

High-Cited Papers in Covid-19: A Scientometric Assessment of Global Literature Using Essential Science Indicators Database

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ABSTRACT

Introduction: The rapid production of a large volume of literature during the last 2-3 phases of the Covid-19 disease outbreak created a substantial burden for clinicians and scientists. Therefore, this paper provides a bibliometric overview on the high-cited papers indexed in the ESI database in the field of Covid-19, during 2020-21, focusing on the research domain and keywords, main actors (countries, organizations and authors) and main sources of publications. **Methods:** The Essential Science Indicators (ESI) database is widely used to assess scientific outputs. ESI include high-cited papers that have received enough citations to place them in the top 1% when compared to all other papers published in the same year in the same field. High-cited papers are defined as papers receiving 100 or more citations since their publication. Therefore, high-cited papers included in ESI database are of high-quality in each field and therefore used in this study. A bibliometric analysis based on 848 high-cited papers extracted from the Essential Science Indicators database was carried out to provide insights into performances and research characteristics of Covid-19 literature. Indicators were applied to evaluate the influence of the most productive journals, countries/territories, organizations and authors. Social network analysis was performed to evaluate and visualize the interaction among productive countries/territories, organizations, authors and keywords using VOSviewer software. **Results:** The results showed that the 848 high-cited papers received 244699 citations were from 9734 authors employed at 2607 organizations based in 101 countries/territories. The papers were published in 369 journals in the field. The top 5 core journals ranked based on: (i) total papers were *New England Journal of Medicine* (37), *Science of the Total Environment* (35), *Science* (28), *The Lancet* (21) and *Nature* (18) and (ii) total citations were *New England Journal of Medicine* (28173), *Lancet* (17128), *JAMA-Journal of the American Medical Association* (9603), *International Journal of Antimicrobial Agents* (5865) and *Nature Medicine* (5659). The top 5 organizations ranked on (i) total papers were Huazhong

University of Science & Technology (42), Harvard Medical School, USA (41), University of Oxford, U.K. (31), University of Cambridge, U.K. (25) and London Global University (UCL)(25) and (ii) total citations were Huazhong University of Science & Technology, China (32563), University of Hong Kong (17868), Tsinghua University, China (15827), University of Oxford (13802) and Guanzhou Medical University, China (13155). The top 5 authors ranked on: (i) total papers were Y. Zhang (15), Y. Hu (14), L. Liu (14), J. Wang (14) and Y. Liu (13) and (ii) total citations were Y. Liu (23285), J. Xiang (.20391), Y. Hu (18804) and Y. Zhang (16495). The top five countries ranked on: (i) total papers were USA (336), China (222), U.K. (153), Italy (90) and Germany (74) and (ii) total citations were China (114620), USA (88474), U.K. (46535), Italy (24546) and Germany (24028). Based on network map using VOSviewer, there were micro, meso and macro level collaborations based on common interests in a specific topic. Analysis of all keywords showed that the research was distributed into 6 clusters. **Conclusion:** Results obtained from this study can provide valuable information for researchers to better identify present and future hotspots in Covid-19-related fields. The most relevant literature on the Covid-19 pandemic will also provide information relevant to the evidence-based decision-making process and future studies are essential to gain precise knowledge on Covid-19 infection across various human organs and various sub-fields and sectors. **Key words:** Covid-19, High-Cited Papers, ESI, Global Papers, Bibliometrics, Scientometrics.

