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Research Article

Pakistan's Contribution to COVID-19 Research: A Scientometric Analysis of Publications from 2020-2023

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ABSTRACT

This study aims to analyse the characteristics, trends, current status and hotspots in Pakistan COVID-19 research output. We retrieved the relevant literature on Pakistan COVID-19 from the Scopus database from 2020 to 2023. Bibliometric and visualisation analysis was undertaken using MS Excel and VOSviewer software. Results: In all 7,749 papers on Pakistan COVID-19 research was published in 1,471 sources contributed by 12,633 authors affiliated to 5,305 institutions. The 17.77% share of 7749 Pakistan publications received external funding support and 64.64% publications were involved in international collaboration with 86 foreign countries. Among foreign countries, Saudi Arabia, China and the USA collaborated with Pakistan in almost half of Pakistan's collaborative publications. The Aga Khan University, Karachi and Dow University of Health Sciences, Karachi contributed the highest number of publications. I. Ullah and S. Ahmad contributed the most, while A.M. Baig and Z.A. Bhutta registered the highest average citations per paper. The Pakistan Armed Forces Medical Journal (*n*=222) and Journal of the Pakistan Medical Association (*n*=176) published the most papers. Only 2.33% share of its total publications were considered as High-Cited Papers (HCPs), as they received 100 to 1,609 citations. This study will provide an opportunity to scholars and policy-makers to understand the overall trends, current status and research hotspots in Pakistan's COVID-19 research, help in identifying the future subject areas of collaboration and may be used as a valuable reference for future research.

Keywords: COVID-19, SARS-CoV-2, Infection, Pakistan, South Asia, Bibliometrics.

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INTRODUCTION

The emergence of COVID-19 is considered a case of pneumonia. with an unknown cause that initially emerged in Wuhan, China, towards the end of December 2019 (Sahin, 2020). The International Committee on Taxonomy of Virus named as it Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) (Zhu *et al.*, 2020). The WHO officially declared a Public Health Emergency of International Concern (PHEIC) for this virus on January 30, 2020 (Rodriguez-Morales *et al.*, 2020; World Health Organization, 2020b) and later named it as Coronavirus disease-19 (COVID-19) (Zu *et al.*, 2020) on February 11, 2020. The COVID-19, considered as the third outbreak of the coronavirus, impacted more than 209 countries, including Pakistan (Wikipedia, the free encyclopedia, 2023). Within a few months of its origin, it became a global pandemic, causing significant disruptions to global activities, experiencing various economic and social costs and impacts and affecting millions of people through infection. As per the WHO data, there have been a total of 1,093,349 confirmed cases and 58,620 deaths (World Health Organization, 2020a, 2020c, 2023). The COVID-19 outbreak and virus was officially detected in Pakistan on 26 February 2020, with two cases reported in Karachi and Islamabad Capital Territory (Abid *et al.*, 2020; Imtiaz *et al.*, 2020). The scientific community in Pakistan promptly mobilised its RandD resources to investigate different facets of COVID-19, such as its transmission, pathophysiology, testing, treatment, diagnosis and vaccine development (Kurtkulagi *et al.*, 2020; Wiersinga *et al.*, 2020).

As a result of Pakistan scientific community efforts, Pakistan's made significant contributions to COVID-19 research output, ranking 30th globally and 2nd in South Asia with approximately 7,600 publications in COVID-19 research (Barai, 2021). Despite its significant output and share in global COVID-19 research, there has been no comprehensive bibliometric study

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to examine its research performance. This gap in research has motivated the authors to undertake the present study which aims to present a qualitative and quantitative analysis of Pakistan COVID-19 research, including identifying characteristics, research trends, publication status, funding and collaboration aspects. Additionally, we aim to identify the key players such as organisations, authors and journals, explore the major themes being pursued and analyse and visualise the co-authorship network among organisations, authors and journals, as well as the co-occurrence of keywords.

METHODOLOGY

The Scopus database was used to identify, retrieve and download the relevant literature on Pakistan COVID-19 research using a predefined search strategy (shown below) utilising all COVID-19 related keywords in "TITLE-ABS-KEY" tag and restricted the search to Pakistan in "Affilcountry" Tag till 18 December 2023. The search yielded 7749 records, which were subsequently refined by broad subject area, document type, source type, organisations, author, journal and keywords using additional search features and tools provided by Scopus. The retrieved bibliometric data of 7749 records, were downloaded as a "full record and cited reference" from the Scopus database for further analysis and bibliographic feature of each record such as publishing year, title, author names, nationalities, affiliations, abstract, keywords and name of journals, finding and citation count were marked and studied. The bibliometric and visual analysis was performed using MS-Excel 2010 and VOSviewer, along with the R bibliometric package (Aria and Cuccurullo, 2017; Chen, 2004; Van Eck and Waltman, 2010). The 181 papers (2.33%) in Pakistan total papers received 100 to 1609 citations and they are assumed as high-cited papers (HCPs) in the present 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, "Pakistan")).

RESULTS

Global and Pakistan overall picture

In all, 599448 global papers on COVID-19 research were published till 18 December 2023, of which. Pakistan contributed 7749 papers, constituting a 1.76% share of global output. Compared with other South Asia countries, India contributed 44243 papers (7.38% global share) and other South Asia countries comparatively much less than Pakistan: Bangladesh, Nepal, Sri Lanka and Nepal. The yearly COVID-19 output from Pakistan showed first an increase: 1061 papers in 2020 to 2328 papers in 2021 to 2593 papers in 2022 and then witnessed a decrease to 1718 papers in 2023. In all, the 7749 Pakistan papers received 107203 citations, averaging 13.83 Citations Per Paper (CPP). Research articles, reviews and letters constitute the largest share of papers (70.15%, 11.72% and 7.79%) in Pakistan's research output.

Only 17.77% (*n*=1377) share of Pakistan's total output in COVID-19 received extramural funding from 150 or more international funding agencies) and together its 1377 funded papers received 31035 citations, averaging 22.54 CPP. National Natural Science Foundation of China (*n*=182) contributed the most funded papers among foreign funding agencies, followed by King Saud University, Saudi Arabia (*n*=186) and the National Institute of Health, USA (*n*=97), U.S. Department of Health and Human Service (*n*=64), Higher Education Commission of Pakistan (*n*=58), Prince Sultan University, Saudi Arabia (*n*=57), National Research Foundation of Korea (*n*=53), Ministry of Science and Technology of People's Republic of China (*n*=46), Bill and Melinda Gates Foundation (*n*=45), etc.

Only 2702 out of 7749 Pakistan papers on COVID-19 reported population age data in author keywords. Among them, 16.12% and 6.22% of the Pakistan publications reported the involvement of Adults and Middle-Aged, whereas 7.29% and 5.24% were focused on Children and Adolescents and Aged populations. Clinical studies and Epidemiology (13.61% and 13.45% share) accounted for the largest share of Pakistan's COVID-19 output by research type, followed by risk factors (4.34% share), diagnosis (3.30% share), complications (2.74% share) and genetics (2.10% share).

International collaboration

The 5009 (64.64%) share of Pakistan total papers were involved in international collaboration with 86 countries and they together received 82721 citations, averaging 16.51 CPP. Among the 86 foreign countries, Saudi Arabia (*n*=1359) contributed the largest share (27.13%), followed by China (*n*=1271), USA (*n*=1033), UK (*n*=864) and India (*n*=728). In terms of CPP, France's collaboration with Pakistan registered the highest CPP (45.81), followed by Nigeria (40.13 CPP), Italy (35.32 CPP), Brazil (33.91 CPP) and Canada (33.73 CPP).

