DOI: 10.5958/0976-2469.2021.00043.9

LIBRARY HERALD
Vol 59 No 4
December 2021

Covid-19 and Neuroscience Research: A Scientometric Assessment of India's Publications during 2020-21

NEERAJ KUMAR SINGH*
P. VISAKHI**

Neurological management in the present global Covid-19 crisis in India could be evaluated by undertaking assessment of current literature which may be useful to policy-makers and clinicians. Keeping this in view, the present study examines the Indian output on 'Covid-19 and Neuroscience' using bibliometric methods. The quantitative and qualitative analysis of Indian publications was performed for all the publications in Scopus database by using 'Covid-19' and its synonyms keywords in 'Keyword' and 'Title' tags. The results obtained were further restricted to subject 'Neurosciences' under subject tag. The top 5 countries producing the highest number and share in global output were: United States 1,316 papers and 29.65% share), United Kingdom (597 papers and 13.45% share), Italy (552 papers and 12.44% share), China (382 papers and 8.61% share) and India (292 papers and 6.58% share). The organisations that produced the highest number of publications were NIHMANS-Bangalore, PGIMER-Chandigarh and AIIMS-New Delhi (30 papers each), K.G. Medical University-Lucknow (13 papers) and AIIMS-Rishikesh (11 papers). The journalsthat produced the highest number of publications were 'Neurology India' (29 papers), 'Psychiatry Research' (24 papers), 'Journal Of Neurosciences In Rural Practice' (16 papers), 'Lancet Psychiatry' (14 papers) and 'Peerj' (13 papers). The most commonly investigated topics in terms of frequency of appearances of keywords were 'anxiety' (36), 'neurological disease' (32), 'depression' (26), 'mental disease' (26), 'mental health' (26), 'Gullain Barre syndrome' (19), 'neurosurgery' (18),

* Deputy Librarian, Panjab University, Chandigarh, Punjab, India.

** University Librarian, IISER Mohali, Punjab, India.

'Cerebro vascular accidents' and 'stroke' (17 each), 'Cykotine storm' and'nervous system disease' (15 each). The present study has the potential to provide a guide that can contribute to improvement in the literature.

Keywords: *COVID-19, Neurosciences, India, Bibliometrics, Scientometrics,*

1 INTRODUCTION

Although coronaviruses are essentially respiratory viruses, several studies have reported their ability to also infect the central nervous system and cause neurological disorders[1]. The SARS-CoV-2, responsible for Covid-19, belongs to the family of coronaviridae. Cases of neurological damage by other coronaviruses (acute flaccid paralysis[2], encephalitis[3] are known and neurological damage is expected with SARS-CoV-2 as well as its genetic sequence being almost 80% similar to that of SARS-CoV-1 (epidemics of 2002 and 2003)[4].

Growing evidence showed that coronavirus disease 2019 (Covid-19) infection may present with neurological manifestations. Coronaviruses (CoVs) in general, have been known to exhibit neurotropic properties and as such may cause neurological conditions. In addition to infected cells, SARS-CoV-2 binds to membrane receptors angiotensin-converting enzyme 2 (ACE2), present in the pulmonary and vascular endothelium and also at neuronal level.

The path taken by coronaviruses is not precisely known, but it seems that viruses use synaptic pathways to pass from the cardiorespiratory centre to the spinal cord. The mechano-receptors and chemoreceptors of peripheral nerve endings that are found in the lower respiratory tract are believed to be the gateway through which the virus reaches the central nervous system

There are several possible mechanisms why CoV infections damage the CNS. Amongst these mechanisms, (i) the genetic material and proteins of several viruses have been detected in the CSF or brain tissues [5], (ii) using neural pathways, the virus may lead to the disruption of the nasal epithelium and is released mostly on the apical as well as basolateral side of the epithelial cells and reach the bloodstream or lymph to reach other tissues, including the CNS[6-7] (iii) Using neuronal transport, the viruses can also migrate by infecting motor or sensory nerves[8] (iv) Another optionwould be immune-mediated mechanism [9], which is closely related to the development of systemic inflammatory response syndrome. CoV infections can infect macrophages, microglia, and astrocytes. It can activate glial cells and promote a proinflammatory state[9-10]. Cytokines can cross the blood–brain barrier and are associated with acute necrotizing encephalopathy.[11] The neurovirulence of CoV correlates with its ability to induce proinflammatory cytokine signals from astrocytes and microglia[12]