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INTRODUCTION

Coronavirus disease 2019 (Covid-19), the highly contagious viral illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has had a catastrophic effect on the world's demographics, emerging as the most consequential global health crisis since the era of the influenza pandemic of 1918. After the first cases of this predominantly respiratory viral illness were first reported in Wuhan, Hubei Province, China, in late December 2019, SARS-CoV-2 rapidly disseminated across the world in a short span of time, compelling the World Health Organization (WHO) to declare it as a global pandemic on March 11, 2020. Since being declared a global pandemic, Covid-19 has ravaged many countries worldwide and has overwhelmed many healthcare systems. The pandemic has also resulted in the loss of livelihoods due to prolonged shutdowns, which have had a rippling effect on the global economy.¹

Since then, the international scientific efforts to mitigate Covid-19 is moving unprecedented in scale and rapidity. The Covid-19 pandemic required a fast response from researchers to help address biological,

medical, and public health issues to minimize its impact. The confirmed rapid increase in Covid-19 academic publications is encouraging in terms of the academic community rapidly reacting to the need for relevant research and commentaries.² In this rapidly evolving context, scholars, professionals, and the public may need to identify important new studies quickly. For this purpose the need to study high-cited papers becomes most useful. This paper provides a bibliometric overview on the 848 high-cited papers indexed in the ESI database in the field of Covid-19 during 2020-21.

Literature Review

The bibliometric and scientometrics examination of high-cited papers (HCPs) help us identify significant research trends and the most influential research papers. Such analysis has been performed in many fields, including computer science,³ economics and business,⁴ environment science⁵ library and information science,⁶ maize or corn research,⁷

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operations research and management science,⁸ rice research,⁹ type-2 diabetes¹⁰ and water resources¹¹ using ESI database.

Methodology

The publication data in this study were obtained from the Clarivate Analytics ESI and WoS database. The search strategy used for retrieval was as follows: "Covid-19" within topic field for identifying the high-cited papers on Covid-19 in Essential Science Indicator database (Product of Web of Science).¹² Full record and cited references of the included papers were extracted and imported into Histcite and VOSviewer. The search was restricted to document types. Retrieval results showed that there were 848 high-cited SCIE/SSCI papers in Covid-19 research. These were marked as HCPs. The data of the 848 HCPs were downloaded and analyzed comprehensively.

Bibliometric analysis is a powerful and important tool in evaluating scientific performance and development of a research field. Based on these 848 papers, we identified the most influential actors, including countries/regions, institutions, authors and journals. Social network analysis was performed to evaluate and visualize the collaborative interaction among productive countries/territories, organizations, authors and keywords using VOSviewer software. The most-cited papers are then presented. Finally, author keywords, keywords plus and words in title are analyzed, with hot research topics and future directions being provided. The co-authorship network visualization of authors, organizations and countries and co-occurrence network visualization of all keywords are visualized using VOSviewer software.

Objectives

The main objective of this paper is to examine 848 high-cited papers on Covid-19 extracted from the Essential Science Indicators database. It provides insights into performances and research characteristics of publications on Covid-19, using indicators to evaluate the influence of the most countries/territories, organizations, authors and journals. Social network analysis was used to evaluate and visualize the interaction among productive countries/territories, organizations, authors and keywords using VOSviewer software. Also identify the present status and future hotspots in Covid-19 research

Data Analysis and Results

In all 848 high-cited papers were extracted from Essential Science Indicators Database during 2020-21 and these papers have received 244699 citations, averaging 288.56 citations per paper. Of the 848 high-cited papers, 42 papers (4.95% share) accrued more than 1000 citations per paper, 85 papers (10.03%) received 501-1000 citations per paper and 721 papers (43.99%) received 101-500 citations.

Most Active Countries

In all 80 countries unevenly participated in 848 high-cited papers: 20 countries published 1 paper each, 39 countries 2-9 papers each, 28 countries 10-90 papers each and 3 countries 153-336 papers each. In terms of distribution of citations, 10 countries registered less than 1000 citations, 28 countries 1001 to 10, 000 citations, 8 countries 10860 to 88474 citations and 1 country 114620 citations.

