

# A Scientometric Assessment of India's International Collaboration with South Asia Countries in COVID-19 Research

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## ABSTRACT

**Aim:** This study seeks to ascertain India's leadership status in collaborative research in COVID-19 at South Asia level and at international level using bibliometric indicators. **Background:** India has so far witnessed enormous growth in its international collaborative research in COVID-19 with developed and developing countries. In particular, India is credited to have provided technical assistance and initiated few research programmes for promoting international collaboration with South Asia. There is a need to understand the current status of India in collaborative research in COVID-19 with countries in South Asia as well as with countries outside South Asia. **methodology:** The research publications data was sourced from the Scopus database covering COVID-19 scholarly literature indexed as of May 2023. The data was systematically analyzed to create tables for understanding India's performance in collaborative research at international, regional, national, institutional, and research author level. The country affiliation of co-authors to research papers was used as a methodology to identify and compute regional and international collaboration in research. The scope of analysis of COVID-19 collaborative research is limited to five South Asia countries namely India, Pakistan, Bangladesh, Sri Lanka and Nepal. The study presents a creative view of collaboration networks across affiliating countries, research organizations/institutes, and research authors to publications in COVID-19. **Results:** India contributed a 7.31% share to global output (506691) in COVID-19 research studies, as of May 2023. This global share of India is three times as much as the global share (2.45%) put together of four other South Asia countries, namely Pakistan, Bangladesh, Sri Lanka and Nepal. International collaborative publications by Pakistan, Bangladesh, Sri Lanka and Nepal accounted for a bulk of their national output (54.19% to 64.76%), in contrast India contributed just 27.92%. In overall, India contributed a total of 1293 international collaborative publications involving collaboration of two types. For instance, Type (i) covers publications from collaboration across South Asia countries which accounted for a 14.3% share (185) and Type (ii) covers publications from not just with South Asia countries but also from countries outside South Asia representing co-authors to publications under study. This type of inter-regional (international) collaboration accounted for an 85/7% share (1108). The role of India and other South Asia countries in international collaboration (1108) is very small. Most credit in research publications goes largely to developed and developing countries. These 1293 collaborative papers by India received an average of 22.17 citations per paper since their publication. **Conclusion:** The study concludes that though India dominates as a leading player in collaborative research at South Asia level in COVID-19, but its academic performance in international collaborative research has not been as significant. In this regard India needs to evolve suitable strategies and work out programmes in order to raise its international academic status in COVID-19 research.

**Keywords:** Collaboration, COVID-19, South Asia, International, Scientometrics, India, Research.

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**Received:** 29-06-2023;

**Revised:** 13-08-2023;

**Accepted:** 16-10-2023.



DOI: 10.5530/jcitation.2.3.26

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## INTRODUCTION

International collaboration across disciplines, institutions and borders is central to researchers in their on-going research pursuit to gain, understand and add value to scientific knowledge which endeavour otherwise seems to be beyond what one team could achieve alone (Dua, 2023). Working across boundaries, is a great way to strengthen research capacity, fast track research, improve research quality, create new ideas, produce some of the most innovative results, early breakthroughs in research. (Anuradha, 2007), (Arunachalam, 2000), (Arunachalam, 1994), (Arunachalam, 2008). Given such rich benefits from international collaboration, scientific agencies world over have been undertaking fresh initiatives to design and support programmes that aims to promote and advance international research collaborations in science, technology and medicine. (Basu, 2001), (Dua, 2022), (Basu, 2000)

Over time, the numbers of international collaborations across nations, covering a wide spectrum of subjects, have increased manifolds. (Gupta, 2002), (Uddin, 2014), (Prakasan, 2014). Since its outbreak, COVID-19 research witnessed international collaboration on an unprecedented scale in the hope to receive an accelerated scientific response from the global scientific community to the pandemic. For instance, what infections it causes, develop therapies and vaccines early, and protocols to prevent and contain transmission of the virus on a global scale. (Cascella, 2023) Further it was found that, within the first 11 months since COVID-19 outbreak, the US and China acted fast in evolving international collaboration and that they were able to contribute as much as a quarter of their COVID-19 papers with international collaboration with researchers in other countries. (Grammes, 2020), (Carvalho, 2023).

India has so far witnessed enormous growth in COVID-19 related publications and also in its international collaborative publications with developed and developed countries, including with South Asia. India is credited to have provided technical assistance and initiated few research programmes for promoting international research collaboration in COVID-19 with South Asia countries. The study attempts to assess and analyze COVID-19 related international collaborative publications with four South Asia countries, to understand the nature of collaboration, key participating countries, organizations and authors and their collaborative relationship and linkages, broad subject areas of research, the core media of communication and characteristics of high-cited papers.

## METHODOLOGY

A bibliometric approach has been envisaged to undertaken this study which aims to measure and analyse international research collaboration on a series of indicators. The study used country affiliation of co-authors to identify and compute international

collaboration (Dawn, 2006), (Ki-Wan, 2006). The study used select bibliometric indicators for examining the performance India's collaborative research with South Asia countries, at regional, national, institutional, and individual author level. The data for the study was sourced from the Scopus database. The search strategy applied for the purpose of data searching and retrieval of India's research output on COVID-19 is as follows. This search was further restricted to India's international collaborative linkages with four South Asia countries, namely Pakistan, Bangladesh, Nepal and Sri Lanka individually and together, utilizing the the Affiliation Country tag. The South Asia countries covered in this study include India, Pakistan, Bangladesh, Nepal, and Sri Lanka. The other South Asia countries such as Myanmar, Bhutan, Maldives and Afghanistan are out of the scope of this study due to lack of their participation in the research or due to very low volumes of their output in collaborative research in the subject under study.

TITLE-ABS-KEY ("COVID 19" OR "2019 novel coronavirus" OR "coronavirus 2019" OR "SARS-CoV-2" OR "SARS-CoV 2" OR "coronavirus disease 2019" OR "2019-novel CoV" OR "2019 nCoV" OR "COVID 2019" 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 "Novel Coronavirus") AND (LIMIT-TO (AFFILCOUNTRY, "India")).

## ANALYSES AND RESULTS

### Overall Picture of India

As indexed in Scopus database till 9.5.2023, the global research output count in COVID-19 was 506,691 publications since the first publication was reported in the subject. South Asia countries under study were ranked on their share to global output in the COVID-19. India ranked as the 4<sup>th</sup> largest country in the world with a 7.31% global share (37,095 papers) to the global output, followed distantly by Pakistan ranked 27<sup>th</sup> in global ranking with a 1.32% global share (6,671 papers), Bangladesh ranked 39<sup>th</sup> in global ranking with a 0.75% global share (3824 papers), Nepal ranked 69<sup>th</sup> in global ranking with a 0.23% global share (published 1156 papers) and Sri Lanka ranked 75<sup>th</sup> in global ranking with a 0.15% global share (764 papers).

The South Asia countries contributed 0.15% to 7.31% share to global output in COVID-19 research. India contributed 7.31% global share, the largest vis-à-vis other South Asia countries, three times as much as the other South Asia countries (2.45%) had together contributed to global output in the subject under study.

The South Asia countries contributed 27.92% to 64.76% share of their national output with international collaboration. Pakistan contributed 64.76% share of its national output with international collaboration, followed by Bangladesh (63.15%), Nepal (61.68%),

Sri Lanka (54.19%). In comparison, India contributed just 27.92% of the national output with international collaboration.

South Asia countries individually contributed 12.48% to 50.91% share of its national output in COVID-19 to regional collaboration involving international collaboration with South Asia countries. Nepal contributed the largest 50.91% share to the regional output with international collaboration, Sri Lanka (33.33%), Nepal (29.98%), Pakistan (17.85%) and India (12.48%).