Pooled evidence from several studies [12]showed that myalgia and headache were the most typical neurological symptoms of Covid-19, followed by headache and dizziness, dizzines, nausea, nausea and vomiting, vomiting, and confusion. Although neurological symptoms arise in Covid-19 infections, its occurrence may be considered low, that is, the upper limit of the 95% CI of myalgia symptom is 0.25 and the lower limit of the 95% CI of confusion is 0.02). The most common neurological complications associated with this infection were cerebrovascular disorders presenting as acute cerebral infarction or hemorrhage, or cerebral sinus venous thrombosis. Furthermore, other documented COVID-19-related cases were encephalopathy, encephalitis, oculomotor nerve palsy, isolated sudden-onset anosmia, and GBS which included MFS.

11 LITERATURE REVIEW

Although a number of bibliometric studies have been conducted both on coronavirus in general and Covid-19 in particular. Only two studies have been carried related to 'Impact of Covid-19 on Neurosciences'. Among such studies, Collantes, Espiritu, Sy,Anlacan and Jamora [12]presented the evaluation of the neurological manifestations of Covid-19 infection with relevant information from 49 studies involving 6,335 patients. The review is the first large qualitative and quantitative analyses of neurological symptoms, complications, laboratory findings, and outcomes associated with this condition. Kiraz[13] analysed the global outputs of Covid-19 (13784 publications) in the field of neuroscience through bibliometric methods, using Web of Science database. Of these publications, 459 were published in the field of Neurosciences Neurology. The top 5 countries that produced the highest number of publications were the USA (139, 30.2%), Italy (110, 23.9%), UK (57, 12.2%), China (49, 10.6%), and Germany (43, 9.3%). The journals that produced the highest number of publications were Brain Behavior and Immunity, Journal of Neurology, Neurological Sciences, Nature Human Behavior and Acta Neurochirurgica. The most commonly investigated topics were stroke, encephalitis, depression, mental health, stress, neurosurgery, Parkinson's disease, Guillain-Barre syndrome, multiple sclerosis, anxiety, and headache

Since no comprehensive study was available on this topic 'Covid-19 and Neurology' both at national and national level, so we decided to undertake such a bibliometric study at India's national level.

2 OBJECTIVES

This study sought to study the 'Covid-19 and Neuroscience' research in India based on key metrics with the aim to assess and evaluate the status of

this fieldat national, institutional, and individual author level. The data for study was sourced from the Scopus database covering the publication period 2020-2021. The study aimed to assess and evaluate the subject on parameters such as (i) distribution of India publications output by source and type, (ii) publications growth — annual and cumulative, (iii) citation impact of national publications (iv) most productive countries, (v) publication distribution by broad subjects and significant keywords, (vi) most productive organisations and authors and their collaborative linkages, (vii) leading communications channels and (viii) bibliographic characteristics of highly- cited papers in the subject.

3 METHODOLOGY

Using a well designed search strategy, publications data as required for the study in the subject was identified, retrieved and downloaded from the Scopus database (https://www.scopus.com). A set of keywords related to Covid-19 were used in conjunction with a field tag 'Title' (Article Title) for search and retrieval, and subsequently the global search was limited to publication years 2020-2021. The Scopus database retrieved a total 154929 global records and 289 Indian research publications in the subject. The global output was further refined by the country name, one by one, in order to identify and generate data on most productive countries in the subject. In addition, analytical provisions as provided in the Scopus database was utilised to ascertain the distribution of publications output by broad subject areas, collaborating countries, contributing authors, affiliating organisations and source journals, etc. The citations to publications were counted from date of their publication till 22.06.2021. The study used metrics and indicators to quantify and evaluate the performance of the most productive countries, organisations, authors and journals. The VOS viewer and Biblioshiny app for bibliometrix were used to evaluate and visualise the collaborative interaction among most productive countries, organisations, authors and keywords.