The top 30 countries contributed 10 to 336 papers and their global share varied from 1.2% to 30.6%. Together these 30 countries contributed more than 100 per cent global publications (467060) share and more than 100 per cent (467060) citations share. On further analysis it was observed that: (i) 9 countries contributed more than the average publication productivity (50.77) of all top 30 countries; and (ii) 10 countries registered average citation per paper and relative citation index above average (306.67 and 1.06) all 30 countries. Out of top 30 countries,

Table 1 list the top 10 most productive countries and 10 most impactful countries each in terms of citations per papers and total citations received. Figure 1 presents the network collaborative linkages among top 20 countries. The top 20 countries in Figure 1 are viewed and presented in three clusters represented by three colors. USA has the highest collaboration intensity (TLS = 2991) followed by China (TLS=2597), England (TLS=1659), Italy (TLS=1029) in the top 20 countries/territories. Figure 1 shows visualization of international collaborations and link strength combinations between the top 20 countries/territories. In network visualization, size of the circle of an item is determined by the weight of that item. The higher the weight of an item, larger is the circle of that item. The link strength between USA and UK is maximum, with the number

Table 1: Top 10 Most Productive Countries and 10 Most Impactful Countries by Total Citations and Citations per paper.

S.No	Name of the country	TP	%TP	TC	CPP	RCI
Top 10 Most Productive Countries						
1	USA	336	39.6	88474	263.31	0.91
2	China	222	26.2	114620	516.31	1.79
3	UK	153	18	46535	304.15	1.05
4	Italy	90	10.6	24546	272.73	0.95
5	Germany	74	8.7	24028	324.70	1.13
6	Canada	59	7	14772	250.37	0.87
7	Australia	57	6.7	13106	229.93	0.80
8	France	55	6.5	17424	316.80	1.10
9	Spain	53	6.3	13508	254.87	0.88
10	Netherlands	46	5.4	17498	380.39	1.32
Top 10 Most Impactful by Citations Per Paper						
1	China	222	26.2	114620	516.31	1.79
2	Denmark	17	2	6626	389.76	1.35
3	Singapore	28	3.3	10860	387.86	1.34
4	Netherlands	46	5.4	17498	380.39	1.32
5	Greece	14	1.7	4975	355.36	1.23
6	South Korea	18	2.1	5933	329.61	1.14
7	Germany	74	8.7	24028	324.70	1.13
8	Switzerland	29	3.4	9381	323.48	1.12
9	France	55	6.5	17424	316.80	1.10
10	Japan	27	3.2	8495	314.63	1.09
Top 10 Most Impactful Organizations by Total Citations Received						
1	China	222	26.2	114620	516.31	1.79
2	USA	336	39.6	88474	263.32	0.91
3	UK	153	18	46535	304.15	1.05
4	Italy	90	10.6	24546	272.73	0.95
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7	France	55	6.5	17424	316.80	1.10
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9	Spain	53	6.3	13508	254.87	0.88
10	Australia	57	6.7	13106	229.93	0.80

TP=Total papers; TC=Total citations; CPP=Citations per paper; RCI=Relative citation index

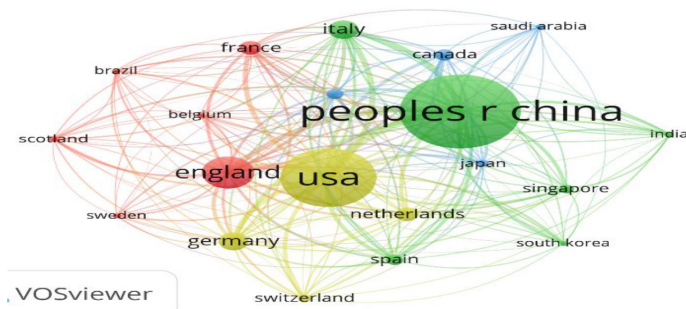


Figure 1: Network Collaboration Network Linkages among Top 20 Countries.

of USA–UK collaboration linkages being 64. In the collaborations, USA is at the central position, which shows its research potential in the Covid-19 field.

Most Active Organizations

In all 2607 organizations unevenly participated in 848 high-cited papers: 1909 organizations contributed 1 paper each, 647 organizations 2-9 papers each, 51 organizations 10-42 papers each. Of the top 30 organizations, 8 organizations registered 10615 to 32563 citations, 16 organizations 5001 to 9999 citations and 6 organizations 2681 to 4651 citations.