It is reassuring to note that the proportion of publications with international collaboration by Pakistan, Bangladesh, Nepal and Sri Lanka was very substantial, ranging from 54.19% to 64.76% of their country output. The corresponding share of India has been quite less, just 12.48%.

From the above facts presented regarding global COVID-19 output, it is observed that India is a strong player in global COVID-19 research (4<sup>th</sup> global rank) and substantial part of its COVID-19 research output (27% of national output) involved international collaboration collaborations with 150 or more countries. In order to study India's importance and assistance in South Asia countries, we will study to what extent India international collaboration in COVID-19 involves other south Asia countries.

This sort of special importance that India gives to South Asia in the international collaboration underlines the need to undertake such bibliometric studies on regular basis. The findings from such bibliometric studies will eventually help stakeholders understand the features of India's collaboration with other South Asia collaboration in greater detail as well as help them further in planning and promoting fresh international collaboration programmes with South Asia.

### Overall Picture of India's International Collaboration with South Asia

In the world output of research papers on COVID-19, India contributed 37,095 during the period under study. Of these, only 10357 papers (27.92%) were published with international collaboration. In a set of 1293 papers (a subset of 10357 papers, 3.48% share), India was found to have been involved in regional collaboration with South Asia countries (Pakistan, Bangladesh, Nepal and Sri Lanka) and also in international collaboration sharing its manuscript authorship with researchers in other countries.

The annual count of South-Asia focused international collaborative papers by India in COVID-19 research gradually increased from 178 in 2020 to 407 in 2021, then to 552 in 2022 and in 2023 shrinking down sharply to 156 (mainly due to partial coverage limited to first 4 months of year 2023). These 1293 India's international collaborative papers with South Asia were found to have received 28669 citations since their publication, with an average value of 22.17 CPP.

Of the 1293 India's international collaborative papers with South Asia, 282 (21.81%) were the output from COVID-19 research projects which were duly funded and supported by 100 plus external funding agencies. These 282 papers put together received 11317 citations, averaging to 40.13 CPP. The major funding agencies that came in for support to COVID-19 research projects were: National Institute of Health (41 papers), Bill and Melinda Gates Foundation (19 papers), King Saud University (18 papers), National Institute of Health and Care Research (16 papers), WHO (15 papers), National Health and Medical Research Council and Department of Science and Technology, India (14 papers each), European Commission, Medical Research Council, Pfizer and The Wellcome Trust (13 papers each), National Institute of Aging and National Natural Science Foundation of China (11 papers each), U.K. Research and Innovation (10 papers), Australia Research Council and Canadian Institutes of Health Research and AstraZeneca (9 papers each), Novartis and ICMR, India (6 papers each), etc.

Amongst 1293 India's international collaborative papers with South Asia, 779 were published as articles, 253 as reviews, 126 as letters, 45 as notes, 29 as conference papers, 20 as editorials, 15 as book chapters and erratum, 5 as data paper, 4 as books and 2 as short surveys.

Analysis 1293 India's international collaborative papers with South Asia: (i) by type of research revealed that 234 were on the topic of epidemiology, followed by clinical studies (165 papers), risk factors (94 papers), diagnosis (48 papers), complications and pathophysiology (46 papers each) and genetics (39 papers); and (ii) by population-age wise groups revealed that adults accounted for 204 papers, constituting the largest group in the study, followed by middle aged group (77 papers), child group (75 papers), aged group (65 papers) and adolescents group (47 papers).

Amongst 1293 India's international collaborative papers with South Asia on COVID-19, India-Pakistan bilateral pair accounted for the largest contribution (47.18% share, 610 papers), followed by India-Bangladesh (43.77%, 566 papers), India-Nepal (23.12%, 299 papers) and India-Sri Lanka (9.51%, 123 papers). In terms of citations performance, India-Nepal bilateral pair registered the highest value in citations per paper (32.54), followed by India-Sri Lanka (22.15 CPP), India-Bangladesh (21.18 CPP) and India-Pakistan (19.2 CPP).

Of the 1293 India's international collaborative papers with South Asia, a large number of developed and developing countries, including individually four South Asia countries, have participated. In these 1293 India's collaborated papers, the dominating role is played by developed countries (including as first author publications).

In order to understand the type of collaboration, we divided these 1293 papers into two groups. (i) Inter-regional collaboration and

(ii) Intra-regional collaboration: Here besides, India and South Asia countries, several other countries outside South Asia region actively participated in collaborative research by India along with South Asia. Being junior players, the role of India and other South Asia countries in international collaboration is very small. Most credit in research publication goes to many developed and developing countries. Of the 1293 India's international collaborative papers with South Asia, 1108 (85.69%) involve inter-regional collaboration; and (ii) intra-regional collaboration. Here along with India, only four other south Asia countries have participated. This involved both regional collaboration and bilateral collaboration among South Asia countries. Of the 1293 India's international collaborative papers with South Asia, only 185 papers (14.31%) involve intra-regional collaboration or regional collaboration.

### India's Inter-Regional Collaboration in COVID-19

Out of 1293 international collaborative papers on COVID-19 research, 1108 (85.69%) involved inter-regional regional collaboration, i.e., contributed by India in collaboration with researchers from top 20 countries including the USA, the UK, and others.

### Role of Foreign Countries

India had a lot of collaboration in COVID-19 outside South Asia region. In its collaboration with top 20 foreign countries, (11 developed world countries and 9 developing world countries) India contributed a total of 1108 publications (Table 1). India in collaboration with seven leading most countries (USA, UK, Saudi Arabia, Australia, China, Egypt, and Malaysia) contributed 50% of its 1108 publications. India in its collaboration with the USA contributed the most publications, a 40.25% share (446 out of 1108 publication). Publications in collaboration with Columbia accounts for the highest impact (77.75 citations per paper, CPP). In contrast the impact of the publications in collaboration with the USA was far less, 33.45 CPP. Evidently, collaborating countries output differ in terms of quantity and quality of collaborative research publications in COVID-19 studies, in overall, the publications count by country of collaboration ranges from 119 to 446, (10.74% to 40.25%) and their impact by collaborating country ranges from 20.92 to 77.75 CPP. The co-authorship to manuscripts for 1108 publications involved researchers from multiple countries. Hence, the sum-total of publications output by country of collaboration (3811, as shown in Table 1) far exceeds the figure 1108, which being the actual publications output by India in collaboration with 20 foreign countries.

### Role of Foreign Organizations

Top 20 foreign research organizations/institutions that are listed in Table 2 have contributed 868 papers with international collaboration involving researchers from India, South Asia, and from 20 countries as listed in Table 1. These top organizations

in Table 2 account for 78.34% share of net output (1108) of top 20 countries and that they received 53422 citations since the publication of their output. Among the top 20 organizations, nine contributed more than the average publications productivity (43.4): John's Hopkins Aramco Healthcare, Saudi Arabia ( $n=64$ ), King's College, London, U.K and University of Toronto, Canada ( $n=52$  each), Harvard Medical School, USA ( $n=51$ ), University of Sao Paulo, Brazil and University of Oxford, U.K. ( $n=49$  each), Alexandria University, Egypt ( $n=47$ ), Fudacion Universitaria Autonoma de las Americas, Columbia ( $n=45$ ) and University of Melbourne, Australia ( $n=44$ ). Nine organizations registered more than the average (61.55) citation per paper: University of British Columbia, Canada (164.47), Imperial College, London, U.K. (138.12), Karolinska Institutet, Sweden (106.6), Harvard Medical School, USA (97.33), University of Sao Paulo, Brazil (94.63), UNSW, Sydney, Australia (92.33), King Saud University, Saudi Arabia (91.85), University of Oxford, U.K. (85.290 and Fudacion Universitaria Autonoma de las Americas, Columbia (71.69) (Table 2).

