780 %
8	GENERAL INTERNAL MEDICINE	55	3.249 %
9	GENETICS HEREDITY	51	3.012 %
9	PHARMACOLOGY PHARMACY	51	3.012 %
10	CELL BIOLOGY	49	2.894 %
11	BEHAVIORAL SCIENCES	47	2.776 %
11	PATHOLOGY	47	2.776 %
12	RADIOLOGY NUCLEAR MEDICINE MEDICAL IMAGING	45	2.658 %
13	BIOTECHNOLOGY APPLIED MICROBIOLOGY	44	2.599 %
14	ONCOLOGY	43	2.540 %
15	RESEARCH EXPERIMENTAL MEDICINE	36	2.126 %
16	INFECTIOUS DISEASES	32	1.890 %
16	SCIENCE TECHNOLOGY OTHER TOPICS	32	1.890 %
17	PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH	29	1.713 %
18	ANESTHESIOLOGY	25	1.477 %
19	GERIATRICS GERONTOLOGY	24	1.418 %
20	MEDICAL LABORATORY TECHNOLOGY	20	1.181%

Highly cited publications:

Table 9 depicts the list of the top 10 articles, which are highly cited by other researchers. It is evident from table 9 that the article title “A draft map of the human proteome” written by Kim, Min-Sik.; Pinto, Sneha M.; Getnet, Derese; et al. published in the journal “Nature” in the year 2014 got first position with 915 citations followed by the article entitled “Global Mental Health 2 Child and adolescent mental health worldwide: evidence for action” written by Kieling, Christian; Baker-Henningham, Helen; Belfer, Myron; et al. published in the journal “LANCET” in the year 2011 got 2nd position with 450 citations and the article “Exome Sequencing Links Corticospinal Motor Neuron Disease to Common Neurodegenerative Disorders” published by Novarino, Gaia; Fenstermaker, Ali G.; Zaki, Maha S.; et al. in the journal “Science” in the year 2014 got 3rd position with 222 citations.

Table 9. Top 10 highly cited publications

Rank	Title	Authors	Source	Impact factor (2018)	Total citations
1	A draft map of the human	Kim, Min-Sik.; Pinto, Sneha	NATURE, Volume: 509	43.070	915

	proteome	M.; Getnet, Derese; et al.	Issue: 7502 pp.575, 2014.		
2	Global Mental Health 2 Child and adolescent mental health worldwide: evidence for action	Kieling, Christian; Baker-Henningham, Helen; Belfer, Myron; et al.	LANCET Volume: 378 Issue: 9801 Pages: 1515-1525, 2011.	59.102	450
3	Exome Sequencing Links Corticospinal Motor Neuron Disease to Common Neurodegenerative Disorders	Novarino, Gaia; Fenstermaker, Ali G.; Zaki, Maha S.; et al.	SCIENCE Volume: 343 Issue: 6170 Pages: 506-511, 2014.	41.037	222
4	Targeted therapy for high-grade glioma with the TGF-beta 2 inhibitor trabedersen: results of a randomized and controlled phase IIb study	Bogdahn, U.; Hau, P.; Stockhammer, G.; et al.	NEURO-ONCOLOGY Volume: 13 Issue: 1 Pages: 132-142, 2011.	10.091	184
5	Suicide mortality in India: a nationally representative survey	Patel, Vikram; Ramasundarahettige, Chinthanie; Vijayakumar, Lakshmi; et al.	LANCET Volume: 379 Issue: 9834 Pages: 2343-2351, 2012.	59.102	173
6	India: Towards Universal Health Coverage 3 Chronic diseases and injuries in India	Patel, Vikram; Chatterji, Somnath; Chisholm, Dan; et al.	LANCET Volume: 377 Issue: 9763 Pages: 413-428, 2011	59.102	161
7	Mutations in STIL, Encoding a Pericentriolar and Centrosomal Protein, Cause Primary Microcephaly	Kumar, Arun; Girimaji, Satish C.; Duvvari, Mahesh R.; et al.	AMERICAN JOURNAL OF HUMAN GENETICS Volume: 84 Issue: 2 Pages: 286-290, 2009	9.924	145
8	Plasma Proteome Database as a resource for proteomics research: 2014 update	Nanjappa, Vishalakshi; Thomas, Joji Kurian; Marimuthu, Arivusudar; et al.	NUCLEIC ACIDS RESEARCH Volume: 42 Issue: D1 Pages: D959-D965, 2014	11.147	123
9	Genome-wide expression profiling identifies deregulated miRNAs in malignant astrocytoma	Rao, Soumya A. M.; Santosh, Vani; Somasundaram, Kumaravel	MODERN PATHOLOGY Volume: 23 Issue: 10 Pages: 1404-1417, 2010	6.365	117
10	Rescue of fragile X syndrome phenotypes in Fmr1 KO mice by the small-molecule PAK inhibitor FRAX486	Dolan, Bridget M.; Duron, Sergio G.; Campbell, David A.; et al.	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA Volume: 110 Issue: 14 Pages: 5671-5676, 2013	9.58	105