The top 30 organizations contributed 13 to 42 papers and their global share varied from 1.53% to 4.95%. Among the top 30 organizations, 12 were from USA, 6 each from China and UK, 2 from Italy, one each from Singapore, France, Canada and Australia.

Together these 30 organizations contributed 68.51% (581 papers) global publications and more than 100 per cent (257428) citations share. On further analysis it was observed that: (i) 11 organizations contributed more than the average publication productivity (10.37) of all top 30 organizations; and (ii) 9 organizations registered average citation per paper and relative citation index above average (443.08 and 1.54) all 30 organizations. Out of top 30 organizations, Table 2 list the top 10 most productive organizations, 10 most impactful organizations in terms of citations per papers and top 10 most impactful organizations in terms of total citations received.

Figure 2 presents the collaborative linkages among top 30 organizations. The organizations are presented in three clusters represented by three colors. Figure 2 shows the visualization of collaborations and link strength combinations between the top 30 organizations. Harvard Medical School with 199 highest number of link strength followed by Huazhong University Science and Technology (178), Oxford University (170) and among others. The colors are used to distinguish between different clusters.

Most Active Authors

In all 9734 authors unevenly participated in 848 high-cited papers: 8309 authors contributed 1 paper each, 1417 authors 2-9 papers each and 8 authors 10-15 papers each. Out of top 30 authors, 18 authors registered 1302-4958 citations, 4 authors 5830-8209 citations and 8 authors 11303-23285 citations. The top 30 authors contributed 6-15 papers and their global share varied from 0.71% to 1.77%.

Together these 30 authors contributed 30.90% (262 papers) share in global publications and 85.03% (208079) share in global citations. On further analysis it was observed that: (i) 10 authors contributed more than the average publication productivity (8.73) of all top 30 authors; and (ii) 8 authors registered average citation per paper and relative citation index above average (799.19 and 1.64) all 30 authors. Out of top 30 organizations, Table 3 list the top 10 most productive authors,

Table 2: Top 10 Most Productive Organizations and Most Impactful Organizations by Total Citations and Citations Per Paper.

S.No	Name of the organization	Country	TP	TC	CPP	RCI	%TP
Top 10 Most Productive Organizations							
1	Huazhong University Science and Technology	China	42	32563	775.31	2.69	4.95
2	Harvard Medical Schools	USA	41	11811	288.07	1.00	4.83
3	University of Oxford	UK	31	13802	445.23	1.54	3.66
	Chinese Academic of Science	China	25	6531	261.24	0.91	2.95
5	London's Global University (UCL)	UK	25	9215	368.60	1.28	2.95
6	University Cambridge	UK	25	9787	391.48	1.36	2.95
7	Icahn School of Med Mount Sinai	USA	24	7685	320.21	1.11	2.83
8	University Washington	USA	23	10615	461.52	1.60	2.71
9	University of Hong Kong	China	22	17868	812.18	2.81	2.59
10	Brigham and Women's Hospital	USA	20	5840	292.00	1.01	2.36
Top 10 Most Impactful Organizations by Citations per Paper							
1	Tsinghua University	China	14	15827	1130.50	3.92	1.65
2	Guangzhou Medical University	China	13	13155	1011.92	3.51	1.53
3	University of Hong Kong	China	22	17868	812.18	2.81	2.59
4	Huazhong University Science and Technology	China	42	32563	775.31	2.69	4.95
5	Wuhan University	China	18	11782	654.56	2.27	2.12
6	University of Milano Bicocca	Italy	13	6197	476.69	1.65	1.53
7	National University of Singapore	Singapore	14	6577	469.79	1.63	1.65
8	University Washington	USA	23	10615	461.52	1.60	2.71
9	University of Oxford	UK	31	13802	445.23	1.54	3.66
10	University of North Carolina	USA	14	6194	442.43	1.53	1.65
Top 10 Most Impactful Organizations by Total Citations							
1	Huazhong University Science and Technology	China	42	32563	775.31	2.69	4.95
2	University of Hong Kong	China	22	17868	812.18	2.81	2.59
3	Tsinghua University	China	14	15827	1130.50	3.92	1.65
4	University of Oxford	UK	31	13802	445.23	1.54	3.66
5	Guangzhou Medical University	China	13	13155	1011.92	3.51	1.53
6	Harvard Medical Schools	USA	41	11811	288.07	1.00	4.83
7	Wuhan University	China	18	11782	654.56	2.27	2.12
8	University Washington	USA	23	10615	461.52	1.60	2.71
9	University Cambridge	UK	25	9787	391.48	1.36	2.95
10	London's Global University (UCL)	UK	25	9215	368.60	1.28	2.95