### Role of Foreign Authors

The top 20 foreign authors as listed in Table 3 contributed 400 papers out of 1108 papers that India published with international collaboration. These top 20 authors account for 36.10% publications share (400/1108) and 59.67% citations share (16049/26896). Among top 20 authors, six authors contributed more than their average publications productivity (20.0): A.A. Rabaan ( $n=61$ ), M.Y. Essar ( $n=42$ ), A.J. Rodriquez ( $n=41$ ), S.Alhumaid ( $n=27$ ), M.Haque ( $n=26$ ) and H.Harapan ( $n=21$ ). Five authors registered more than the average (40.12) citation per paper: D.K.Bonilla-Aldana (155.24), H. Harapan (96.05), Z.A. Bhutta (83.75), A.J. Rodriquez (78.510 and A.A. Rabaan (55.64) (Table 3).

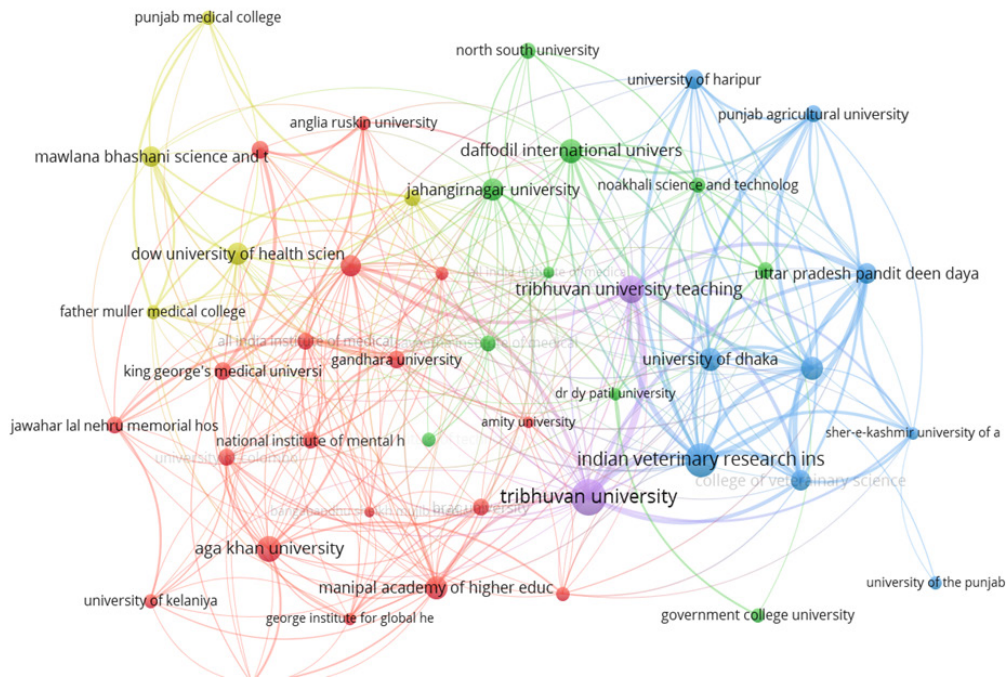
### Subject-Wise Analysis

#### Broad Subjects-Wise Distribution

Classifying the India's COVID-19 research output of 1293 papers with international collaboration by Scopus defined broad subject categories, it was observed that "Medicine" accounted for the largest share (60.32%) of total papers, followed by "Immunology and Microbiology", "Biochemistry, Genetics and Molecular Biology" and Computer Science (13.07%, 11.83% and 9.20%), "Engineering", "Pharmacology, Toxicology and Pharmaceutics" (7.97% and 7.12%), "Environment Science" and "Social Science" (6.96% each), etc. In terms of impact, "Neurosciences" registered the highest citations per paper (40.33) and Computer Science the least (11.16) (Table 4).

### Significant Keywords in COVID-19 Research

Both the author generated keywords and the Scopus generated keywords were used to generate a keyword network for clustering.



**Figure 1:** Collaboration Network among top 45 South Asia organizations.

**Table 1: Research Publications Output by India in Collaboration with Countries outside South Asia Region in COVID-19.**

Sl. No.	Collaborating Country	TP	TC	CPP	%TP
1	USA	446	14687	32.93	40.25
2	U.K.	370	13662	36.92	33.39
3	Saudi Arabia	266	12531	47.11	24.01
4	Australia	234	8758	37.43	21.12
5	China	212	10218	48.20	19.13
6	Egypt	201	8308	41.33	18.14
7	Malaysia	190	3974	20.92	17.15
8	Brazil	185	10089	54.54	16.70
9	Italy	168	8617	51.29	15.16
10	Canada	166	8738	52.64	14.98
11	Nigeria	161	3894	24.19	14.53
12	Japan	157	9296	59.21	14.17
13	Indonesia	144	6735	46.77	13.00
14	Germany	141	8217	58.28	12.73
15	South Africa	136	5910	43.46	12.27
16	Turkey	135	5528	40.95	12.18
17	Spain	129	8981	69.62	11.64
18	Mexico	128	9018	70.45	11.55
19	Columbia	123	9563	77.75	11.10
20	UAE	119	5571	46.82	10.74
	Country-Wise Total	3811	172295		
	Actual Output	1108	26896	24.27	100.00

**Table 2: Leading Organizations in Collaboration with India and South Asia Countries in COVID-19.**

Sl. No.	Name of the organization	TP	TC	CPP
1	John's Hopkins Aramco Healthcare, Saudi Arabia.	64	3438	53.72
2	King's College, London, U.K.	52	1760	33.85
3	University of Toronto, Canada.	52	2349	45.17
4	Harvard Medical School, USA.	51	4964	97.33
5	University of Sao Paulo, Brazil.	49	4637	94.63
6	University of Oxford, U.K.	49	4179	85.29
7	Alexandria University, Egypt.	47	981	20.87
8	Fudacion Universitaria Autonoma de las Americas, Columbia.	45	3226	71.69
9	University of Melbourne, Australia.	44	1663	37.80
10	Karolinska Institutet, Sweden.	42	4477	106.60
11	King Saud University, Saudi Arabia.	41	3766	91.85
12	UNSW, Sydney, Australia.	40	3693	92.33
13	Alfaisal University, Saudi Arabia.	40	544	13.60
14	Ministry of Health, Saudi Arabia.	38	683	17.97
15	Kabul University, Afghanistan.	38	315	8.29
16	University of Cape Town, South Africa.	37	1008	27.24
17	University of British Columbia, Canada.	36	5921	164.47
18	Ain Shams University, Egypt.	36	741	20.58
19	University of Wollongong, Australia.	34	519	15.26
20	Imperial College, London, U.K.	33	4558	138.12
	Leading Organizations Total	868	53422	61.55
	All Organizations Total	1108	26896	24.27
	% Share of All Organizations	78.34		

More than 10,000 keywords were isolated. Only 56 keywords with a frequency of 26 occurrences or more were shortlisted for clustering analysis. The clustering analysis resulted in four clusters showing that the network is dense. Cluster one and two had eighteen keywords each. Hydroxychloroquine was most frequently occurring keyword in cluster 1 with 56 occurrences. COVID-19 (885) was the most frequently occurring keywords in cluster two. Hospitalization was the most frequent occurring keyword in 12 member-clusters three with 42 occurrences. Vaccination (140) topped the list in eight-member cluster four. Details of clusters and links count in respect of these KWs are given in Table 5.