(TITLE ("Covid 19" OR "2019 novel coronavirus" OR "coronavirus 2019" OR "coronavirus disease 2019" OR "2019-novel CoV" OR "2019 ncov" OR covid 2019 OR covid19 OR "corona virus 2019" OR ncov-2019 OR ncov2019 OR "nCoV 2019" OR 2019-ncov OR covid-19 OR "Severe acute respiratory syndrome coronavirus 2" OR "SARS-CoV-2") OR KEY ("COVID 19" OR "2019 novel coronavirus" OR "coronavirus 2019" OR "coronavirus disease 2019" OR "2019-novel CoV" OR "2019 ncov" OR covid 2019 OR covid19 OR "corona virus 2019" OR ncov-2019 OR ncov2019 OR "nCoV 2019" OR 2019-ncov OR covid-19 OR "Severe acute respiratory syndrome coronavirus 2" OR "SARS-CoV-2") AND (LIMIT-TO (SUBJAREA," NEUR")) AND (LIMIT-TO (AFFILCOUNTRY,"India"))

3 ANALYSISAND RESULTS

31 TOP 10 COUNTRIES

The global output on Covid-19 consisted of 154929 publications as covered in Scopus database on 16th June 2021. On further classifying the Covid-19 output by broad subjects (as classified by Scopus database), 4438 (2.86%) publications were reported in neurosciences. The largest contribution (29.65% share) on the theme 'Covid-19 and Neurosciences' comes from the USA, followed by U.K and Italy (13.45% and 12.44%), China (8.61%), India, Germany, Canada and Spain (from 5.90% to 6.58%) and France Brazil (4.80% and 4.51%).The top 10 countries contributed 300 to 1316 publications and together accounted for 98.45% share in global output on this theme. On further analysis, it was observed that: (i) Only three countries published more than average productivity (436.9) of all 10 countries: United States (1,316 papers), United Kingdom (597 papers) and Italy (552 papers); (ii) Only two countries registered average citation per paper and relative citation index above the group average of all the 10 countries: China (40.5 and 2.58) and U.K. (17.39 and 1.11). The share of international collaborative papers of top 10 countries varied from 38.95% to 65.69%, with an average of 46.85%(Table 1).

Table 1. Profile of Top 10 Countries in Global Output in 'Covid-19 and Neurosciences'

S. No.	Country	TP	TC	CPP	H-Index	ICP	%ICP	% TP	RCI
1	United States	1,316	17189	13.06	57	520	39.51	29.65	0.83
2	United Kingdom	597	10384	17.39	44	340	56.95	13.45	1.11
3	Italy	552	7037	12.75	42	215	38.95	12.44	0.81
4	China	382	15470	40.50	50	164	42.93	8.61	2.58
5	India	292	2549	8.73	24	129	44.18	6.58	0.56
6	Germany	281	3538	12.60	30	165	58.72	6.33	0.80
7	Canada	274	4193	15.30	28	180	65.69	6.17	0.98
8	Spain	262	3103	11.84	29	119	45.42	5.90	0.75
9	France	213	2428	11.40	26	121	56.81	4.80	0.73
10	Brazil	200	2643	13.22	24	94	47.00	4.51	0.84
	Total	4369	68534	15.69			46.85	98.45	1.00
	Global Total	4438							

32 RESEARCH FROM INDIA

Of the 4438 global publications, only 292 (6.58%) originated from India on 'Covid-19 and Neurosciences'. These 292 publications from India received 2549 citations, averaging 8.73 citations per paper. Of the 292 publications, 126 (43.15%) were published as international collaborative publications (ICP).

Of the 292 publications from India, only 55(18.83%) received external funding support from 50+ research agencies. The 55 funded papers have received 927 citations, averaging 16.85 citations per paper. The major funding agencies supporting India's research on neurosciences along with their output are: National Institute of Health, USA (16 papers), U. S. Department of Health and Human Service (13 papers), Department of Biotechnology, Govt. of India and National Institute of Neurological Disorders and Stroke, USA (7 papers each), Department of Science & Technology, Govt. of India (6 papers), The European Commission (4 papers), etc. Articles, letters and reviews (36.79%, 25.95% and 24.56%) constitute the major document type contributing to Indian publications in neurosciences, followed by notes and editorials (5.19% and 3.46%) and erratum and short surveys (0.69% and 0.34%).

These 126 ICP received 1580 citations, averaging 12.54 citations per paper. Among India's ICP, USA contributed the largest publication share (57.94%), followed by U.K. (28.57%) and the rest of other 6 countries namely Australia, China, Italy, Brazil, Canada and Germany contributed from 11.90% to 16.67%.In terms of research impact per paper of foreign collaborative partners in Indian ICP, Brazil and China registered the largest impact (18.86 and 18.15), followed by Italy (17.83%), Germany (17.0), USA (16.6), U.K. (14.38), Canada (13.46) and Australia (11.09).