TP=Total papers; TC=Total citations; CPP=Citations per paper; RCI=Relative citation index

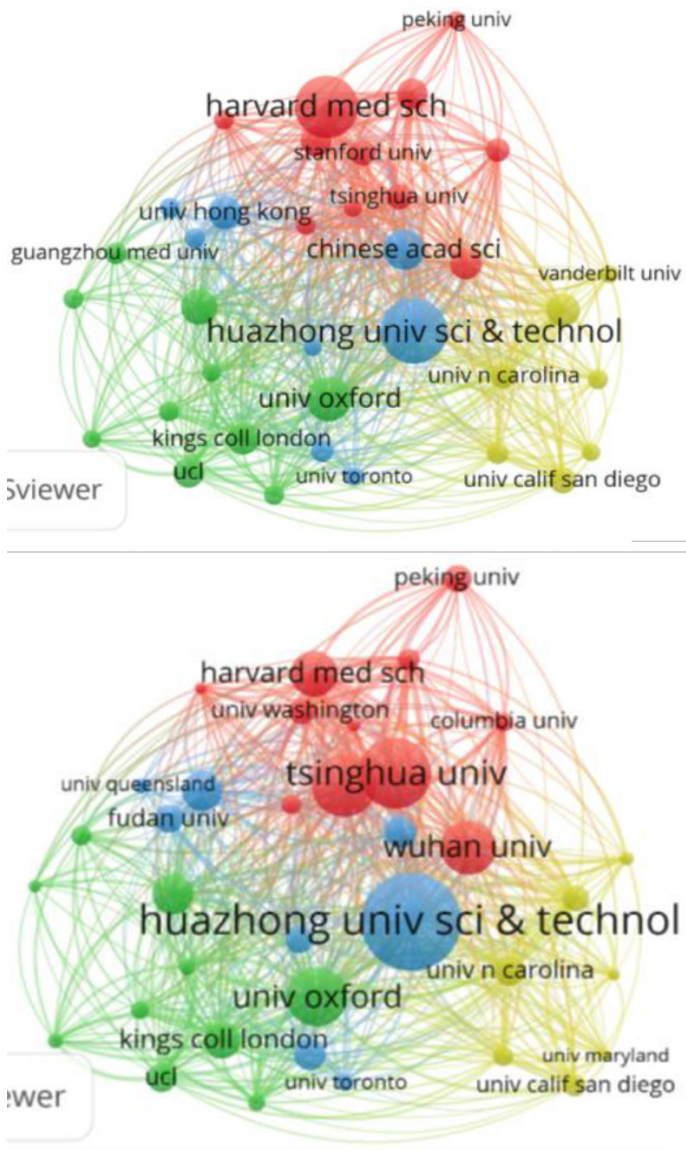


Figure 2: Network Collaboration Network Linkages among Top 30 Organizations.

10 most impactful authors in terms of citations per papers and total citations received.

Most Active Journals

Table 4 represents the journals-wise distribution of high-cited papers in Covid-9. Out of 848 document, 715 (84.30%) constitute journal articles and 128 (15.1%) reviews. The Covid-19 high-cited papers are spread over 322 different source journals. Table 4 gives the leading journals each with number of publications, and impact factor of the journal. Of the 322 journals, 197 journals published 1 paper each, 123 journals 2-9 publications each and 14 journals 10-37 papers each. The top 30 journals constitute 52.45% (375) share in total journal output. The top 10 journals ranked according to productivity, citations per paper, total citations and impact factor are listed in Table 4.