Cluster 1 (18 keywords) includes Hydroxychloroquine, Immune Response, Virology, Angiotensin Converting Enzyme 2, Antivirus Agents, Remdesivir, Drug Efficacy, Drug Safety, Drug Therapy, Virus Replication, Antiviral Agents, Severe Acute Respiratory Syndrome, Azithromycin, Interleukin 6, Tocilizumab, Molecular Docking and Favipiravir;

Cluster 2 (18 keywords) includes COVID-19, Public Health, Virus Transmission, Virus Pneumonia, Anxiety, Depression, Lockdown,

Social media, Psychology, Infection Control, Quarantine, Deep Learning, Telemedicine, Social Distancing, Infection Prevention, Mental Disease, Machine Learning, Cytokine Storm and Fear;

Cluster 3 (12 keywords) includes Hospitalization, Comorbidity, Hypertension, Diabetes Mellitus, Headache, Fatigue, Artificial Ventilation, Diarrhea, Obesity, Coughing and C. Reactive Protein;

Cluster 4 (6 keywords) includes Vaccination, Prevention and Control, SARS-CoV-2 Vaccine, Vaccine, Vaccine Hesitancy;

Cluster 5 (1) includes Infection Risk.

### Most Productive and Most Impactful Organizations

More than 10,000 foreign and South Asian organizations are found to have participated in India's collaboration with South Asia which resulted in 1293 international collaborative papers. The top 45 organizations published 20 to 122 papers each. Together these 45 organizations contributed 1658 papers and received 36437 citations. The count of total papers and total citations exceeds the actual figures already reported in earlier paras. This is because some organizations being common to two or more papers are counted more than once. Of the top 45 organizations, 22 are from

India, 11 from Bangladesh, 8 from Pakistan and 2 each from Nepal and Sri Lanka (Annexure 1).

Fifteen organizations contributed to productivity more than the average of all 45 organizations: Tribhuvan University, Kathmandu, Nepal ( $n=1220$ , IVRI, Bareilly, India ( $n=112$ ), The Aga Khan University, Pakistan ( $n=88$ ), Tribhuvan University Teaching Hospital, Kathmandu, Nepal ( $n=75$ ), Daffodil International University, Bangladesh ( $n=57$ ), University of Dhaka, Bangladesh ( $n=54$ ), Jahangirnagar University, Bangladesh ( $n=5=10$ , Dow University of Health Sciences, Pakistan (49), BGC Trust University, Bangladesh ( $n=43$ ), Mawlani Bhashani Univ of S and T, Bangladesh ( $n=42$ ), Manipal Academy of Higher Education, India ( $n=41$ ), PGIMER, Chandigarh and College of Veterinary Science, Mathura, India ( $n=40$  each), University of Haripur, Pakistan ( $n=390$  and AIIMS, New Delhi ( $n=38$ ).

Seventeen organizations registered their CPP and RCI more than the average (21.98 CPP and 0.99 RCI) of all 45 organizations:

Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, India (61.81 and 2.79), Poshin Chikitsa Vidya Vishwavidyalaya Evam Go Anusandhan Sansthan (52.25 and 2.36), College of Veterinary Science, Mathura, India (48.2 and 2.17), Tribhuvan University Teaching Hospital, Kathmandu, Nepal (41.91 and 1.89), IVRI, Bareilly, India (39.87 and 1.8), Tribhuvan University, Kathmandu, Nepal (33.07 and 1.49), Vellore Institute of Technology, India (30.57 and 1.38), University of Colombo, Sri Lanka (27.83 and 1.26), Enam Medical College and Hospital, Bangladesh (25.91 and 1.17), Jahangirnagar University, Bangladesh (25.9 and 1.17), Anglia Ruskin University, Bangladesh (25.52 and 1.15), King George's Medical University, Lucknow, India (25.36 and 1.14), AIIMS-Jodhpur, India (25.24 and 1.14), BRAC University, Bangladesh (24.31 and 1.1), Amity University, India (24.10 and 1.09), George Institute of Global Health, India (23.23 and 1.05), and MAHE,, India (22.07 and 1.0).

**Table 3: Leading Authors in International Collaboration with India and South Asia Countries in COVID-19.**

Sl. No.	Name of the author	Affiliation of the author	TP	TC	CPP
1	A.A. Rabaan	John's Hopkins Aramco Healthcare, Saudi Arabia.	61	3394	55.64
2	M.Y. Essar	Kabul University, Afghanistan.	42	327	7.79
3	A.J. Rodriquez	Universidad Tecnologica de Preira, Columbia.	41	3219	78.51
4	S. Alhumaid	Ministry of Health, Saudi Arabia.	27	453	16.78
5	M. Haque	National Defense University of Malaysia.	26	481	18.50
6	H. Harapan	UniversitasSyiah Kuala, Indonesia.	21	2017	96.05
7	D.K. Bonilla-Aldana	FudacionUniversitariaAutonoma de las Americas, Columbia.	17	2639	155.24
8	A. AlMutair	Princes Norah Bint Abdulrahman University, Riyadh, Saudi Arabia.	16	422	26.38
9	A.T. Aborode	Healthy African Platform, R and D, Ibadan, Nigeria.	14	113	8.07
10	F. Nainu	Hasanuddin University, Indonesia.	14	419	29.93
11	S. Swed	University of Aleppo, Syria.	14	59	4.21
12	M.O. Folayan	Obafemi Auoloa University, Egypt.	13	225	17.31
13	B. Godman	University of Strathclyde, U.K.	13	249	19.15
14	M.A. Ajanore	Alexandria University, Egypt.	12	267	22.25
15	Z.A. Bhutta	Hospital for the Sick Children, Totonto, Canada.	12	1005	83.75
16	M. Bilal	Huaiyin Institute of Technology, China.	12	339	28.25
17	M. El Tantawi	Alexandria University, Egypt.	12	235	19.58
18	E. Ara	Obafemi Awolowo University, Egypt.	11	62	5.64
19	P. Elakany	Mental Health and Wellness Study Group, Ile-Ife, Nigeria.	11	62	5.64
20	B. Gafar	Mental Health and Wellness Study Group, Ile-Ife, Nigeria.	11	62	5.64
			400	16049	40.12
			1108	26896	24.27
			36.10	59.67	

## Organization to Organization Collaborative Linkages Network

The TLS or collaborative linkages of 45 organizations with South Asia varied from 10 to 184, the largest being 184 linkages by Tribhuvan University, Nepal, followed by IVRI, Bareilly, India ( $n=136$ ), Tribhuvan University Teaching Hospital, Nepal ( $n=106$ ), The Aga Khan University, Pakistan ( $n=99$ ), University of Dhaka, Bangladesh ( $n=88$ ), Daffodil International University, Bangladesh ( $n=78$ ), Dow University of Health Sciences, Pakistan and MAHE, Manipal, India ( $n=75$  each), Jahangirnagar University, Bangladesh ( $n=67$ ), AIIMS, New Delhi ( $n=62$ ), PGIMER, Chandigarh ( $n=59$ ), etc.

The organization-to-organization collaborative linkages among top 45 organizations varied from 1 to 43. The largest collaborative linkages being 43 was found in institutional pairs such as "Tribhuvan University, Nepal and IVRI, Bareilly, India" ( $n=43$ ), followed by "Tribhuvan University, Teaching Hospital, Nepal and IVRI, Bareilly, India" ( $n=38$ ), B.G. Trust University, Bangladesh and IVRI, Bareilly, India" ( $n=22$ ), "University of Haripur, Pakistan and IVRI, Bareilly, India" ( $n=20$ ), Tribhuvan University Teaching Hospital, Nepal and College of Veterinary Science, Mathura, India" ( $n=19$ ), "King George's Medical University, India and Enam Medical College and Hospital" ( $n=19$ ), "Punjab Agricultural University, India and BGC Trust University, Bangladesh" ( $n=21$ ), "PGIMER, India and Tribhuvan University" ( $n=15$ ), "Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, India and Tribhuvan University" ( $n=14$ ), "Punjab Agricultural University, India and University of Dhaka, Bangladesh" ( $n=13$ ), "AIIMS, Jodhpur and Jahangirnagar University, Bangladesh" ( $n=13$ ), etc.