Among the international collaborative papers (ICPs) of Pakistan in COVID-19, South Asia countries together participated in 988 papers and these together received 22620 citations, averaging 22.89 CPP. Among South Asia ICPs, India participated in 728 papers, followed by Bangladesh (*n*=319), Nepal (*n*=114)), Sri Lanka (*n*=63), etc.,

Figure 1 presents the VOSviewer collaboration network visualisation map top 20 foreign countries collaborating with Pakistan and contributing 200 or more publications). The 20 countries were classified into two clusters, establishing 210 links with Total Link Strength (TLS) of 18857.

Role of foreign organisations

We identified the top 30 foreign organisations participating in ICPs from Pakistan, which individually contributed 2793 papers and 66412 citations, accounting for 36.04% and 61.95% share in overall Pakistan's papers and citations. Among the top 30 organisations, 13 were from Saudi Arabia, 5 from the UK and 3 from China. Three universities of Saudi Arabia namely King Saud University (*n*=215), King Abdulaziz University (*n*=168) and King Khalid University (*n*=119) were the highest publishing institutions, while the University of Oxford, U.K. (64.70), Harvard Medical School, USA (55.2) and University of Melbourne (48.24) registered the highest Citation impact (CPP).

Role of foreign authors

The top 30 foreign authors participating in ICPs of Pakistan, which individually contributed 57 to 215 papers and together contributed 945 papers with 15212 citations. MY Essar (Afghanistan) (*n*=121), A.A. Rabaan (Saudi Arabia) (*n*=70), Y.H Khan and T.H Mallhi (Saudi Arabia) (*n*=47 each) were the most productive authors, while J. Abbas (China) (86.32), D.Q. Wei China (28.84) and A. Khan (China) (27.91) registered the highest CPP.

Most productive and impactful organisations

In all, 5305 organisations participated in 7749 COVID-19 papers from Pakistan, of which 587 organisations were affiliated with Pakistan. It was observed that 17 organisations have contributed more than the average publication productivity (147.98). The most productive organisations were Aga Khan University, Karachi (*n*=5020), Dow University of Health Sciences, Karachi (*n*=440) and University of Punjab (*n*=376), National University of Medical Sciences (*n*=357). The 19 organisations were more influential as they registered higher CPP than the average and the top among them were Gandhara University (180.0), Lahore University of Management Science (37.75) and Khyber Medical University (23.93). The ICP's share of the top 50 organisations varied from 17.07% to 97.06%, with an average value of 64.18%. Table 1 lists the top most productive and top 10 most impactful Pakistan organisations out of the top 50.

The Total Link Strength (TLS) of top 50 Pakistan organisations varied from 32 to 501, with the highest (*n*=501) depicted by Dow University of Health Sciences, Karachi, followed by University of Medical Sciences (*n*=291) and Aga Khan University, Karachi (*n*=285). Among top 50 institutions, the bilateral collaborative linkages varied from 1 to 122, with the highest linkages (*n*=122) depicted by institutional pair "Dow University of Health Sciences-Dow Medical College, Pakistan", followed by "The Aga Khan University-The Aga Khan University Hospital" (*n*=94) and "National University of Medical Sciences-Army Medical College Pakistan" (*n*=58). The VOSviewer software was used to develop a network collaboration map among top 20 top organisations (Figure 2), which revealed a distinctive clustering pattern and were classified into four clusters, establishing 98 links with a TLS of 265.

Most productive and impactful authors

In all, 12633 authors (4269 from Pakistan) contributed to 7749 COVID-19 papers from Pakistan. Among them, the top 50 authors individually contributed 17 to 110 papers individually and together contributed 1649 papers and received 27590 citations, accounting for 21.28% and 25.74% share each in Pakistan's total publications and citations. Among top 50 authors: (i) 15 authors have contributed more than the average publication productivity (32.98): I. Ullah (Gandhara University) (*n*=110), S. Ahmad

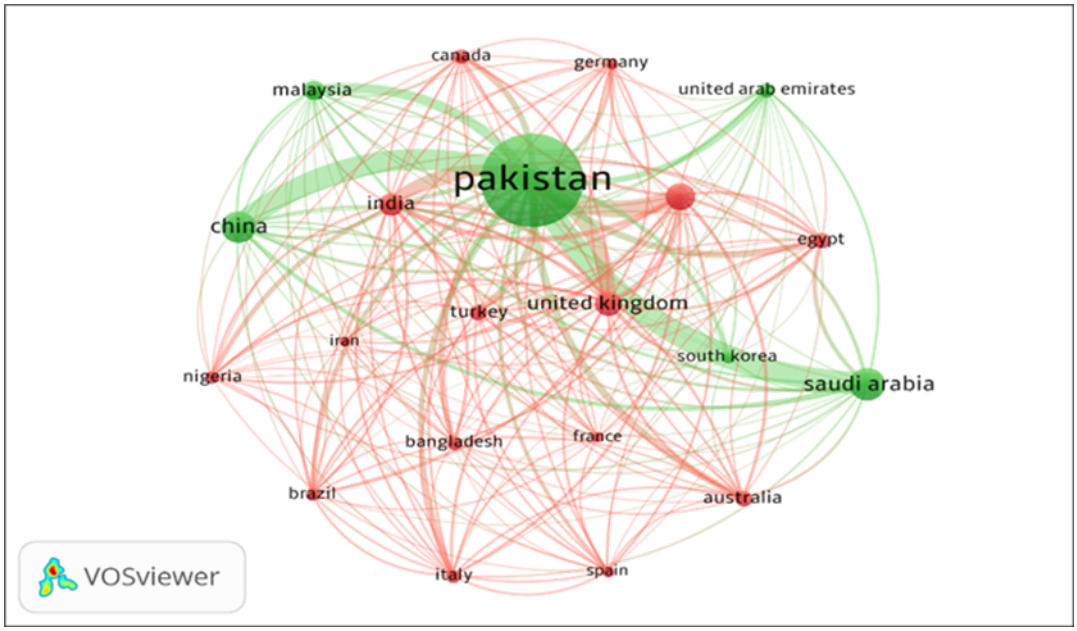

Figure 1: Co-authorship maps of 20 foreign Countries participating in Pakistan's COVID-19 research.

Table 1: Bibliometric Profile of the Top 10 Most Productive and Impactful Pakistan's Organisations in COVID-19 Research.

Sl. No.	Name of the Organisations	TP	TC	CPP	ICP	%ICP
Top 10 Most Productive Organisations						
1	The Aga Khan University, Karachi.	502	11842	23.59	310	61.75
2	Dow University of Health Sciences, Karachi.	440	4284	9.74	245	55.68
3	University of the Punjab, Lahore.	376	4594	12.22	244	64.89
4	National University of Medical Sciences, Rawalpindi.	357	3630	10.17	105	29.41
5	The Aga Khan University Hospital, Karachi.	297	3965	13.35	102	34.34
6	University of Management and Technology, Lahore.	267	5446	20.40	169	63.30
7	University of Lahore, Lahore.	266	3537	13.30	200	75.19
8	Quaid-i-Azam University, Islamabad.	251	4979	19.84	169	67.33
9	National University of Science and Technology of Pakistan, Islamabad.	224	3118	13.92	139	62.05
10	COMSATS University, Islamabad.	222	2969	13.37	153	68.92
Top 10 Most Impactful Organisations						
1	Lahore University of Management Science, Lahore.	84	3171	37.75	63	75.00
2	Khyber Medical University, Peshawar.	69	1651	23.93	44	63.77
3	The Aga Khan University, Karachi.	502	11842	23.59	310	61.75
4	University of Health Sciences, Lahore.	89	2045	22.98	68	76.40
5	University of Swat, Swat.	68	1526	22.44	66	97.06
6	University of Malakand, Malakand.	127	2797	22.02	109	85.83
7	University of Management and Technology, Lahore.	267	5446	20.40	169	63.30
8	University of Veterinary and Animal Sciences, Lahore.	171	3456	20.21	124	72.51
9	Quaid-i-Azam University, Islamabad.	251	4979	19.84	169	67.33
10	University of Sargodha, Sargodha.	100	1955	19.55	71	71.00

TP=Total Papers; TC=Total Citations; CPP=Citations per Paper; ICP=International Collaborative Papers.