Subject-Wise Distribution of Publications

The high-cited papers on Covid-19 research has been published in the context of different subject fields (as reflected in Web of Science database

Table 3: Top 10 Most Productive Organizations and Most Impactful Authors by Total Citations and Citations Per Paper.

S. No	Name of the author	TP	TC	CPP	RCI	% TP
Top 10 Most Productive Authors						
1	Zhang Y	15	16495	1099.67	3.81	1.77
2	Hu Y	14	18804	1343.14	4.65	1.65
3	Liu L	14	14690	1049.29	3.64	1.65
4	Wang J	14	8209	586.36	2.03	1.65
5	Liu Y	13	23285	1791.15	6.21	1.53
6	Wang Y	13	7825	601.92	2.09	1.53
7	Zhang L	13	7446	572.77	1.98	1.53
8	Wang L	10	5830	583.00	2.02	1.18
9	Chen J	9	4958	550.89	1.91	1.06
10	Yuen KY	9	12293	1365.89	4.73	1.06
Top 10 Most Impactful Authors by Citations Per Paper						
1	Chen Z	6	11303	1883.83	6.53	0.71
2	Wang T	7	13166	1880.86	6.52	0.83
3	Liu Y	13	23285	1791.15	6.21	1.53
4	Li L	8	12309	1538.63	5.33	0.94
5	Yuen KY	9	12293	1365.89	4.73	1.06
6	Hu Y	14	18804	1343.14	4.65	1.65
7	Zhang Y	15	16495	1099.67	3.81	1.77
8	Liu L	14	14690	1049.29	3.64	1.65
9	Drosten C	6	4412	735.33	2.55	0.71
10	Cecconi M	7	4911	701.57	2.43	0.83
Ten Most Impactful Authors by Total Citations						
1	Chen Z	6	11303	1883.83	6.53	0.71
2	Wang T	7	13166	1880.86	6.52	0.83
3	Liu Y	13	23285	1791.15	6.21	1.53
4	Li L	8	12309	1538.63	5.33	0.94
5	Yuen KY	9	12293	1365.89	4.73	1.06
6	Hu Y	14	18804	1343.14	4.65	1.65
7	Zhang Y	15	16495	1099.67	3.81	1.77
8	Liu L	14	14690	1049.29	3.64	1.65
9	Drosten C	6	4412	735.33	2.55	0.71
10	Cecconi M	7	4911	701.57	2.43	0.83

classification), with highest number of publications coming from Medicine - General Internal (with 13.43% share), followed by Public - Environmental Occupational Health (10.01% share), Environmental Sciences (8.12% share), Psychiatry (6.83% share), Pharmacology Pharmacy (5.54% share) and Infectious Diseases (5.42% share), etc. (Table 5)

Keyword Analysis

The frequency occurrence of keywords is shown in Table 6 and Figure 3. The highest frequency (818) was observed for Covid, followed by Patient (384), SARS-COV (364), Pandemic (309), Severe Acute Respiratory Syndrome Coronavirus (248), Virus(194), Age(189) and Outbreak (189). Figure 3 shows the network visualization of author keywords (occurrences ≥ 60). The entire network of the author keywords

Table 4: Top 10 Most Productive Journals and 10 Most Impactful Journals by Total Citations, Citations Per Paper and by Impact Factor.