A cluster analysis of top organizations in South Asia was carried out limited to institutions that had contributed nineteen or more papers (Figure 1). The analysis resulted in five clusters. Cluster one contained 19 members with The Aga Khan University Pakistan being the biggest contributor. Cluster two had 10 members with Daffodil University Bangladesh on top. Cluster 3 had nine members with IVRI, India contributing highest number of articles. There were five institutions in cluster four with Dow University of Health Sciences, Pakistan on top. The cluster five had only three members.

Cluster 1: The Aga Khan University, Pakistan, MAHE, India, PGIMER, Chandigarh, AIIMS, New Delhi, Gandhara University, Pakistan, Enam Medical College and Hospital, Bangladesh, King George's Medical University, Lucknow, India, BRAC University, Bangladesh, SGPGIMS, India, University of Kelaniya, Sri Lanka, ICDDC Bangladesh, JLN Memorial hospital, Aligarh, India, NIMHNS, India, Anglia Ruskin University, Bangladesh, George Institute of Global Health, India, King Edward Medical University, Lahore, Pakistan, Amitty University, India and Banglabandhu Sheikh Mujib Medical University, Bangladesh;

Cluster 2: Daffodil International University, Bangladesh, Jahangirnagar University, Bangladesh, Chitkara University, Punjab, North South University, Bangladesh, Saveetha Institute of Medical and Technical Sciences, India, Dr DY Vidyapeeth, Pune, Government College University Faisalabad, Pakistan, AIIMS-Jodhpur, India, Noakhali S and T Univ, Bangladesh and VIT, India;

Cluster 3: IVRI, Bareilly, India, University of Dhaka, Bangladesh, BGC Trust University, Bangladesh, College of Veterinary Science, Mathura, India, College of Veterinary Science, Mathura,

**Table 4: Subject-Wise Distribution India's Collaborative Research with South Asia.**

Sl. No.	Name of the broad subject	TP	TC	CPP	%TP
1	Medicine	780	18236	23.38	60.32
2	Immunology and Microbiology	169	2567	15.19	13.07
3	Biochemistry, Genetics and Molecular Biology.	153	3176	20.76	11.83
4	Computer Science	119	1328	11.16	9.20
5	Engineering	103	1331	12.92	7.97
6	Pharmacology, Toxicology and Pharmaceutics	92	1545	16.79	7.12
7	Environment Science	90	1521	16.90	6.96
8	Social Sciences	90	1165	12.94	6.96
9	Neurosciences	54	2178	40.33	4.18
10	Psychology	54	581	10.76	4.18
11	Agricultural and Biological Sciences.	46	581	12.63	3.56
12	Veterinary Science	16	248	15.50	1.24
	India's total collaborative papers with South Asia.	1293	28669	22.17	



India, University of Haripur, Pakistan, U.P. Pandit Deen Dayal Upadhyaya Yashwan Chikitsa Vidya Vishwavidyalaya Evam Go Anusandhan Sansthan, Punjab Agricultural University (PAU), Ludhiana, India, University of the Punjab, Pakistan and Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, India;  
 Cluster 4: Dow University of Health Sciences, Pakistan, Mawlana Bhashani Univ of S and T, Bangladesh, Kasturba Medical College

**Table 5: Most Significant Keywords Ranked by Frequency of their Occurrences.**

Sl. No.	Name of keyword	Frequency of occurrence	Cluster	Links	Sl. No.	Name of keyword	Frequency of occurrence	Cluster	Links
1	COVID-19	885	2	1842	31	Telemedicine	37	2	109
2	Vaccination	140	4	514	32	Drug Therapy	36	1	195
3	Public Health	98	2	255	33	Social Distancing	36	2	88
4	Prevention and Control	91	4	361	34	Infection Prevention	35	2	170
5	SARS-CoV-2 Vaccine	87	4	391	35	Virus Replication	35	1	202
6	Virus Transmission	80	2	336	36	Antiviral Agents	34	1	197
7	Virus Pneumonia	69	2	251	37	Headache	33	3	196
8	Anxiety	62	2	191	38	Infection Risk	33	5	150
9	Depression	62	2	172	39	Mental Disease	33	2	91
10	Hydroxychloroquine	56	1	384	40	Fatigue	32	3	183
11	Immune Response	56	1	250	41	Vaccine Hesitancy	32	4	150
12	Hospitalization	42	3	290	42	Machine Learning	31	2	40
13	Virology	54	1	228	43	Artificial Ventilation	30	3	161
14	Comorbidity	53	3	300	44	Severe Acute Respiratory Syndrome	31	1	113
15	Angiotensin Converting Enzyme 2	51	1	308	45	Azithromycin	30	1	216
16	Hypertension	51	3	290	46	Choloroquine	30	1	254
17	Lockdown	51	2	175	47	Cytokine Storm	30	2	360
18	Diabetes Mellitus	49	3	221	48	Interleukin 6	30	1	171
19	Antivirus Agents	48	1	264	49	Tocilizumab	30	1	254
20	Remdesivir	46	1	335	50	Fear	29	2	97
21	Social Media	46	2	149	51	Diarrhea	28	3	373
22	Psychology	45	2	168	52	Molecular Docking	28	1	72
23	Drug Efficacy	44	1	229	53	Obesity	27	3	138
24	Vaccine	44	4	186	54	Coughing	27	3	152
25	Infection Control	43	2	170	55	C. Reactive Protein	26	3	141
26	Drug Safety	41	1	225	56	Favipiravir	26	1	197
27	Quarantine	41	2	174					
28	Deep Learning	40	2	36					
29	ICU	40	3	185					
30	Dyspnea	37	3	239					

(KMC), Manipal, Punjab Medical College, Pakistan and Fr Mueller Medical College Hospital, India;

Cluster 5: Tribhuvan University, Kathmandu, Nepal, Tribhuvan University Teaching Hospital, Kathmandu, Nepal and IVRI, India.

### Most Productive and Most Impactful Authors

More than 18,000 foreign and South Asia authors contributed to 1293 international collaborative papers in COVID-19 research. The top 45 authors contributed 9 to 106 papers, and together they contributed 919 papers, received 23813 citations to their papers.

These 919 papers account for 71.08% of total 1293 papers, and for 83.06% share of total citations. Of the top 45 authors, 24 were from India, 8 from Bangladesh, 6 each from Nepal and Pakistan and 1 from Sri Lanka.

Out of 45 top authors, 12 authors contributed more than the average productivity (20.42) of all 45 authors: K. Dhama (India) ( $n=106$ ), R. Sah (Nepal)( $n=66$ ), T.B. Emran (Bangladesh)( $n=53$ ), S. Shoib (India)( $n=51$ ), R. Tiwari (India)( $n=38$ ), M.M. Hasan (Bangladesh) and I. Ullah (Pakistan)( $n=35$  each), S. Ahmad (Pakistan), SMY Arafat (Bangladesh) and M. Dhawan (India) ( $n=27$  each), S.K. Kar (India) and R.K. Mohapatra (India)( $n=23$  each).”

