Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Coronavirus: a scientometric study of worldwide research publications

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1. Introduction

Since the outbreak of the coronavirus (CoV) in Wuhan Province in China, doctors, health organizations, and administrations across the globe have been stretched in response to the increasing incidence and distribution of the outbreak. CoVs are a large family of viruses that cause respiratory illness. CoV is related to the severe acute respiratory syndrome coronavirus (SARS-CoV) and the Middle East respiratory syndrome coronavirus (MERS-CoV). Historically, SARS-CoV entered the spotlight when it caused an epidemic in Hong Kong. Thereafter, China, Vietnam, Canada, Saudi Arabia, and other parts of the globe witnessed outbreaks of the virus. The main cause of SARS was identified as CoV [1–4]. The other form of CoV identified in 2013 as MERS-CoV is genetically related to humans [5,6]. However, CoV has been the subject of virology research since 1931 and was identified as a pathogen affecting both humans and animals [7]. The major symptoms of CoV and its variants are characterized by respiratory illness (pneumonia, bronchitis, etc.) and intestinal infections (gastroenteritis, diarrhea, etc.) in both humans and animals [7,8]. The origin of the current strain of CoV has been linked to bats in China [9] and camels (*Camelus dromedarius*) in the Middle East region [10].

In contemporary ages, bibliometric study has become popular, which applies literature metrology characteristics to measure the aid of an area of research, predicts exhaustive developments of research or hotspots in a certain field, and makes an important contribution to the prevention and treatment of diseases.

Descriptive analyses were conducted to evaluate the characteristics and types of documents, and the top 25 authors and journals involved in coronavirus disease 2019 (COVID-19)-related research and publications were identified. Also, coauthorship among all the authors in the bibliography was measured, and an evaluation of how many

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of them were connected within documents authored or coauthored by individuals was performed. Additionally, the affiliating institutions and countries of the respective authors were mapped using a network analysis approach. This set of analyses allowed comparing the nature and magnitude of collaboration at the individual, institutional, and global degrees and analyzing how such collaboration impacted the information base on COVID-19. Additionally, keywords and texts in titles and abstracts within scientific documents had been identified and evaluated for the use of textual content-mining methods, and network analyses were conducted to assess the connectedness among those documents and related keywords. Furthermore, the co-occurrence of multiple authors, keywords, institutions, and countries, different thresholds were used to create visualizations of frequency distributions for each variable, whereas all entries within each variable were assessed for the same threshold to ensure equitable comparisons within respective fields of analyses. In addition, a multidimensional scaling approach was used to conduct a factorial analysis and construct a conceptual structure map depicting hierarchic relationships among knowledge areas within the research landscape of COVID-19.

Evaluation of research developments is executed through bibliometric techniques. Bibliometric methods aid in the measurement of the publication form on a given topic, journals, authors, institutions, and countries using statistical methods [11–13]. Research on SARS had been reported [14] and there has been international linkages of CoV research output [15–17], however there are no specific bibliometric analyses on CoV. Bibliometric studies related to SARS were stated through 2003, with no descriptive bibliometric research to be associated with CoV thereafter. The aim of this study is to present a bibliometric perspective of CoV research for the period 1989–2020 (32 years).

2. Methodology

The study was analyzed the research output of CoV for the period 1989–2020 on several parameters. The Web of Science (WoS) citation database has been used to retrieve the publications data for 32 years. These WoS database is maintained by Clarivate Analytics, which is the world's leading scientific citation search and analytical information platform. The study period 1989–2020 is selected, as the database is available. Search string used for the data retrieval is SU = (Corona virus) AND Timespan = 1989–2020. Database = SCSCI, A&HCI, this search criterion yielded 12,726 records. In addition MS Excel was used for the purpose of data analysis, and collaboration networks have been generated by using VOSviewer software [5,9,18,19].

These are the major bibliometric parameters established in other research publications [16,20]. The number of citations accumulated by the publication through February 22, 2020, was used to determine the impact factor (IF). The number citations received in the year of publication is denoted as TP, the number of citations in the year 2020 is denoted as C2020, and total citations (TC) are denoted as TC 2020. The qualitative parameter of an article's Hirsch index (h-index) [21] was obtained from the database for

the most productive authors and institutes. Citation analysis is 2 S. RAM, a tool for journal evaluation, and the evaluation is carried out based on its IF [10,18,22–31]. The IF is a yearly mean number of citations received by articles published in a journal during the past 2 years [32]. IFs of the journals were obtained from the 2018 Journal Citation Report (JCR) and denoted as IF2018; the research direction in a field can be assessed using bibliometric analysis. Authors provide keywords that are useful in determining the hot research areas [33–35]. Research trends using author keywords were analyzed using VOSviewer [10,18,24–27]. The collaboration network is defined from the authors' affiliations [10,18,24–30,36].