(Punjab Medical College) (*n*=80) and M. Salman (National Institute of Health. Pakistan) (*n*=80); and (ii)) 21 authors registered CPP more than their group average (16.73): A.M. Baig (The Aga Khan University., Karachi) (76.54), Z.A. Bhutta (The Aga Khan University, Karachi) (52.92) and J. Akram (University of Health Sciences, Lahore) (48.84). The ICP share of the top 50 authors varied from 17.07% to 97.06%, with an average value of 64.18%. Table 2 lists the top 10 most productive and top 10 most impactful Pakistan authors out of the top 50.

TP=Total Papers; TC=Total Citations; CPP=Citations per Paper; ICP=International Collaborative Papers.

The TLS of the top 50 Pakistan authors varied from 5 to 182, with the highest (*n*=182) depicted by M. Salman, followed by A. Ikram (*n*=150) and M. Umair (*n*=109). Among top 50 authors, the bilateral author-to-author collaborative linkages varied from 1 to 40, with the highest linkages (*n*=40) depicted by author pair "A. Sarfraz- Z. Sarfraz", followed by "M. Salman-A. Ikram" (*n*=37), "M. Salman-Y.H. Khan" and "M. Salman-M. Umair" (*n*=28 each). Figure 3 illustrates a network of co-authorship among the top 50 authors, each having a minimum of 17 publications. Within this group, there are instances of collaboration, leading to their classification into 11 clusters. The network consists of a total of 217 links and a Total Link Strength (TLS) of 1086. In this visualisation, each author is represented by a node, with the size of the node reflecting the author's productivity, measured by the number of publications. The connections between nodes depict the collaborative relationships, with the thickness of the links indicating the intensity of collaboration.

Most productive and impactful journals

The 7749 COVID-19 papers from Pakistan were published in 1471 sources. The top 50 contributing journals contributed 20 to 222 papers each individually and together contributed 2680 papers which received 31858 citations. The most productive among top 50 journals were the *Pakistan Armed Forces Medical Journal* (*n*=222), *Journal of the Pakistan Medical Association* (*n*=176) and *Annals of Medicine and Surgery* (*n*=157). The most impactful journals in terms of CPP were *IEEE Access* (64.69), *Chaos, Solitons and Fractals* (62.0) and the *European Review for*

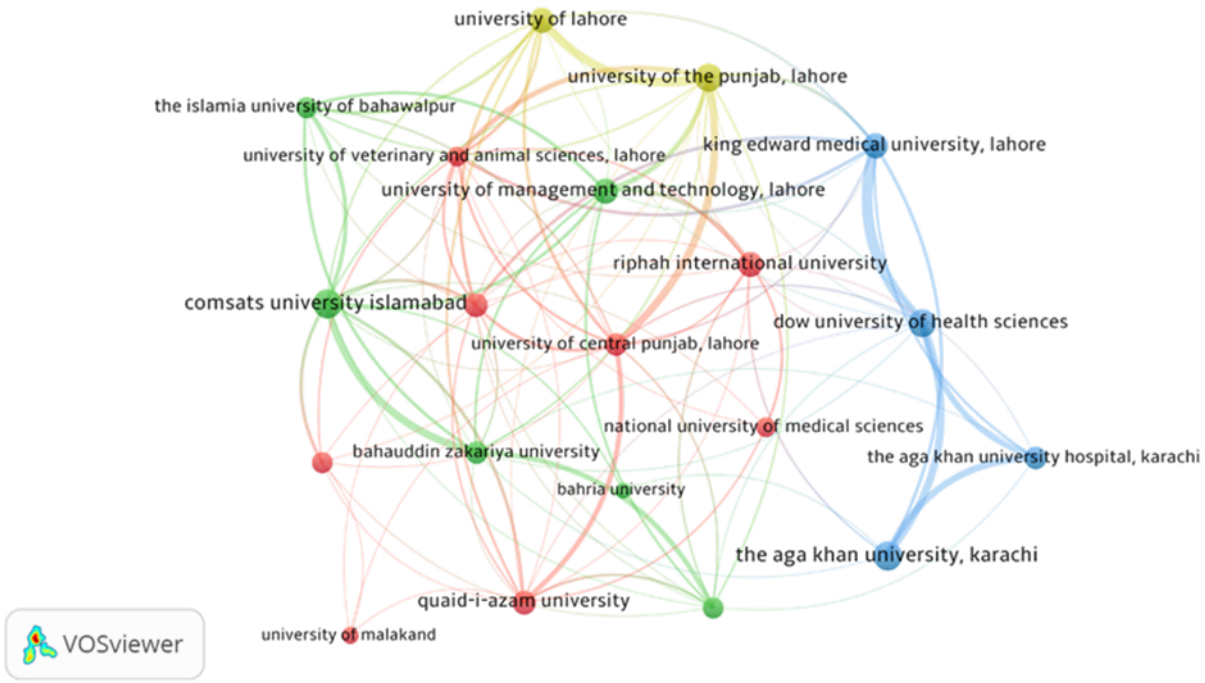

Figure 2: Co-authorship network map of top 20 Pakistan's organisations in COVID-19 research.

Table 2: Profile of Top 10 Most Productive and Impactful Pakistan Authors in COVID-19 Research.

Sl. No.	Authors	Affiliations	TP	TC	CPP	ICP	%ICP
Top 10 Most Productive Organisations							
1	I. Ullah	Gandhara University, Peshawar.	110	2107	19.15	101	91.82
2	S. Ahmad	Punjab Medical College, Faisalabad.	80	666	8.33	80	100.00
3	M. Salman	National Institute of Health, Islamabad.	80	707	8.84	48	60.00
4	A. Ikram	National Institute of Health, Islamabad.	70	704	10.06	27	38.57
5	M.J. Tahir	Lahore General Hospital, Lahore.	60	550	9.17	44	73.33
6	M.S. Asghar	Dow University of Health Sciences, Karachi.	51	382	7.49	37	72.55
7	Z.A. Bhutta	The Aga Khan University, Karachi.	51	2699	52.92	49	96.08
8	K. Shah	University of Malakand, Malakand.	51	1559	30.57	48	94.12
9	Z. Sarfraz	Fatima Jinnah Medical University, Lahore.	42	331	7.88	35	83.33
10	F. Yasmin	Dow University of Health Sciences, Karachi.	42	439	10.45	23	54.76
Top 10 Most Impactful Organisations							
1	A.M. Baig	The Aga Khan University, Karachi.	28	2143	76.54	8	28.57
2	Z.A. Bhutta	The Aga Khan University, Karachi.	51	2699	52.92	49	96.08
3	J. Akram	University of Health Sciences, Lahore.	19	928	48.84	18	94.74
4	N. Ahmed	Altamash Institute of Dental Medicine, Karachi.	17	697	41.00	16	94.12
5	S.S. Ali	University of Swat, Swat.	22	705	32.05	21	95.45
6	F. Aslam	COMSATS University, Islamabad.	17	539	31.71	13	76.47
7	K. Shah	University of Malakand, Malakand	51	1559	30.57	48	94.12
8	I. Yousaf	Air University, Islamabad.	27	768	28.44	23	85.19
9	N.L. Malik	University of Sargodha, Sargodha.	24	609	25.38	24	100.00
10	M.A. Khan	HITEC University, Texla, Pakistan.	18	444	24.67	18	100.00