**Table 6: Top 30 Journals Which Published COVID-19 Research by India with International Collaboration.**

Sl. No.	Journal Name	TP	TC	CPP
1	Annals of Medicine and Surgery.	36	96	2.67
2	Frontiers in Public Health.	24	654	27.25
3	Asian Journal of Psychiatry.	16	356	22.25
4	Vaccines	16	177	11.06
5	PLOS One	15	201	13.40
6	Human Vaccines and Immuno-therapeutics.	13	302	23.23
7	International Journal of Surgery London, England.	13	0	0.00
8	Journal of Medical Virology.	13	175	13.46
9	Environmental Science and Pollution Research.	12	142	11.83
10	World Surgery	12	83	6.92
11	Clinical Epidemiology and Global Health.	11	90	8.18
12	Frontiers in Psychiatry	10	208	20.80
13	Journal of Pure and Applied Microbiology.	10	112	11.20
14	Frontiers in Pharmacology	9	152	16.89
15	International Journal of Environmental Research and Public Health.	9	68	7.56
16	International Journal of Surgery.	9	40	4.44
17	American Journal of Tropical Medicine and Hygiene.	8	82	10.25
18	BMJ Open	8	24	3.00
19	The Lancet	8	347	43.38
20	Psychiatry Research	8	554	69.25
21	Rheumatology International	8	72	9.00
22	BMJ Global Health	7	48	6.86
23	Sustainability	8	92	11.50
24	Health Science Reports	7	15	2.14
25	Infezioni in Medicina	7	479	68.43
26	International Journal of Health Planning and Management.	7	53	7.57
27	International journal of Rheumatologic Diseases.	7	47	6.71
28	Journal of Experimental Biology and Agriculture.	7	27	3.86
29	Science of the Total Environment.	7	114	16.29
30	Travel Medicine and Infectious Diseases.	7	1913	273.29

Out of 45 top authors, 13 registered CPP and RCI greater than their average (25.91 and 1.17) value of all 45 authors: M.I. Yattoo (India)(71.64 and 3.23), Y.S. Malik (India)(68.71 and 3.1), M. Pathak (India)(60.4 and 2.72), J.M. Chatterjee (Nepal)(54.30 and 2.45), R. Sah (Nepal)(50.95 and 2.3), R. Tiwari (India)(50.45 and 2.28), K. Sharun (India)(46.76 and 2.11), S.K. Patel (India)(46.53 and 2.10), K Dhama (India)(40.8 and 1.84), P. Sharma (Nepal) (40.23 and 1.81), S.K. Kar (India)(33.26 and 1.5), J. Charan (India) (30.92 and 1.39) and R. Kabir (Bangladesh)(30.67 and 1.38).

The TLS or collaborative linkages in respect of top 45 South Asia authors varied from 5 to 184. K. Dhama (India) at 124 depicted the largest number of linkages, followed by R. Sah (Nepal) ( $n=87$ ), T.B. Emran (Bangladesh) and S. Shoib (India)( $n=69$  each), I. Ullah (Pakistan)( $n=51$ ), M.M. Hasan (Bangladesh)( $n=51$ ), etc.

### Author to Author Collaborative Linkages Network

The author-to-author collaborative linkages across top 45 authors varied from 1 to 41. "K. Dhama and R. Sah" authorship-pair received the largest collaborative linkages ( $n=41$ ), followed by "K. Dhama and T.B. Emran" ( $n=31$ ), "M. Dhawan and T.B. Emran" ( $n=24$ ), "R. Tiwari and R. Sah"( $n=22$ ), "S. Shoib and T. Ullah" and "S.K. Kar and SMY Arafat ( $n=19$  each), "S. Kumar and M. Haque" and "S. Dutts and S. Islam" ( $n=14$  each), "Y.S. Malik and R. Sah" and "A. Mohanti and R. Sah" ( $n=13$  each), "S. Dutta and M. Hague", "B.K. Padhi and R. Sah", "S.K. Patel and R. Sah" and S.K. Karand R. Kabir" ( $n=12$  each), "R. Tiwari and T.B. Emran" ( $n=11$ ), M.I. Yattoo and R. Sah" and "J. Charan and M. Haque" ( $n=10$  each), etc.

A visual view of collaboration among authors which contributed 8 or more papers was created using VOSviewer, [www.vosviewer.com](http://www.vosviewer.com) (Figure 2) It reveals eight clusters of collaboration.

Cluster 1-It contained nine members. K. Dhama of IVRI, India is the highest contributor. Cluster 2-It also had nine members with SMY Arafat of Enam Medical College and Hospital, Bangladesh on top.

Cluster 3 had eight members with S. Shoib of JLN Memorial Hospital, India contributing most. Cluster four and five had six authors each, with S. Ahmad of Punjab Medical College, Pakistan and K. Sharun of IVRI, Bareilly, India Indian contributing most. Similarly, cluster sixth and seventh had four members each with R. Tiwari of IVRI and R. shah of Tribhuvan University Nepal contributing most. Cluster eight had only one member i.e., J.M. Chatterjee of Lord Buddha Education Foundation, Nepal.

Cluster 1: K Dhama, T.B. Emran, M. Dhawan, R.K. Mohapatra, H. Chopra, M.A. Islam, C. Chakraborty, M. Kumar and O.P. Chowdhary;

Cluster 2: SMY Arafat, S.K. Kar, R. Kabir, S. Islam, S. Kumar, J. Charan, P. Sharma, S. Dutta and V. Menon;

Cluster 3: S. Shoib, A. Javed, R. Ransing, M. Chandradasa, A. Agrawal, T. Behl and M.S. Uddin;

Cluster 4: M.M. Hasan, S. Rackimurthu, M. Bardhan, J.M. Chatterjee, Z. Islamanad A. Mohan;

Cluster 5: R. Tiwari, Y.S. Malik, K. Sharun, S.K. Patel, M.I. Yattoo and M. Pathak;

Cluster 6: R. Sah, A. Mohanty, B.K. Padhi and S. Shrestha;

Cluster 7: L. Gupta, Babar Salim, V. Agarwal and H. Chinoy;

Cluster 8: J.M. Chatterjee.

### Leading Journals

India published 332 out of 1293 international collaborative papers, accounting for 25.68% share, in top 30 journals (Table 6). This data demonstrates that India's productivity rate per author is low and below expectations.

### Highly-Cited Papers (HCPs)

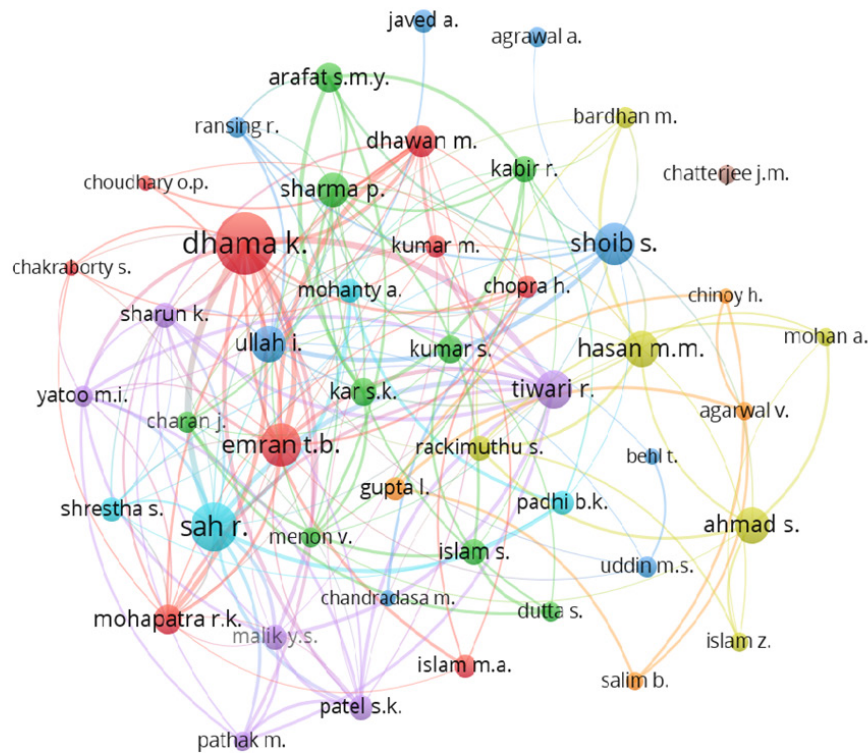
Of the 1293 papers under study, 248 papers received no citation and the rest 1045 received 1 to 1527 citations. Of the 1045 cited papers, 630 papers received 1-10 citations, 313 received 11-50 citations, 56 received 51 to 100 citations and 46 papers received 100 to 1527 citations.