S. No	Name of the Journal	IF(Year)	TP	TC	CPP
Top 10 Most Productive Journals					
1	New England Journal of Medicine	74.69	37	28173	761.43
2	Science of the Total Environment	6.55	35	4019	114.83
3	Science	41.84	28	8262	295.07
4	Lancet	60.39	21	17128	815.62
5	Nature	42.77	18	6923	384.61
6	Nutrients together account for	4.54	18	1782	99.00
7	Cell	38.63	17	5268	309.88
8	JAMA-Journal of the American Medical Association	45.54	14	9603	685.93
9	Psychiatry Research	2.2	13	3097	238.23
10	Radiology	7.93	12	6208	517.33
Top 10 Journals by Citations Per Paper					
1	Lancet	60.39	21	17128	815.62
2	New England Journal of Medicine	74.69	37	28173	761.43
3	JAMA-Journal of the American Medical Association	45.54	14	9603	685.93
4	International Journal of Antimicrobial Agents	4.62	9	5865	651.67
5	Nature Medicine	36.13	9	5659	628.78
6	Lancet Respiratory Medicine	25.09	7	4188	598.29
7	JAMA Cardiology	12.79	7	4078	582.57
8	Lancet Infectious Diseases	24.44	8	4187	523.38
9	Radiology	7.93	12	6208	517.33
10	BMJ-British Medical Journal	30.22	8	4010	501.25
Top 10 Journals by Total Citations					
1	New England Journal of Medicine	74.69	37	28173	761.43
2	Lancet	60.39	21	17128	815.62
3	JAMA-Journal of the American Medical Association	45.54	14	9603	685.93
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7	International Journal of Antimicrobial Agents	4.62	9	5865	651.67
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9	Cell	38.63	17	5268	309.88
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4	Nature	42.77	18	6923	384.61
5	Science	41.84	28	8262	295.07
6	Cell	38.63	17	5268	309.88
7	Nature Medicine	36.13	9	5659	628.78
8	BMJ-British Medical Journal	30.22	8	4010	501.25
9	Lancet Respiratory Medicine	25.09	7	4188	598.29
10	Lancet Infectious Diseases	24.44	8	4187	523.38

Table 5: Subject-Wise Distribution of High-Cited Papers.

S.No	Name of the Subject Category	TP	%TP	S.No	Name of the Subject Category	TP	%TP
1	Medicine General Internal	114	13.43	17	Nanoscience Nanotechnology	21	2.47
2	Public Environmental Occupational Health	85	10.02	18	Cardiac Cardiovascular Systems	20	2.36
3	Multidisciplinary Sciences	71	8.36	19	Chemistry Multidisciplinary	19	2.24
4	Environmental Sciences	69	8.13	20	Hematology	18	2.12
5	Psychiatry	58	6.83	21	Materials Science Multidisciplinary	15	1.77
6	Pharmacology Pharmacy	47	5.54	22	Critical Care Medicine	14	1.65
7	Infectious Diseases	46	5.42	23	Pediatrics	14	1.65
8	Biochemistry Molecular Biology	42	4.95	24	Peripheral Vascular Disease	14	1.65
9	Cell Biology	37	4.36	25	Biology	12	1.41
10	Clinical Neurology	32	3.77	26	Endocrinology Metabolism	12	1.41
11	Medicine Research Experimental	28	3.30	27	Mathematical Interdisciplinary Applications	12	1.41
12	Microbiology	28	3.30	28	Physics Mathematical	12	1.41
13	Neurosciences	26	3.06	29	Physics Multidisciplinary	12	1.41
14	Nutrition Dietetics	26	3.06	30	Respiratory Systems	12	1.41
15	Immunology	22	2.59	31	Business Finance	11	1.30
16	Radiology Nuclear Medicine Medical Imaging	22	2.59	32	Chemistry Physical	10	1.18

(occurrences ≥ 60) is presented. The author keywords have been divided into four groups and each group presented with a certain colour. In network visualization, the colour of author keywords is determined by the cluster to which the item belongs, according to VOSviewer.

SUMMARY AND CONCLUSION

In the present paper, a scientometric analysis was performed on 848 high-cited documents using bibliometric methods having received 100 or more citations indexed in WoS database and covered in Essential Science Indicators database from the beginning of 2020 up to June, 2021. The contribution and influence of most productive countries/territories, organizations, authors and journals was evaluated. Among countries, the most productive countries were USA (336 papers), China (222 papers), U.K. (153 papers), Italy (90 papers) and Germany (74 papers) and the most impactful countries were: China (56.31), Denmark (389.76), Singapore (387.86), Netherlands (380.39) and Greece (355.56) in terms of average citations per paper. The USA had a dominant position in the collaboration network of the top 20 productive countries/territories. At the institution level, the most productive organizations

Table 6: List of Most Significant Keywords.