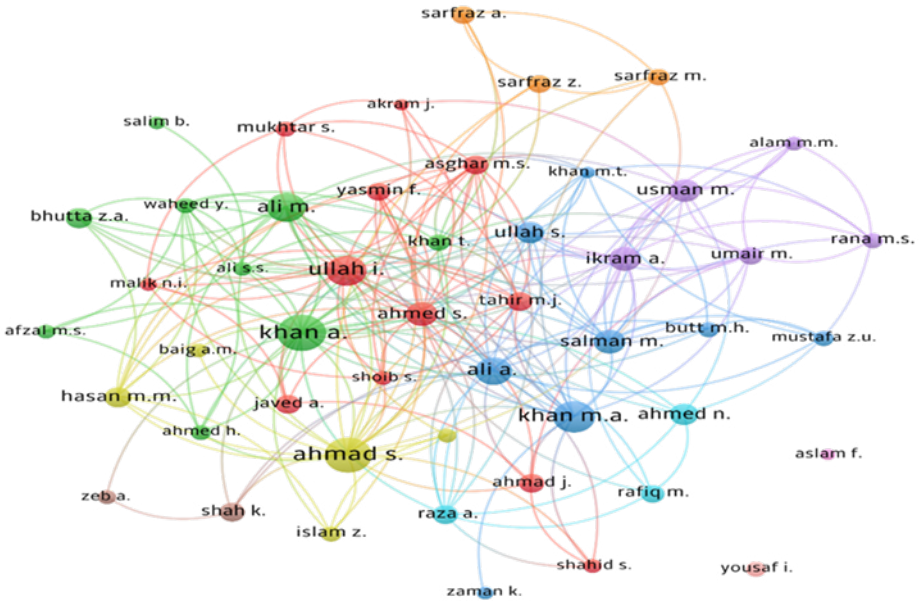

Figure 3: Co-authorship network map of the top 50 Pakistan's most productive authors in COVID-19 research.

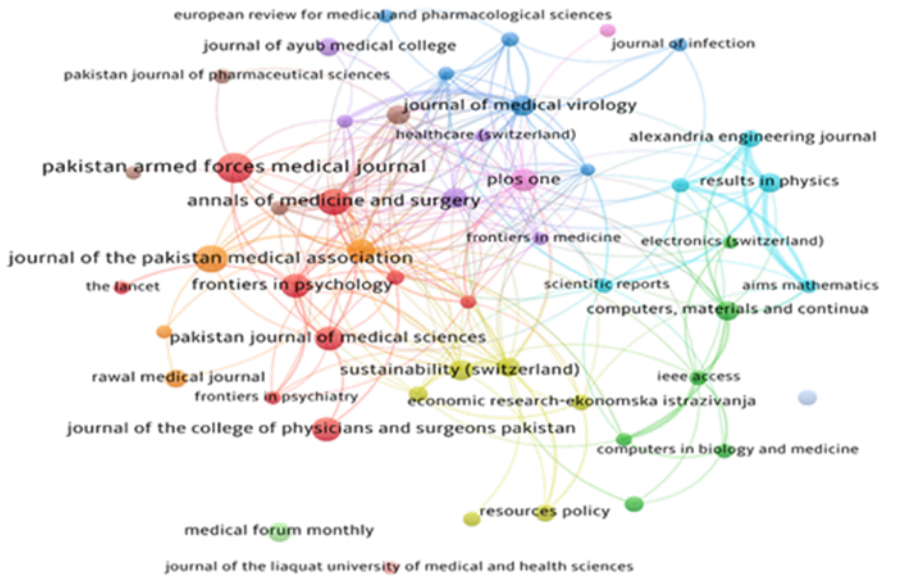

Figure 4: Co-Citation Network Map of Top 50 Journals Publishing Pakistan's Papers on COVID-19.

Medical and Pharmacological Sciences (42.57). Most citations were received by the Pakistan Journal of Medical Sciences (*n*=2684), *International Journal of Environmental Research and Public Health* (*n*=2348) and *IEEE Access* (*n*=2070). Of the top 50 journals, only 1 journal has a journal impact factor (JIF) more than 10 (The Lancet=IF=12.113). The publications details of top 10 most productive and top 10 impactful journals are presented in Table 3.

Figure 4 illustrates a co-citation network analysis of the top 50 journal sources conducted via the VOSviewer tool, identifying twelve distinct clusters. Among the top 50 journals, there are a total of 214 connections established with a TLS of 594.

Distribution by Subject and Co-Occurrence of Keywords

Distribution by broad

Pakistan's COVID-19 papers were classified into 24 Scopus subject categories (Table 4). Medicine, Computer Science and Social Sciences (51.23%, 13.21% and 10.65%) contributed the largest share, followed by Engineering, Biochemistry, Genetics and Molecular Biology and Immunology and Microbiology (9.18%, 8.44% and 7.61%), etc. In terms of CPP, Neuroscience (50.01 CPP), Physics and Astronomy (22.47 CPP) and Environment Science (19.83 CPP) registered the highest citation impact, whereas subject areas such as Arts and Humanities (8.36 CPP),

Table 3: Bibliometric Profile of Top 10 Most Productive and Impactful Journals Publishing Pakistan's COVID-19 Research.

Sl. No.	Name of the journal	TP	TC	CPP	SJR 2023
	Top 10 Most Productive Journals				
1	Pakistan Armed Forces Medical Journal.	222	138	0.62	0.116
2	Journal of the Pakistan Medical Association.	176	332	1.89	0.236
3	Annals of Medicine and Surgery.	157	830	5.29	0.387
4	Frontiers in Psychology.	123	512	4.16	0.800
5	Journal of the College of Physicians and Surgeons, Pakistan.	123	445	3.62	0.247
6	Pakistan Journal of Medical Sciences.	119	2684	22.55	0.114
7	Frontiers in Public Health.	106	1147	10.82	0.895
8	PLOS One.	101	1664	16.48	0.839
9	Journal of Medical Virology.	81	1508	18.62	1.560
10	Sustainability (Switzerland).	80	1164	14.55	0.672
	Top 10 Most Impactful Journals				
1	IEEE Access	32	2070	64.69	0.960
2	Chaos, Solitons and Fractals.	28	1736	62.00	1.349
3	European Review for Medical and Pharmacological Sciences.	23	979	42.57	0.580
4	Lancet	24	823	34.29	12.113
5	Computers in Biology and Medicine.	27	859	31.81	1.481
6	International Journal of Environmental Research and Public Health.	76	2348	30.89	0.808
7	American Journal of Tropical Medicine and Hygiene.	23	579	25.17	0.834
8	Resources Policy.	44	1097	24.93	2.063
9	Results in Physics.	62	1490	24.03	0.690
10	Journal of Biomolecular Structure and Dynamics	37	871	23.54	0.600

TP=Total Papers; TC=Total Citations; CPP=Citations per Paper.

Nursing (8.24 CPP) and Dentistry (5.22) registered the least citation impact.