The leading foreign organisations collaborating with India in research on 'COVID-19 and Neurosciences' are: Harvard Medical School, USA and NYU Grossman School of Medicine, USA (9 papers each), Enam Medical College and Hospital, Bangladesh (8 papers), Michigan State University, USA, University of Oxford, Medical Science Division, U.K and University of Auckland, New Zealand (7 papers each), etc. The leading foreign authors collaborating with Indian authors are: S.M.Y. Arafat (Bangladesh)(8 papers), P. Sharma (Nepal) and S. Sriwastava (USA) (6 papers each), S. El-Hayek (Lebanon), S.Kataria (USA) and V. Pereira – Sanchez (USA) (5 papers each), F. Adiukwu (Nigeria) and J.Benito-Leon (Spain)(4 papers each), etc.

Of the 289 Indian publications, only 55(5.25%) received external funding support from 50+ research agencies. The 55 funded papers have received 927

citations, averaging 16.85 citations per paper. The major funding agencies supporting India's research on neurosciences along with their output are: National Institute of Health, USA (16 papers), U.S.Department of Health and Human Service (13 papers), Department of Biotechnology, Govt. of India and National Institute of Neurological Disorders and Stroke, USA (7 papers each), Department of Science and Technology, Govt. of India (6 papers), etc.

Articles, letters and reviews (36.79%, 25.95% and 24.56%) constitute the major document type contributing to India's publications in neurosciences, followed by notes and editorials (5.19% and 3.46%) and erratum and short surveys (0.69% and 0.34%).

321 SUBJECT-WISE DISTRIBUTION OF PUBLICATIONS

On classifying 292 publications on 'Covid-19 and Neuroscience' by type of studies, it was observed that clinical studies accounted for the largest share (19.86%) of total output, followed by pathophysiology (14.04%), treatment by drugs (13.01%), complications (11.3%), epidemiology (10.27%), risk factors (8.56%) and genetics (3.77%). In terms of impact, publications on genetics registered the highest citation impact per paper (20.9), followed by epidemiology (18.73), clinical studies (16.93), risk factors (12.8), complications (12.54), pathophysiology (11.7), and treatment by drugs (5.65).

322 SIGNIFICANT KEYWORDS

The 36 significant keywords (with frequency of appearance varying from 5 to 260) have been identified from the literature, which throw light on the trends of research on his theme. The most frequently used keywords with largest frequency of occurrence (260) was reported by keyword COVID-19, followed by virology and anxiety (36 each), neurological disease (32), depression, mental disease and mental health (26 each), etc. (Table 2)

323 DISTRIBUTION OF PAPERS BY POPULATION AGE GROUPS

On classifying the 292 publications on 'Covid-19 and Neurosciences' by population age groups, it was found that 'adults' constitute the largest share (15.75%) of publications, followed by the 'middle aged' (8.56%), 'aged' and 'child' (5.48% each) and 'adolescents' (4.79%). In terms of impact, 'adults' registered the highest (19.52) citation impact per paper, followed by 'middle aged' (14.0), 'aged' (10.37), 'child' (9.75) and 'adolescents' (9.71)

Table 2. List of Significant Keywords appearing in Literature on "Covid-19 and Neurosciences"

S.No.	Keywords	TP	S.No	Keywords	TP
1	Covid-19	260	19	Ageusia	12
2	Virology	36	20	Parkinson's Disease	12
3	Anxiety	36	21	Mental Health Care	11
4	Neurological Disease	32	22	Distress Syndrome	11
5	Depression	26	23	Myelitis	10
6	Mental Disease	26	24	Neuroimaging	10
7	Mental Health	26	25	Seizure	10
8	Gullain Barre Syndrome	19	26	Brain Ischemia	9
9	Neurosurgery	18	27	Encephalitis	9
10	Cerebrovascular Accidents	17	28	Sleep Disorder	9
11	Stroke	17	29	Suicide	9
12	Cykotine Storm	15	30	Brain Hemorrhage	7
13	Nervous System Disease	15	31	Epilepsy	7
14	Brain Disease	14	32	Multiple Sclerosis	7
15	Fear	13	33	Schizophrenia	7
16	Lockdown	13	34	Cerebrovascular Disease	7
17	Mental Stress	13	35	Neurological Complications	6
18	Mental Health Service	12	36	Neuropathy	5