Institutions wise distributions:

The publication records of NIMHANS were indexed in Web of Science database during the period 2009-2018. Institution collaboration shows that the Indian Institute of Science (IISc) Bangalore has more articles with 75 (4.430%) and got 1st position followed by Manipal

University with 71 (4.194%) articles in 2nd position. Department of Science and Technology, India gained 3rd position with 53 (3.131%) articles.

Table 10. Collaboration with other institutions

Rank	Institute Name	Records	%
1	INDIAN INSTITUTE OF SCIENCE IISC BANGALORE	75	4.430%
2	MANIPAL UNIVERSITY	71	4.194%
3	DEPARTMENT OF SCIENCE TECHNOLOGY INDIA	53	3.131%
4	JOHNS HOPKINS UNIVERSITY	48	2.835%
5	INST BIOINFORMAT	42	2.481%
6	COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA	41	2.422%
7	UNIVERSITY OF LONDON	36	2.126%
8	ALL INDIA INSTITUTE OF MEDICAL SCIENCES	32	1.986%
9	AMRITA VISHWA VIDYAPEETHAM UNIVERSITY	31	1.831%
9	PONDICHERRY UNIVERSITY	31	1.831%
10	HARVARD UNIVERSITY	28	1.654%
10	PGIMER CHANDIGARH	28	1.654%
10	ST JOHN S NATIONAL ACADEMY OF HEALTH SCIENCES	28	1.654%
10	YENEPOYA UNIV	28	1.654%
11	JAWAHARLAL NEHRU CENTER FOR ADVANCED SCIENTIFIC RESEARCH	27	1.595%
12	SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES TECHNOLOGY	25	1.477%
12	ST JOHN S MEDICAL COLLEGE	25	1.477%
13	GOVT MED COLL	24	1.418%
14	DEPARTMENT OF BIOTECHNOLOGY DBT INDIA	23	1.359%
15	UNIVERSITY OF CALIFORNIA SYSTEM	20	1.181%

Country collaboration:

Collaboration with other countries becomes an important indicator. Table 11 reveals that the NIMHANS' researchers have collaborated with USA 209 (12.345%) followed by England with 90 (5.316%), Australia with 54 (3.190%) and Canada with 48 (2.835%).

Table 11. Top 10 collaboration with other countries

Rank	Country	Records	%	TLCS	TGCS
1	USA	209	12.345%	120	5116
2	England	90	5.316%	75	3895
3	Australia	54	3.190%	35	1007

4	Canada	48	2.835%	38	1843
5	Brazil	35	2.067%	14	1166
5	Peoples R China	35	2.067%	28	1788
6	Germany	33	1.949%	20	986
7	Switzerland	28	1.654%	21	891
8	Italy	26	1.536%	20	584
9	Netherlands	25	1.477%	26	412
10	France	24	1.418%	15	754

Testing of Lotka's law of scientific productivity:

Alfred J Lotka¹³ (1926) developed a law which deals with the author's productivity pattern. It states that the number of authors making 'n' contributions is approximately equal to $1/n^2$ of the number of authors that produce only one contribution. i.e., in a given field, about 60% of authors out of One Hundred will have one article each, 15% will have two articles each, 7% will have 3 articles each, and so on. Lotka's Law is mathematically expressed as:

$$Y_x = C/X^n$$

Where, Y is the number of authors credited with X (1, 2, 3, 4, 5, 6, 7, 8, 9.....) papers C is the number of authors contributing one paper and n is a rate

$$X^n * Y_x = C \text{ (Where } X = 1)$$

$$\text{i.e., } 1 * 2934 = C \text{ (C = 2934, number of authors contributing one article)}$$

When X= 2

$$2^n * 641 = C \quad (C=2934)$$

$$2^n * 641 = 2934$$

$$2^n = 2934/641 = 4.5772 \text{ (by applying log)}$$

$$n \log 2 = \log (4.5772)$$

$$n = \log (4.5772) / \log 2$$

$$n = 0.6606/0.3010$$

$$n = 2.195$$

Where, Y is the number of authors credited with X (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 34, 36, 37, 38, 39, 41, etc.) papers, C are the number of authors contributing one article.