Significant keywords

A bibliometric analysis method using keyword co-occurrence approach helps in capturing current topics in the various subjects. A total of 9235 keywords were extracted from 7749 documents. These keywords have frequency of occurrence, ranging from 1 to 5367, indicating the extent of their importance in this area. The leading significant keywords identified were: "COVID-19" (*n*=5367), "Vaccination" (*n*=597), "SARS-CoV-2 Vaccine" (*n*=465), "Mental Health" (*n*=346), "Prevention and Control" (*n*=3360, "Virus Pneumonia" (*n*=324), "Virus Transmission" (*n*=283), "Anxiety" (*n*=283), "Deep Learning" (*n*=271), "Social Media" (*n*=2590) and "Depression" (*n*=256). Of the 9235 keywords, 90 significant keywords were selected (with a frequency of occurrence from 18 to 7749) for detailed co-occurrence network analysis using VOSviewer, which presented them into six clusters represented by distinct colours (red, green, blue, yellow, purple and aqua) in Figure 5. Together, these keywords indicated 1689 links with a TLS of 13056. Figure 6 presents the cloud word map of 90 significant keywords.

High-Cited Papers

Of the 7749 papers on COVID-19 from Pakistan, only 181 papers (2.33%) received 100 to 1609 citations and they together received 41417 citations, averaging 228.82 CPP. Of the 181 papers, 146 and 23 HCPs were in citation ranges 100-298 and 313-490 (Table 5). The 126 (69.61%) HCPs appeared as research articles in 181, followed by reviews (22.65%), letters (3.87%), notes (3.31%) and others 1 (0.55%). The 148 (81.77%) HCPs were involved in international collaboration, registering together 33361 citations, averaging 225.41 CPP. Among foreign countries participating in 181 Pakistan's HCPs, China contributed the largest number of papers (*n*=52), followed by the USA (*n*=51), U.K. (*n*=46), India (*n*=30) and Saudi Arabia (*n*=27). The 57 (31.49%) HCPs received external funding support and together received 15132 citations, averaging 265.47 CPP.

The leading organisations participating in 181 Pakistan HCPs were The Aga Khan University (*n*=25), University of Management and Technology, Lahore (*n*=11), The Aga Khan University Hospital

Table 4: Subject-Wise Distribution of Pakistan COVID-19 Output by Scopus Subject Categories

Sl. No.	Name of the subject	TP	TC	CPP	%TP	Sl. No.	Name of the subject	TP	TC	CPP	%TP
1	Medicine	3970	50246	12.66	51.23	14	Agricultural and Biological Sciences	234	1976	8.44	3.02
2	Computer Science	942	12447	13.21	12.16	15	Chemistry	229	3421	14.94	2.96
3	Social Sciences	825	10300	12.48	10.65	16	Materials Science	212	4147	19.56	2.74
4	Engineering	711	10540	14.82	9.18	17	Nursing	205	1690	8.24	2.65
5	Biochemistry, Genetics and Molecular Biology	654	12353	18.89	8.44	18	Energy	185	3061	16.55	2.39
6	Immunology and Microbiology	590	9297	15.76	7.61	19	Decision Sciences	167	2173	13.01	2.16
7	Environment Science	523	10373	19.83	6.75	20	Neuroscience	128	6401	50.01	1.65
8	Mathematics	518	7055	13.62	6.68	21	Chemical Engineering	118	1316	11.15	1.52
9	Economics, Econometrics and Finance	460	8931	19.42	5.94	22	Arts and Humanities	108	903	8.36	1.39
10	Business, Management and Accounting	424	4713	11.12	5.47	23	Dentistry	97	506	5.22	1.25
11	Pharmacology, Toxicology and Pharmaceutics	419	5020	11.98	5.41	24	Earth and Planetary Sciences	53	709	13.38	0.68
12	Psychology	332	5094	15.34	4.28		*TP=Total papers; TC=Total citation; CPP=Citations per paper.*				

and Quaid-i-Azam University (*n*=9 each), Dow University of Health Sciences and Lahore University of Management Science (*n*=7 each), The Islamic University of Bahawalpur and University of Malakand, Chakdar (*n*=6 each), University of the Punjab, National University of Medical University, COMSATS University, Islamabad, University of Veterinary and Animal Sciences, Lahore, University of Karachi and Gandhara University (*n*=5 each).

The leading authors participating in 181 Pakistan HCPs were Z.A. Bhutta (Aga Khan Univ., Karachi) and I. Ullah (Gandhara University, Peshawar) (*n*=5 each), S. Mukhtar (Univ. of Management and Technology, Lahore), S.A. R. Rizvi (Lahore Univ. of Management Sciences, Lahore) and J. Akram (Univ. of Health Sciences, Lahore, Pakistan) (*n*=4 each), A.M. Baig (Aga Khan Univ., Karachi, Pakistan), O. Haroon (Lahore Univ. of Management Sciences), S.K.A. Rizvi (Lahore School of Economics, Lahore) and K. Shah (Univ. of Malakand, Chakdara, Pakhtunkhwa)(*n*=3 each), etc.

The 181 HCPs were published in various journals and some of the most productive journals publishing HCPs on COVID-19 from Pakistan were: *Pakistan Journal of Medical Science* and *Chaos, Solitons and Fractals* (*n*=6 each), *The Lancet Psychiatry, IEEE Access, PLOS One* and *International Journal of Environment Research and Public Health (n=4 each), Journal of Bimolecular and Structural Dynamics, Journal of Medical Virology, Health Information and Libraries, Frontiers in Public Health, Finance Research Letters, European Review of Medical and Pharmaceutical Sciences, Environmental Research* and *BMJ Global Health* (*n*=3 each), etc.

DISCUSSION

COVID-19 was a global pandemic caused by SARS-CoV-2. Pakistan contributed 7749 papers on COVID-19 research, constituting only 1.76% share of global output during 2020-2023. The present study presents a comprehensive picture of bibliometric analysis of Pakistan COVID-19 research output, which increased from 2020 to 2022 and then declined obviously as the impact of the virus substantially reduced. Pakistan's 7749 COVID-19 papers registered 107203 citations, with an average of 13.83 CPP. The articles and reviews constituted the major share (70.15% and 11.72%) of Pakistan 4. Only 1377 (17.77%) Pakistan publications received extramural financial support from 150+

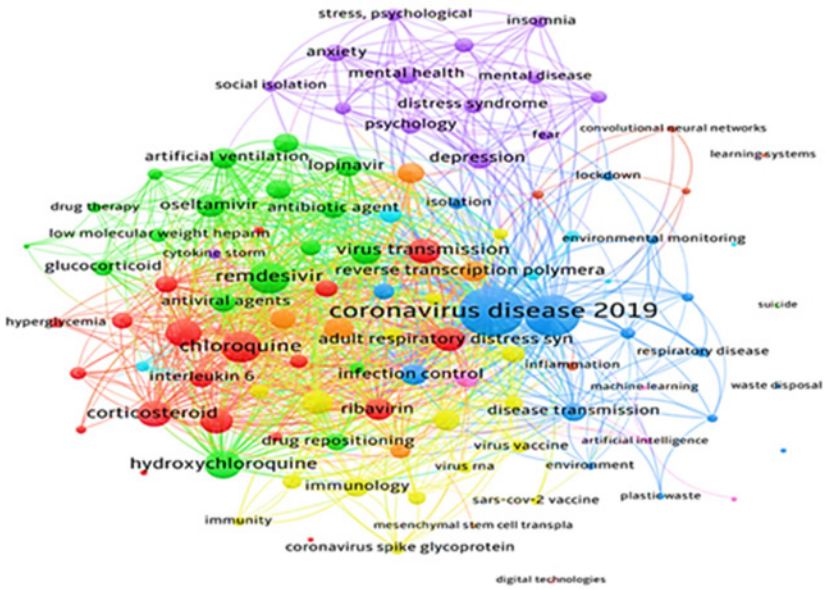

Figure 5: Network Co-occurrence Visualisation of the 90 Significant Keywords.