Such research publications which have received 100 or 100+ citations per paper since their publication have been presumed as Highly Cited Papers (HCPs). In all, this study contributed 46 highly cited papers accounting for a 3.55% share of 1293 collaborative publications under study.

Of the 46 HCPs papers, 24 received citations in the range 100-198 citations per paper, 11 papers were in the 211-336 citation range, 5 papers in 409-478 citation range, 2 papers in 581-934 citation range and 4 papers in 1247-1527 citation range. These 46 HCPs received a total of 15696 citations, averaging 341.22 CPP. Of the 46 HCPs, 35 appeared as articles, 8 as reviews and 3 as letters. 45 papers were involved in international collaboration and only one paper in bilateral collaboration.

Among the foreign countries that participated in 46 HCPs, USA contributed the largest number of papers ( $n=26$ ), followed by U.K ( $n=23$ ), Saudi Arabia ( $n=21$ ), China and Brazil ( $n=18$  each), Mexico ( $n=16$ ), Australia, Columbia, France, Japan, Germany and Spain ( $n=14$  each), Canada, Egypt, Italy, Malaysia and Netherlands ( $n=13$  each), Switzerland ( $n=11$ ), Iran and Sweden ( $n=10$  each), South Africa, UAE and Russia Federation ( $n=9$  each), Indonesia, Singapore and Turkey ( $n=8$  each), Nigeria ( $n=6$ ), South Korea ( $n=5$ ), Thailand ( $n=4$ ), etc.

Among the participating organizations, Tribhuvan University, Nepal accounted for the largest contribution (9 papers), followed by IVRI, India (8 papers), The Aga Khan University, Pakistan (6 papers), Tribhuvan University Teaching Hospital, Nepal,



**Figure 2:** Collaboration Network among top 45 South Asia authors.

U.P. Pandit Deen Dayal Upadhyayaposhin Chikitsa Vidya Vishwavidyalaya Evam Go Anusandhan Sansthan, India and College of Veterinary Science, Mathura, India (5 papers each), Bai Jerbai Wadia Hospital for Children, Mumbai, India and Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, India (4 papers each), Khyber Medical University, Pakistan and Transnational Health Science and Technology Institute, Faridabad, India (3 papers each), Holy Family Red Crescent Medical College, Dhaka, Bangladesh, Apollo Specialty Hospital, Chennai India, Lord Buddha Education Foundation, Nepal, MAHE, India, Medanta, Gurgaon, India, Nepal Medicity Hospital, Nepal Intensive Care Foundation, Public Health Foundation of India, University of Dhaka, Bangladesh, University of Colombo, Sri Lanka, Tata Memorial Hospital, Mumbai, India, and Vellore Institute of Technology, India.

Among participating authors, K. Dhama, India accounted for the largest contribution ( $n=8$ ), followed by R. Sah, Nepal ( $n=7$ ), R. Tiwari ( $n=5$ ), Y.S. Malik ( $n=4$ ), M.I. Yattoo, S. Chakravorty and M. Desai ( $n=3$  each), D. Aryal, J.M. Chatterjee, A. Duggal, D. Jayakumar, S. Murthy and S.K. Patel, etc. ( $n=2$  each), T.B. Emran, S.M.Y. Arafat, M. Dhawan, R.K. Mohapatra, S.K. Kar, R. Kabir ( $n=1$  each), etc.

The 44 HCPs were published in 36 journals, of which 3 papers each were published in New England Journal of Medicine and Travel Medicine and Infectious Diseases, followed by 2 papers each in The Lancet Psychiatry, Psychiatry Research, Science and Science Immunology and 1 paper each in 30 other journals such as American Journal of Obstetrics and Gynecology, Anesthesia,

Applied Energy, Chaos, Solitons and Fractals, Diabetes Research and Clinical Practice, Dental and Medical Problems, Environmental Research, Epidemiology and Health, Frontiers in Public Health, Hepatology Internal, Infezioni in Medicina, International Journal of Infectious Diseases, International Journal of Stroke, JAMA Journal, JAMA Pediatrics, Journal of Critical Care, Journal of Neurological Sciences, Journal of Retailing and Consumer Services, Journal of Urban Health, JMIR Public Health Surveillance, The Lancet, The Lancet Microbe, The Lancet Respiratory Medicine, Mobile Networks and Applications, Molecules, Nature Communications, Nature Medicine, Postgraduate Medical Journal, Symmetry, Vaccines and Veterinary Quarterly

## CONCLUSION

India contributed 1293 international collaborative publications in COVID-19 as of May 2023. Scholarly output by India in collaboration with South Asian countries was 14.3% and in collaboration countries outside South Asia its output was 85.7%. Most of the collaborative research output was primarily produced by collaborating authors and organizations/institutions from countries outside South Asia region. Evidently, India is far more dependent on inter-regional collaboration in its research pursuits in COVID-19. For enabling South Asia to establish and develop centres of excellence, it is desirable that India and South Asian countries reduce their dependency on inter-regional collaboration. For this, India and other countries in the South Asia region will have to strengthen their research capacity and

improve the quality of their research. To fill this gap South Asian countries (i) must evolve appropriate strategies to expand and improve their financial and administrative mechanisms for stronger collaborative research support; (ii) encourage and reward research productivity and competitiveness; (iii) enable researchers to develop high-quality proposals, both for domestic and international projects; (iv) involve postgraduate students and postdoctoral research fellows into collaborative research at national, regional, and international level; and (v) involve private sector into collaborative research with academic and research institutions, and also encourage their joint participation in international research programs funded by multilateral institutions.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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**Cite this article:** Dhawan SM, Gupta BM, Singh Y, Walke R, Bansal M. A Scientometric Assessment of India's International Collaboration with South Asia Countries in COVID-19 Research. *Journal of Data Science, Informetrics, and Citation Studies*. 2023;2(3):175-90.