Table 8: Lotka's Law of Scientific Productivity

No of Articles	No. of Authors (Observed)	Observed %	No. of Authors (Expected)	Expected %
X	7009		4359	
1	2934	41.86	2934	67.31
2	641	9.15	641	14.70
3	2752	39.26	263	6.04
4	200	2.85	140	3.21
5	91	1.30	86	1.97
6	137	1.95	57	1.32
7	33	0.47	41	0.94
8	31	0.44	31	0.70
9	30	0.43	24	0.54
10	15	0.21	19	0.43
11	10	0.14	15	0.35
12	18	0.26	14	0.32
13	2	0.03	11	0.24
14	13	0.19	9	0.21
15	7	0.10	8	0.18
16	3	0.04	7	0.15
17	9	0.13	6	0.13
18	2	0.03	5	0.12
19	6	0.09	5	0.11
20	2	0.03	4	0.09
22	4	0.06	3	0.08
23	4	0.06	3	0.07
24	2	0.03	3	0.06
25	3	0.04	3	0.06
26	2	0.03	2	0.05
28	2	0.03	2	0.04
29	5	0.07	2	0.04
30	6	0.09	2	0.04
31	3	0.04	2	0.04
32	1	0.01	1	0.03
34	2	0.03	1	0.03
36	2	0.03	1	0.03
37	1	0.01	1	0.02
38	3	0.04	1	0.02

39	2	0.03	1	0.02
41	1	0.01	1	0.02
43	1	0.01	1	0.02
45	1	0.01	1	0.02
47	1	0.01	1	0.01
50	1	0.01	1	0.01
51	1	0.01	1	0.01
53	2	0.03	0	0.01
54	2	0.03	0	0.01
59	1	0.01	0	0.01
61	1	0.01	0	0.01
62	1	0.01	0	0.01
63	2	0.03	0	0.01
65	1	0.01	0	0.01
69	1	0.01	0	0.01
71	1	0.01	0	0.01
72	1	0.01	0	0.01
76	1	0.01	0	0.01
77	2	0.03	0	0.01
79	1	0.01	0	0.01
87	1	0.01	0	0.01
90	1	0.01	0	0.01
94	1	0.01	0	0.01
99	1	0.01	0	0.01
116	1	0.01	0	0.01
133	1	0.01	0	0.01
142	1	0.01	0	0.01

There were 1694 articles published by 19852 authors during the period 2009-2018. Table.8 indicates that the number of authors observed is 2934 (41.86%) authors who produced one article, 641 (9.15%) authors produced two articles, 2752 (39.26%) authors who produced three articles, 200 (2.85%) authors contributed four articles and so on. According to Lotka's Law, there will be 641 (14.70%) authors who produce two articles, 263 (6.04%) authors contribute three articles, 140 (3.21%) authors produce four articles. At this point, the present study non-confirms the Lotka's law of scientific productivity.

Findings and Conclusion:

The study has been conducted to analyze the publications' output of NIMHANS. 2984 papers were published during the period 2009-2018. The study is restricted to "Articles" only i.e. 1694 papers. The highest number of articles published in the year 2017 was 241(14.235%), followed by the year 2018 with 239(14.117%). Ten years publications lead to 1694 papers which received

20158 citations. Mahadevan, A., Sinha, S., and Taly, A.B. are the top three authors who contributed the papers. The degree of collaboration is 0.99. The multi-authored publications are very high. The average author per paper is 11.72 and the average productivity per author is 0.08. The academics of NIMHANS mostly preferred to publish their research in the subject area of "Neurosciences Neurology" with 735 (43.41%) followed by "Psychiatry" with 429 with (25.34%) and "Surgery" with 133 (7.856.%). Indian Institute of Science, followed by Manipal University and the Department of Science and Technology has highly collaborated with NIMHANS. As far as Global wise collaboration is concerned, the USA, England, Australia, Canada, Brazil and China have extended. NIMHANS' researchers mostly prefer to publish the work in Indian journals like "Neurology India, Annals of Indian Academy of Neurology, Asian Journal of Psychiatry, and Indian Journal of Psychiatry. The study will benefit policymakers and higher authorities of NIMHANS. On par with international research, the institution and nation should adopt new policies and guidelines to enhance the research.

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