Figure 6: Cloud map of top 50 most significant keywords in Pakistan's COVID-19 research.

plus funding agencies and together received 31035 citations, averaging 22.54 CPP, which was much higher than the average CPP. Most external funding came from China, Muslim and European and North American countries, which help to increase Pakistan research output and improve its research impact. Pakistan's organisations showed a substantial collaboration at both national and international levels, still, they need to develop and strengthen their collaborative mechanism, particularly with developed countries to achieve and produce more qualitative research and increase research productivity.

We noticed that the most top Pakistan authors were involved in national and international collaboration, but they showed less collaboration intensity compared to top organisations. Most authors gave more importance to international collaboration, particularly with authors in Muslim countries which supported them through their national funding, but that does not always lead to quality publications. A very small part (2.33% share) of Pakistan's COVID-19 output was HCPs. Among these 81.77% and 31.49% were involved in international collaboration and received external funding support.

Bibliometrics, a burgeoning interdisciplinary field rooted in statistics and mathematics, is employed to quantitatively analyse advancements in COVID-19 within a specific research domain (Roldan-Valadez *et al.*, 2019). This approach possesses notable attributes and benefits, including its simplicity, expediency, comprehensiveness and precision (Ye *et al.*, 2023). With the exponential growth of publications on COVID-19, many studies were undertaken on bibliometric assessment of its global research output (Gupta, Dhawan, Mueen Ahmed, *et al.*, 2021a, 2021b; Hamidah *et al.*, 2020; Hossain, 2020; Zhou and Chen, 2020), however, an only few studies have analysed and summarised South Asia COVID-19 as a whole (Gupta, Dhawan, and Surulinathi, 2021; Gupta, Mamdapur, *et al.*, 2024; Koser, 2022; Naseer *et al.*, 2023) and rest on individual South Asia and Asian Muslim countries of Asia: India (Gupta, 2021; Gupta, Mamdapur, and Dayal, 2021; Gupta, Mamdapur, Gupta, *et al.*,

Table 5: Bibliometric Profile of Top 20 HCPs on Pakistan's COVID-19 Research.

Sl. No.	Authors	Affiliations	Title of paper	Sources	TC
1	Pan H. *et al.*	Shaukat Khanum Memorial Cancer Hospital and Research Center, Lahore, Pakistan.	Repurposed antiviral drugs for COVID-19-InteriM WHO solidarity trial results.	New England journal of medicine 384.6 (2021): 497-511.	1604
2	Baig, Abdul Mannan, *et al.*	Aga Khan University, Karachi, Pakistan and Mohammad Ali Jinnah University, Karachi, Pakistan.	Evidence of the COVID-19 Virus Targeting the CNS: Tissue Distribution, Host-Virus Interaction and Proposed Neurotropic Mechanisms.	ACS Chemical Neuroscience 11.7 (2020): 995-998.	1476
3	Peeri, Noah C., *et al.*	National University of Medical Sciences, Rawalpindi, Pakistan.	The SARS, MERS and novel coronavirus (COVID-19) epidemics, the newest and biggest global health threats: what lessons have we learned?	International journal of epidemiology 49.3 (2020): 717-726.	943
4	Gunnell, David, *et al.*	Aga Khan University, Karachi, Pakistan.	Suicide risk and prevention during the COVID-19 pandemic	The Lancet Psychiatry 7.6 (2020): 468-471.	925
5	Chowdhury, Muhammad EH, *et al.*	University of Engineering and Technology, Peshawar, Pakistan.	Can AI Help in Screening Viral and COVID-19 Pneumonia?	IEEE Access, (2020): 132665-132676.9144185.	884
6	Sharif, A. *et al.*	Eman Institute of Management and Sciences, Karachi, Pakistan.	COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach.	International review of financial analysis 70 (2020): 101496.	863
7	Villar J. *et al.*	Aga Khan University, Karachi, Pakistan.	Maternal and Neonatal Morbidity and Mortality among Pregnant Women with and without COVID-19 Infection: The INTERCOVID Multinational Cohort Study.	JAMA pediatrics 175.8 (2021): 817-826.	764
8	Cameroni E. *et al.*	Aga Khan University, Karachi, Pakistan.	Broadly neutralizing antibodies overcome SARS-CoV-2 Omicron antigenic shift.	Nature 602.7898 (2022): 664-670.	631
9	Mukhtar, K., Javed, K., Arooj, M., and Sethi, A.	The University of Lahore, Lahore, Pakistan and Khyber Medical University, Peshawar, Pakistan.	Advantages, limitations and recommendations for online learning during the COVID-19 pandemic era.	Pakistan journal of medical sciences 36. COVID19-S4 (2020): S27.	604
10	Solís Arce, Julio S., *et al.*		COVID-19 vaccine acceptance and hesitancy in low- and middle-income countries.	Nature medicine 27.8 (2021): 1385-1394.	575
11	Khailany, R. A., Safdar, M., and Ozaslan, M.	Cholistan University of Veterinary and Animal Sciences, Bahawalpur, Pakistan.	Genomic characterization of a novel SARS-CoV-2.	Gene Reports 19 (2020): 100682	565
12	Jiang, L. *et al*	Aga Khan University, Karachi, Pakistan.	COVID-19 and multisystem inflammatory syndrome in children and adolescents.	The Lancet Infectious Diseases 20.11 (2020): e276-e288.	523

Sl. No.	Authors	Affiliations	Title of paper	Sources	TC
13	Bashir, Muhammad Farhan, *et al.*	Government of The Punjab, Pakistan.	Correlation between climate indicators and COVID-19 pandemic in New York, USA.	Science of the Total Environment 728 (2020): 138835.	490
14	Ejaz, H. *et al*	The Children's Hospital and The Institute of Child Health, Lahore, Pakistan; GC University, Lahore, Pakistan; and Tehsil Headquarter Hospital Kamoke, Pakistan.	COVID-19 and comorbidities: Deleterious impact on infected patients.	Journal of infection and public health 13.12 (2020): 1833-1839.	471
15	Rahman, Tawsifur, *et al.*	University of Engineering and Technology, Peshawar, Pakistan.	Exploring the effect of image enhancement techniques on COVID-19 detection using chest X-ray images.	Computers in biology and medicine 132 (2021): 104319.	466
16	Shaukat, Natasha, Daniyal Mansoor Ali and Junaid Razzak.	Aga Khan University, Karachi, Pakistan.	Physical and mental health impacts of COVID-19 on healthcare workers: a scoping review.	International journal of emergency medicine 13 (2020): 1-8.	454
17	Chakaya, Jeremiah, *et al.*	Chak Shahzad, Islamabad, Pakistan;	Global Tuberculosis Report 2020-Reflections on the Global TB burden, treatment and prevention efforts	International journal of infectious diseases 113 (2021): S7-S12	437
18	Ali, M., Alam, N., and Rizvi, S. A. R.	Lahore University of Management Sciences (LUMS), Lahore, Pakistan	Coronavirus (COVID-19)-An epidemic or pandemic for financial markets	Journal of Behavioral and Experimental Finance 27 (2020): 100341	417
19	Abdullah, Muhammad, *et al.*	University of Management and Technology, Lahore, Pakistan.	Exploring the impacts of COVID-19 on travel behavior and mode preferences.	Transportation Research Interdisciplinary Perspectives 8 (2020): 100255.	411
20	Pirkis, Jane, *et al.*	Aga Khan University, Karachi, Pakistan.	Suicide trends in the early months of the COVID-19 pandemic: an interrupted time-series analysis of preliminary data from 21 countries.	The Lancet Psychiatry 8.7 (2021): 579-588.	393

2021; Vaishya *et al.*, 2023), Bangladesh (Gupta, Kappi, Walke, *et al.*, 2023; Vaishya *et al.*, 2024), Nepal (Gupta, Kappi, Bansal, *et al.*, 2023; Raut *et al.*, 2021), Pakistan (Gupta, Dhawan, *et al.*, 2024), Sri Lanka (Vijayaluxmy, 2023) and UAE (Gupta, Dhawan, and Kappi, 2023).