324 PROFILE OF TOP 15 ORGANISATIONS

In all 273 organisations participated unevenly in India's research on 'COVID-19 and Neurosciences': 262 organisations contributed 1-5 papers each, 19 organisations 6-10 papers each and 5 organisations 11-34 papers each. The top 15 organisations individually contributed 4 to 34 papers and together contributed 60.96% and 67.88% respectively share in India's publications and citations.On further analysis, it was observed that: (i) Four organisations contributed papers higher than their group average (18.77) and (ii) Eight organisations registered citation per paper and relative citation index above their group average (9.57 and 1.11). Table 3 lists the top 5 most productive and 5 most impactful organisations (Table 3).

Table 3. Profile of Top 5 Most Productive and Most Impactful Organisations on 'Covid-19 and Neurosciences'

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	% ICP	RCI
Top 5 Most Productive Organizations								
1	National Institute of Mental Health and Neurosciences, Bangalore	34	278	8.18	9	11	32.35	0.95
2	Postgraduate Institute of Medical Education & Research, Chandigarh	30	269	8.97	7	9	30.00	1.04
3	All India Institute of Medical Sciences, New Delhi	30	133	4.43	6	7	23.33	0.52
4	King George's Medical University, Lucknow	13	252	19.38	7	7	53.85	2.26
5	All India Institute of Medical Sciences, Rishikesh	11	63	5.73	4	3	27.27	0.67
Top 5 Most Impactful Organizations								
1	Manipal Academy of Higher Education, Manipal	4	107	26.75	3	2	50	3.11
2	Indian Institute of Chemical Biology, Kolkata	4	96	24	2	2	50	2.79
3	King George's Medical University, Lucknow	13	252	19.38	7	7	53.85	2.26
4	B K L Walawalkar Rural Medical College, Sawarda village, Maharashtra .	6	99	16.5	4	5	83.33	1.92
5	Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry	10	143	14.3	5	1	10	1.66

325 PROFILE OF TOP 15 AUTHORS

346 authors participated unevenly in India's research on 'Covid-19 and Neurosciences': 339authors contributed 1-5 papers each and 7 authors 6-8 papers each. The top 15 authors individually contributed 4 to 8 papers each and together contributed 27.40% (80) and 32.28% (810) shares in national publications and citations. On further analysis, it was observed that: (i) Five authors contributed papers higher than their group average (5.33) and (ii) Eight authors registered citation per paper and relative citation index above their group average (10.13 and 1.18). Table 3 lists the top 5 most productive and 5 most impactful organisations (Table 4).

Table 4. Profile of Top 5 Most Productive and Most Impactful Authors on 'Covid-19 and Neurosciences'

S.No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP
Top 5 Most Productive Authors							
1	P. Madaan	PGIMER-Chandigarh	8	11	1.37	05	3
2	S.K. Kar.	K.G. Medical University, Lucknow,	7	139	19.85	14	7
3	Pramod Kumar Pal	NIHMANS-Bangalore	7	113	16.04	33	3
4	M. Tandon	VMMC &Safdarjang Hospital, New Delhi,	7	26	3.71	04	7
5	R. Ransing	BKL Walalwalkar Rural Medical College, Ratnagiri, India	6	99	16.5	10	5
Top 5 Most Impactful Authors							
1	Pramod Kumar Pal	NIHMANS-Bangalore	4	113	28.25	33	3
2	Vikas Menon	JIPMER-Pondicherry	4	104	26.00	13	1
3	S.K. Kar.	K.G. Medical University, Lucknow,	7	139	19.85	14	7
4	R. Ransing	BKL Walalwalkar Rural Medical College, Ratnagiri, India	6	99	16.5	10	5
5	Manjari Tripathi	AIIMS-New Delhi	5	56	11.2	31	2