ID	Name of Keyword	Number of Occurrences	Relevant Score	ID	Name of Keyword	Number of Occurrences	Relevant Score
7	Covid	818	0.7953	5	Coronavirus	165	0.9417
19	Patient	384	0.7004	11	Impact	146	0.6817
21	SARS CoV	364	0.7713	10	Hospital	125	0.5942
17	Pandemic	309	0.947	13	Mortality	120	1.1359
22	Severe Acute Respiratory Syndrome Coronavirus	248	0.5419	24	Spread	114	1.9006
27	Virus	194	1.2264	26	Vaccine	77	0.9565
1	Age	189	1.2333	23	Severe Covid	73	1.6002
15	Outbreak	189	0.6393	2	Anxiety	69	1.4592
16	Outcome	187	1.226				

level, the most productive authors were Y. Zhang (15 papers), Y. Hu, L. Liu and J. Wang (14 papers) and Y. Liu (13 papers) and the most impactful authors were Z. Chen (1993.83), T Wang (1880.86), Y. Liu (1791.15), L. Li (1538.63) and K.Y.Yuen (1365.89) in terms of average citations per paper. The most productive journals were *New England Journal of Medicine* (37 papers), *Science of the Total Environment* (35 papers), *Science* (28 papers), *The Lancet* (21 papers) and *Nature* (18 papers) and the most impactful journal in terms of average citations per paper were *The Lancet* (815.62), *New England Journal of Medicine* (761.43), *JAMA-Journal of the American Medical Association* (685.93), *International Journal of Antimicrobial Agents* (628.78) and *Nature Medicine* (628.78). The top and most popular Web of Science subject categories were Medicine General Internal (114 papers), Public Environmental Occupational Health (85 papers), Environmental Sciences (69 papers), Psychiatry (58 papers), Pharmacology Pharmacy (47 papers) and Infectious Diseases (46 papers).

Results obtained from this study can provide valuable information and insights for researchers and clinicians to better identify present and future hotspots in Covid-19 and related research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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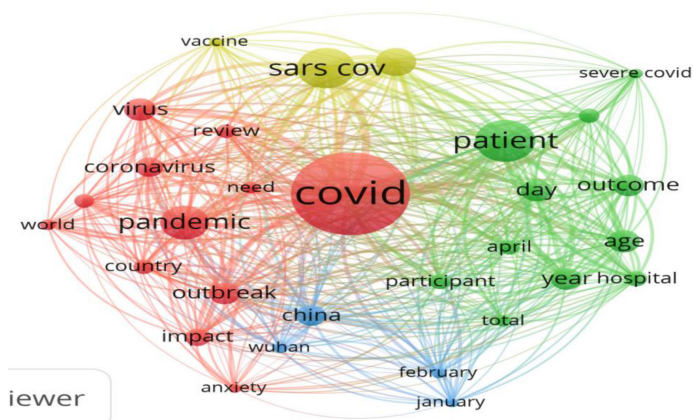


Figure 3: Keyword Co-Occurrence Mapping.

were Huazhong University of Science and Technology, China (41 papers), Harvard Medical School, USA (41 papers), University of Oxford, U.K. (25 papers), London Global University (UCL), U.K. (25 papers) and University of Cambridge, U.K. (25 papers) and the most impactful organizations were Tsinghua University, China (1130.5), Guangzhou Medical University, China (1011.92), University of Hong Kong (812.18), Huazhong University of Science and Technology, China (775.31) and Wuhan University, China (654.56) were in terms of average citations per paper. Harvard Medical School, USA, Huazhong University Science and Technology, China and Oxford University, U.K. have the highest collaboration intensity with link strength of 199, 178 and 170. At the author

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