Among bibliometric studies covering South Asia, Gupta *et al.* examined 4412 COVID-19 publications from South Asia, with coverage from Pakistan restricted to 2246 publications (includes 12 high-cited papers) published from Dec. 2019 to July 2021. More recently, Naseer, Ali and Azhar examined the top 100 most-cited articles on South Asia (including 68 from India, 18 from Bangladesh, 12 from Pakistan and 3 from Nepal) COVID-19 research published from December 2019 to October 2022. Regarding Pakistan, Shah and Shaikh examined Pakistan. COVID-19 publications indexed in the Scopus database till 29 May 2020 (Shah and Shaikh, 2020). More recently, Ullah assessed only 480 Pakistan COVID-19 publications covered in the PakMediNet database till 11 February 2022 (Ullah, 2023).

This study confirms that Pakistan has been actively engaged in COVID-19 research, contributing to global efforts to understand, mitigate and combat the pandemic. Collaborative efforts between research institutions, universities and healthcare organisations played a crucial role in collecting and analysing data related to COVID-19 cases. Challenges such as limited resources and infrastructure exist in a developing country like Pakistan also, but the resilience and dedication of the Pakistani scientific community played a pivotal role in overcoming these hurdles.

FUTURE DIRECTIONS

The current study's results aim to offer insights into the status, key areas of research and possible future directions in the realm of COVID-19 research in Pakistan. This information could be valuable for healthcare professionals, researchers and policymakers in assessing and comprehending the knowledge landscape, as well as guiding the future trajectory of COVID-19 research in Pakistan. Scholars in the field can leverage this bibliometric analysis to pinpoint potential collaborators and significant studies and research themes within their specific areas of focus. Additionally, funding organisations can utilise this study to evaluate existing research initiatives and anticipate future research trends in COVID-19 research in Pakistan.

LIMITATIONS

The publications included in this study were sourced from the Scopus database only and therefore some publications that are not included in the Scopus but are included in other databases (e.g., Web of Science, PubMed Central and Google Scholar) may be excluded. Due to its extensive coverage of scientific journals, conference proceedings and books, Scopus, being the largest curated abstract and citation database, ensures that no significant publications are overlooked in any analysis. Additionally, Scopus serves as a valuable bibliometric data source for conducting comprehensive research assessments, exploring research landscapes, evaluating science policies and establishing university rankings. It is considered one of the most comprehensive and authoritative databases.(Baas *et al.*, 2020) Furthermore, mixing the information and data derived from different bibliographic databases creates difficulties and generally makes the data analysis complex and inaccurate.

CONCLUSION

This study utilised bibliometric methods to quantitatively and qualitatively analyse 7749 Pakistan's COVID-19 publications published during 2020-2023. 17.77% of publications received external funding support and 64.64% were involved in international collaboration. Only 2.33% were highly-cited papers, with more than 100 citations. The average citation per paper (16.5) of Pakistan COVID-19 papers was much less than those with international collaboration, external funding and highly-cited papers. Saudi Arabia, China and the USA participated in almost half of the collaborative papers.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

CPP: Citations Per Paper; **HCPs:** High-Cited Papers; **ICP:** International Collaborative Paper International Concern; **JIF:** Journal Impact Factor; **PHEIC:** Public Health Emergency of International Concern; **SARS-CoV-2:** Severe Acute Respiratory Syndrome Coronavirus-2; **TC:** Total Citations; **TLS:** Total Link Strength; **TP:** Total Papers; **WHO:** World Health Organization.

REFERENCES

Abid, K., Bari, Y. A., Younas, M., Tahir Javaid, S., & Imran, A. (2020). Progress of COVID-19 epidemic in Pakistan. Asia-Pacific Journal of Public Health, 32(4), 154–156. DOI: 10.1177/1010539520927259

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975. DOI: 10.1016/j.joi.2017.08.007

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. Quantitative Science Studies, 1(1), 377–386. DOI: 10.1162/qss_a_00019

Barai, M. K. (2021). COVID 19 in South Asia and the way forward: An introduction. South Asian Survey, 28(1), 7–19. DOI: 10.1177/09715231211002303

Gupta,B.M, Dhawan, D. SM, & Surulinathi, S M. (2021). Select South Asian countries in Covid-19 research: A bibliometric assessment of their publications during 2019–21. Journal of Young Pharmacists, 13(3s), s19–s29. DOI: 10.5530/jyp.2021.13s.67

Chen, C. (2004). Searching for intellectual turning points: Progressive knowledge domain visualization. Proceedings of the National Academy of Sciences of the United States of America, 101 Suppl. 1(suppl_1), 5303–5310. DOI: 10.1073/pnas.0307513100

Gupta,B.M. (2021). India's research on Covid-19: A scientometric assessment of publications 2019–21. Journal of Young Pharmacists, 13(3s), s30–s41. DOI: 10.5530/jyp.2021.13s.68

Gupta, B. M., Dhawan, S. M., & Kappi, M. (2023). United Arab Emirates (UAE): A scientometric assessment of Covid-19 publications. Iberoamerican Journal of Science Measurement and Communication, 3(2). DOI: 10.47909/ijsmc.55

Gupta, B. M., Dhawan, S. M., Mueen Ahmed, K. K., & Mamdapur, G. M. N. (2021a). Global research on COVID-19 disease: A scientific assessment of publications during 2020–21. International Journal of Medicine and Public Health, 11(2), 76–84. DOI: 10.5530/ijmedph.2021.2.14

Gupta, B. M., Dhawan, S. M., Mueen Ahmed, K. K., & Mamdapur, G. M. N. (2021b). Use of convalescent plasma therapy for COVID-19: A scientometric assessment of global publications during 2020–21. International Journal of Medicine and Public Health, 11(2), 65–75. DOI:10.5530/ijmedph.2021.2.13

Gupta, B. M., Dhawan, S. M., Singh, Y., Nupur, S., Vaishya, R., Kappi, M., & Mamdapur, G. M. N. (2024). A scientometric analysis of highly cited papers of Pakistan in COVID-19 research 2020–2023. Journal of Data Science, Informetrics, and Citation Studies, 3(3), 1–15.

Gupta, B. M., Kappi, M., Bansal, J., Walke, R., & Mamdapur, G. M. N. (2023). Scientometric analysis of top 100 highly cited papers on COVID-19 research in Nepal: A study. Indian Journal of Information, Library and Society, 36 (1–2), 43–56.