**Annexure 1: Top 45 Most Productive Organizations in South Asia involved in COVID-19 Research.**

Sl. No.	Name of the organization	TP	TC	CPP	RCI	Collaborative Links
1	Tribhuvan University, Kathmandu, Nepal.	122	4034	33.07	1.49	IVRI (43), Coll Vet Sci (22), U.P. Pandit (17), PGIMER (15), Sher-e-Kasmir (14).
2	Indian Veterinary Research Institute (IVRI), Bareilly, India.	112	4465	39.87	1.80	TribhuvanUniv (43), BGC Trust Univ (24), Univ of Haripur (20).
3	Tribhuvan University Teaching Hospital, Kathmandu, Nepal.	75	3143	41.91	1.89	IVRI (38), Coll Vet Sci (19), U.P. Pandit (15), PGIMER (12), Sher-e-Kasmir (13), Dr DY Patil Med Coll and Hosp (12).
4	The Aga Khan University, Pakistan.	88	1645	18.69	0.84	ICDDR-Bang (10), PGIMER (9), AIIMS-ND (9).
5	Daffodil International University, Bangladesh.	57	282	4.95	0.22	PAU (11), ChitkaraUniv (10), IVRI (11), Coll Vet Sci (8).
6	University of Dhaka, Bangladesh.	54	958	17.74	0.80	PAU (13), IVRI (110), Coll Vet Sci (8).
7	Jahangirnagar University, Bangladesh.	51	1321	25.90	1.17	AIIMS-Jodh (13), BVM Coll Pharm (6).
8	Dow University of Health Sciences, Pakistan.	49	489	9.98	0.45	M.B. S and T Univ (11), Sher-e-Kasmir (5), KMC-Manipal (5).
9	BGC Trust University, Bangladesh.	43	749	17.42	0.79	IVRI (29), PAU (21), Coll Vet Sci (10).
10	MawlaniBhashaniUniv of S and T, Bangladesh.	42	350	8.33	0.38	Dow UnivHlthSci (11), Heitage Inst of Tech (10), Fr Mueller Med CollHosp (9), NICED (9), KMC-Manipal (5).
11	Manipal Academy of Higher Education (MAHE), India.	41	905	22.07	1.00	TribhuvanUniv (11).
12	Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh.	40	726	18.15	0.82	TribhuvanUniv (15), TrivanUniv Teaching Hospital (13), Aga Khan Univ (9).
13	College of Veterinary Science, Mathura, India.	40	1928	48.20	2.17	TribhuvanUniv (22), TrivanUniv Teaching Hospital (19), BGC Trust Univ (10), Univ Dhaka (8).
14	University of Haripur, Pakistan.	39	343	8.79	0.40	IVRI (20), PAU (10), Univ Dhaka (6), Coll Vet Sci (6).
15	All India Institute of Medical Sciences (AIIMS), New Delhi.	38	592	15.58	0.70	Aga Khan Univ (9), TribhvanUniv (8).
16	Gandhara University, Pakistan.	34	502	14.76	0.67	JLN Memorial Hosp (8).
17	Enam Medical College and Hospital, Bangladesh.	33	855	25.91	1.17	KGMU (19), JIPMER (10), JLN Memorial Hosp (7).
18	King George's Medical University, Lucknow, India.	33	837	25.36	1.14	EnamMedColl and Hosp (19), Anglia Ruskin Univ (11).
19	BRAC University, Bangladesh.	32	778	24.31	1.10	UnivColumbo (5), MAHE (4).
20	U.P. Pandit Deen Dayal Upadhyayaposhin Chikitsa Vidya Vishwavidyalaya Evam Go Anusandhan Sansthan.	32	1672	52.25	2.36	TribhuvanUniv (17), TribhuvanUniv Teaching Hosp (15).
21	Punjab Agricultural University (PAU), Ludhiana, India.	30	580	19.33	0.87	BGC Trust Univ (21), Univ Dhaka (13), Daffodil IntUniv (11), Univ Haripur (10).
22	Kasturba Medical College (KMC), Manipal.	29	497	17.14	0.77	Punjab Med Coll (8), Karachi Med Dental Coll (6), Dow Univ Health Sci (5).
23	University of Colombo, Sri Lanka.	29	807	27.83	1.26	Aga Khan Univ (6), BRAC Univ (5).

Sl. No.	Name of the organization	TP	TC	CPP	RCI	Collaborative Links
24	Chitkara University, Punjab.	29	274	9.45	0.43	Daffodil IntUniv (10), BGC Trust Univ (8), Southeast Univ-Dhaka (8).
25	North South University, Bangladesh.	28	387	13.82	0.62	Symbiosis Int Deemed Univ (6).
26	Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow, India.	27	269	9.96	0.45	
27	Jawahar Lal Nehru (JLN) Memorial hospital, Aligarh, India.	25	149	5.96	0.27	GandharaUniv (8), Enam Med Coll and Hosp (7), UnivKelaniya (4).
28	International Centre for Diarrhoeal Disease Research (ICDDC), Bangladesh.	25	369	14.76	0.67	Aga Khan Univ (10).
29	University of Kelaniya, Sri Lanka.	26	134	5.15	0.23	JLN Memorial Hosp (4).
30	National Institute of Mental Health and Neuro Sciences (NIMHNS), Bangalore, India.	25	487	19.48	0.88	GandharaUniv (5), Tribhuvan University (3), MawlanaBhashani S and T University (3).
31	Ministry of Health and Family Welfare, India.	25	321	12.84	0.58	TribhuvanUniv (17), Univ of Dhaka (2), BRAC Univ (2), Dow Univ Health Sci (2), Univ Vet and Animal Sci, Lahore (2), Aga Khan Univ (2)
32	Saveetha Institute of Medical and Technical Sciences, India.	25	192	7.68	0.35	Daffodil IntUniv (5), Univ Central Punjab (4), TRibhuvanUniv (2), University of Haripur (2).
33	Anglia Ruskin University, Bangladesh.	23	587	25.52	1.15	KGMU (12), Patan Academy Health Sci (3), PGIMER (3), JIPMER (3), TribhuvanUniv (3), TRibhuvanUniv Teaching Hosp (3), UnivColumbo (2).
34	University of the Punjab, Pakistan.	23	224	9.74	0.44	TIET (2), Univ of Dhaka (2), Univ Delhi (2).
35	Punjab Medical College, Pakistan.	22	161	7.32	0.33	Fr Mueller Med CollHosp (9), KMC-Manipal (8), MB S and T Univ, Bangladesh (5), Dow Univ Health Sci (3).
36	Government College University Faisalabad, Pakistan.	22	107	4.86	0.22	Dr DY PatilVidyapeeth, Pune (8), JamiaMilliaIslamia (2).
37	George Institute of Global Health, India.	22	511	23.23	1.05	UnivColumbo (5), TribhuvanUniv (5), ICDDC-Bangladesh (4), BRAC Univ (3), Nat Center of Cardiology and Internal Med (2).
38	Dr DY Vidyapeeth, Pune.	22	137	6.23	0.28	TribhuvanUniv (14), TribhuvanUniv Teaching Hosp (13), Govt College UnivFaisalbad (8), Anglia Ruskin Univ (2).
39	Vellore Institute of Technology, India.	21	642	30.57	1.38	Lord Buddha Education Foundation (6), Air Univ Islamabad (6).
40	Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, India.	21	1298	61.81	2.79	TribhuvanUniv (14), TRibhuvanUniv Teaching Hosp (13), BGC Trust Univ (2).
41	King Edward Medical University, Lahore, Pakistan.	21	193	9.19	0.41	IVRI (3), MAMC (2), AIIMS-ND (2).
42	Fr Mueller Medical College Hospital, India.	21	308	14.67	0.66	Ounjab Med Coll (9), MB S and T Univ, Bangla (9), Dow Univ Health Sciences (8), ICDDC-Bang (3).
43	Noakhali S and T Univ, Bangladesh.	21	217	10.33	0.47	IVRI (12), ChitkaraUniv (5).

Sl. No.	Name of the organization	TP	TC	CPP	RCI	Collaborative Links
44	AIIMS-Jodhpur, India.	21	530	25.24	1.14	JahangirnagarUniv (13), TribhuvanUniv (50, North South Univ (4), ICDDC-Bang (3).
45	Amity University, India.	20	482	24.10	1.09	Southeast Univ (5).
	Total of top 45 organizations	1658	36437	21.98	0.99	
	India's total	1293	28668	22.17	1.00	