326 PROFILE OF TOP 15 JOURNALS

Of the total 292 India's publications in this area, 269 are published in 152 journals and 1 in book series. Of the 152 journals participated unevenly in India's research on 'Covid-19 and Neurosciences': 140 journals contributed 1-5 papers each, 6 journals 6-10 papers each and 6 journals 11-29 papers each. The top 15 journals contributed 5 to 29 papers each and together contributed 62.45% share in total publication output in journals. On further analysis it was found that (i) the top 5 most productive journals are: Neurology India (29 papers), Psychiatry Research (24 papers), Journal of Neurosciences In Rural Practice (16 papers), Lancet Psychiatry (14 papers) and Peerj (13 papers) and (ii) the top five journals in terms of citation impact per paper are: Brain Behavior And Immunity (51.25),Psychiatry Research (19.42), Journal of Neuroimmune Pharmacology (16.4), ACS Chemical Neuroscience (13.6) and Lancet Psychiatry (5.14).

327 HIGH CITED PAPERS

Out of 292 articles, only 10 received between 56-342 citations and they together received 1015 citations, averaging 101.5 citations per paper. About 35 countries participated in these 10 comparatively highly cited papers, with largest participation coming from the USA (3 papers), Bangladesh, the U.K., France, Italy, Spain and Turkey (2 papers each), etc. Only 6 articles were written by multinational collaborations from different countries and 1article was authored by researchers from the same country. The 10 high cited articles were published in 6 journals and the journal, Psychiatry Research published the greatest number of articles (n = 4), followed by Brain, Behavior and Immunity (n=2) and the rest by 4 other journals

4 SUMMARY

The Scopus database indexed 4438 global publications on 'Covid-19 and Neuroscience' during 2020-21 as searched on 22nd June 2021 using a well-defined search strategy. The USA contributed the largest global share (29.65%), followed by the U.K. and Italy (13.45% and 12.44%), China (8.61%), India, Germany, Canada and Spain (from 5.90% to 6.58%), etc.

India produced only 292 publications on this theme, which constitute 6.58% share of global output. The 292 Indian publications registered 2549 citations, averaging 8.73 citations per paper. Among Indian publications on this theme, 43.15% (126) publications involve international collaboration. Around 18.85% (55) Indian publications on this theme received external funding support from 50+ research agencies and together received 927 citations, averaging 16.85 citations per paper.

Among the type of studies on this theme, clinical studies constitute the largest publication share (19.86%) of total output, followed by pathophysiology (14.04%), treatment by drugs (13.01%), complications (11.3%), epidemiology (10.27%), risk factors (8.56%) and genetics (3.77%).

The most significant keywords appearing in Indian literature on this theme (with their frequencies of appearance in decreasing order) are Covid-19 (260), Anxiety (36), Neurological Disease(32), Depression (26), Mental Disease (26),Mental Health(26), Gullain Barre Syndrome (19), Neurosurgery (18), Cerebrovascular Accidents(17), etc.

On using population age group classification, it was observed that 'adults' constitute the largest share (15.75%) of publications, followed by the 'middle aged' (8.56%), the 'aged' and 'child' (5.48% each) and 'adolescents' (4.79%).

In all, 273 organisations and 346 authors participated unevenly in India's research on 'COVID-19 and Neurosciences', of which top 15 organisations together contributed 60.96% and 27.40% and 67.88% and 32.28% share in Indian publications and citations respectively. The top 5 most productive organisations are: NIMHANS-Bangalore (34 papers), PGIMER-Chandigarh and AIIMS-New Delhi (30 papers each), K.G.Medical Univ., Lucknow (13 papers) and AIIMS-Rishikesh (5 papers). The most impactful organisations in terms of citations per paper and relative citation index are: MAHE-Manipal (26.75 and 3.11), IICB-Kolkata (24.0 and 2.79), King George's Medical University, Lucknow (19.38 and 2.26), B K L Walawalkar Rural Medical College, Sawarda village, Maharashtra (16.5 and 1.92) and JIPMER-Pondicherry (14.3 and 1.66). The five most productive authors are P. Madaan (8 papers), S.K. Kar (7 papers), Pramod Kumar Pal and M. Tandon (& papers each) and R. Ransing (6 papers). The five most impactful authors are: Pramod Kumar Pal (28.25), Vikas Menon (26.0), S.K. Kar (19.85), R. Ransing(16.5) and Manjari Tripathi (11.2).

5 CONCLUSION

Our study can help researchers identify the most significant and impactful articles on 'COVID-19 and Neurosciences', as well as to provide insight into the most noteworthy scientific trends and to visualise future research needs of the topic.

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