Gupta, B. M., Kappi, M., Walke, R., & Bansal, M. (2023). Covid-19 research in Bangladesh: A scientometric analysis during 2020–23. Iberoamerican Journal of Science Measurement and Communication, 3(1). DOI: 10.47909/ijsmc.445

Gupta, B. M., Mamdapur, G. M. N., & Dayal, D. (2021). Black Fungus (Mucormycosis) research in India during 1998–2021: A Scopus-based scientometric analysis. International Journal of Medicine and Public Health, 11(3), 133–138. DOI: 10.5530/ijmedph.2021.3.24

Gupta, B. M., Mamdapur, G. M. N., Gupta, S., Rohilla, L., & Dayal, D. (2021). Global mucormycosis research: A bibliometric assessment based on Scopus database (1998–2021). Journal of Young Pharmacists, 13(4), 356–362. DOI: 10.5530/jyp.2021.13.89

Gupta, B. M., Mamdapur, G. M. N., Vaish, A., & Vaishya, R. (2024). COVID-19 research output from South Asia: A scientometric analysis of highly cited papers. Apollo Medicine, 21(3), 228–235. DOI: 10.1177/09760016241245854

Hamidah, I., Sriyono, S., & Hudha, M. N. (2020). A bibliometric analysis of COVID-19 research using VOSviewer. Indonesian Journal of Science and Technology, 5(2), 209–216. DOI: 10.17509/ijost.v5i2.24522

Hossain, M. M. (2020). Current status of global research on novel coronavirus disease (COVID-19): A bibliometric analysis and knowledge mapping. F1000Research, 9. DOI:10.12688/f1000research.23690.1

Imtiaz, A., Shah, S. A., & Siddiqui, N. (2020). Pakistan confirms first two cases of coronavirus, Govt says 'no need to panic.' https://www.dawn.com/news/1536792

Koser, N. (2022). Bibliometric analysis of contribution of South Asian countries in research conducted on COVID-19. International Journal of Multidisciplinary Research and Explorer, 2(11), 25–38. DOI: 10.1212/IJMRE.2022685715

Kurtkulagi, O., Kahveci, G. B., & Duman. Atak tel. T., and T., B. M., and Bilgin, S. (2020). Millennium pandemic: A review of coronavirus disease (COVID-19). Experimental Biomedical Research, 3(2), 117-125. DOI: 10.30714/j-ebr.2020259176.

Naseer, B., Ali, M., & Azhar, N. (2023). COVID-19 research in South Asia: A bibliometric analysis of the 100 most-cited articles [Text/html]. GMS Hygiene and Infection Control, 18, Doc22. DOI: 10.3205/DGKH000448

Raut, R., Sah, R., Dixit, K., Rodriguez-Morales, A. J., Marco, Z., Dhama, K., Malik, Y. S., Tiwari, R., Bonilla-Aldana, D. K., & Lee, A. (2021). A review of the scientific contributions of Nepal on COVID-19. Current Tropical Medicine Reports, 8(4), 257–264. DOI: 10.1007/s40475-021-00247-0

Rodriguez-Morales, A. J., Bonilla-Aldana, D. K., Tiwari, R., Sah, R., Rabaan, A. A., & Dhama, K. (2020). COVID-19, an emerging coronavirus infection: Current scenario and recent developments – An overview. Journal of Pure and Applied Microbiology, 14(1), 5–12. DOI: 10.22207/JPAM.14.1.02

Roldan-Valadez, E., Salazar-Ruiz, S. Y., Ibarra-Contreras, R., & Rios, C. (2019). Current concepts on bibliometrics: A brief review about impact factor, Eigenfactor score, CiteScore, SCImago Journal Rank, Source-Normalised Impact per Paper, H-index and alternative metrics. Irish Journal of Medical Science, 188(3), 939–951. DOI: 10.1007/s11845-018-1936-5

Sahin, A. R. (2020). 2019 Novel coronavirus (COVID-19) outbreak: A review of the current literature. Eurasian Journal of Medicine and Oncology, 2019. DOI: 10.14744/ejmo.2020.12220

Shah, S. A. H., & Shaikh, M. A. (2020). COVID-19 (SARS-CoV-2) and bibliometrics of Pakistani research. Lambert Academic Publishing.

Ullah, M. (2023). Bibliometric analysis of Pakistani medical journals evidenced exponential growth of coronavirus disease-related publications. Journal of Electronic Resources in Medical Libraries, 20(1), 1–14. DOI: 10.1080/15424065.2023.2180125

Vaishya, R., Gupta, B. M., Mamdapur, G. M. N., Kappi, M., & Ali, K. S. (2024). Mapping the landscape of COVID-19 research from Bangladesh: A bibliometric analysis of highly cited papers. South Asian Journal of Health Sciences, 1–9. DOI:10.25259/SAJHS_7_2024

Vaishya, R., Gupta, B. M., Misra, A., Mamdapur, G. M. N., Walke, R., & Vaish, A. (2023). Top 100 highly cited papers from India on COVID-19 research: A bibliometric analysis of the core literature. Diabetes and Metabolic Syndrome, 17(11), 102898. DOI: 10.1016/j.dsx.2023.102898

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, 84(2), 523–538. DOI: 10.1007s11192-009-0146-3

Vijayaluxmy, S. (2023). Bibliometric analysis of Covid-19 research in Sri Lanka: A comprehensive study. International Journal of Library and Information Science, 12(3), 22–31.

Wiersinga, W. J., Rhodes, A., Cheng, A. C., Peacock, S. J., & Prescott, H. C. (2020). Pathophysiology, transmission, diagnosis and treatment of coronavirus disease 2019 (COVID-19): A review. JAMA, 324(8), 782–793. DOI: 10.1001/jama.2020.12839

Wikipedia. (2023). the free encyclopedia. COVID-19 pandemic in Pakistan. COVID-19 Pandemic in Pakistan. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Pakistan

World Health Organization. (2020a). Naming the coronavirus disease (COVID-19) and the virus that causes it. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it

World Health Organization. (2020b, April 9). Coronavirus disease 2019 (COVID-19) pandemic: Overview. https://www.who.int/europe/emergencies/situations/covid-19

World Health Organization. (2020c, April 9). Coronavirus disease 2019 (COVID-19) Situation Report-80. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200409-sitrep-80-covid-19.pdf

World Health Organization. (2023). WHO coronavirus (COVID-19) dashboard. WHO coronavirus (COVID-19) dashboard. https://covid19.who.int

Ye, L., Liang, R., Liu, X., Li, J., Yue, J., & Zhang, X. (2023). Frailty and sarcopenia: A bibliometric analysis of their association and potential targets for intervention. Ageing Research Reviews, 92, 102111. DOI: 10.1016/j.arr.2023.102111

Zhou, Y., & Chen, L. (2020). Twenty-year span of global coronavirus research trends: A bibliometric analysis. International Journal of Environmental Research and Public Health, 17(9), 3082. DOI: 10.3390/ijerph17093082

Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song, J., Zhao, X., Huang, B., Shi, W., Lu, R., Niu, P., Zhan, F., Ma, X., Wang, D., Xu, W., Wu, G., Gao, G. F., Tan, W., & China Novel Coronavirus Investigating and Research Team. (2020). A novel coronavirus from patients with pneumonia in china, 2019. The New England Journal of Medicine, 382(8), 727–733. DOI: 10.1056/NEJMoa2001017

Zu, Z. Y., Jiang, M. D., Xu, P. P., Chen, W., Ni, Q. Q., Lu, G. M., & Zhang, L. J. (2020). Coronavirus disease 2019 (COVID-19): A perspective from china. Radiology, 296(2), E15–E25. DOI: 10.1148/radiol.2020200490.

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