3. Analysis and results

3.1 Contribution of coronavirus publications by year

Data on the bibliographic records were collected from the online version of WoS related to CoV research publications from worldwide for the period of 1989–2020. A total of 12,726 publications were collected; Table 22.1 reveals the features of CoV research worldwide, with 12,726 papers and 361,839 citations. As per the WoS data the cumulative publications growth of CoV research had increased from 385 to 749. Highest number (782) of papers was published in the year 2004 and the least (76) number of publications was in the year 1989. In 1989, 76 articles were produced and received 2732 citations with 35.95 average citations per paper, and the highest h-index recorded in the year 2004 was only 90 (Figs. 22.1 and 22.2).

3.2 Forms of publication of coronavirus research

Table 22.2 illustrates the forms of publication of CoV research; these include articles, reviews, proceedings paper, editorial materials, meeting abstracts, letters, notes, news item, book chapters, etc. The study observed that there were a total of 12,726 publications in CoV research output from around the world. The majority of publications are published in journal articles, i.e., 10,358 (82.128%), followed by reviews, 1122 (8.896%), proceedings papers, 439 (3.481%); editorial materials, 357 (2.831%); meeting abstracts, 281 (2.228%); letters, 234 (1.855%); notes, 115 (0.912%); news items, 83 (0.658%); book chapters, 63 (0.5%); corrections, 54 (0.428%); and early access, 41 (0.325%); and less than five articles are published in reprint, three papers as correction addition. It was also observed from the data that more than 99% of articles were published in the English language.

3.3 Language-wise distribution of coronavirus research

Table 22.3 indicates that 97.407% (12,726 publications) of the worldwide publications in CoV were in the English language, followed by French, 87 (0.69%) papers; German, 81 (0.642%); Spanish, 36 (0.285%); Chinese, 31 (0.246%); Hungarian, 23 (0.182%); Polish,

Table 22.1 Contribution of coronavirus publications by year.

Year	TP	TC	ACP	h-index	% of 12,726
1989	76	2732	35.95	26	0.597
1990	96	4211	43.86	36	0.754
1991	158	8139	51.51	45	1.242
1992	149	7006	47.02	49	1.171
1993	155	6763	43.63	45	1.218
1994	148	5114	34.55	43	1.163
1995	175	7249	41.42	47	1.375
1996	148	4949	33.44	42	1.163
1997	168	6585	39.2	47	1.32
1998	198	6414	32.39	40	1.556
1999	158	6511	41.21	49	1.242
2000	145	6500	44.83	48	1.139
2001	215	6211	28.89	48	1.689
2002	144	5730	39.79	45	1.132
2003	385	30,020	77.97	75	3.025
2004	782	32,285	41.23	90	6.145
2005	726	30,363	41.82	84	5.705
2006	714	24,744	34.61	79	5.611
2007	563	20,647	36.54	72	4.424
2008	530	17,468	32.83	65	4.165
2009	473	14,984	31.75	61	3.717
2010	458	13,122	28.59	57	3.599
2011	410	11,245	27.36	53	3.222
2012	463	13,326	28.78	52	3.638
2013	617	19,138	30.97	68	4.848
2014	717	18,540	25.89	66	5.634
2015	697	12,826	18.43	50	5.477
2016	749	9479	12.64	39	5.886
2017	690	5751	8.33	29	5.422
2018	649	2907	4.48	18	5.100
2019	734	831	1.14	8	5.768
2020	236	49	0.41	3	1.854

TP, Total Publications; *TC,* Total Citations; *ACP*, Average Citations per Paper; *h-index,* Hirsch index.

16 (0.127%); Portuguese, 13 (0.103%); Russian, 10 (0.079%); Dutch and Turkish, 9 (0.071%); Italian, 4 (0.032%); Czech and Korean, 2 (0.016%); and less than 1% of papers were published in Greek, Japanese, and other languages.

3.4 Distribution of articles among subdisciplines

The CoV articles published during 1989–2020 were classified under 25 major subdisciplines (as defined by WoS citation database). Table 22.4 reveals the top 25 research areas of the world in the field of CoV. Virology accounted for the largest publications, i.e., 3993 (31.483%), followed by veterinary sciences, 1908 (15.044%) publications; infectious

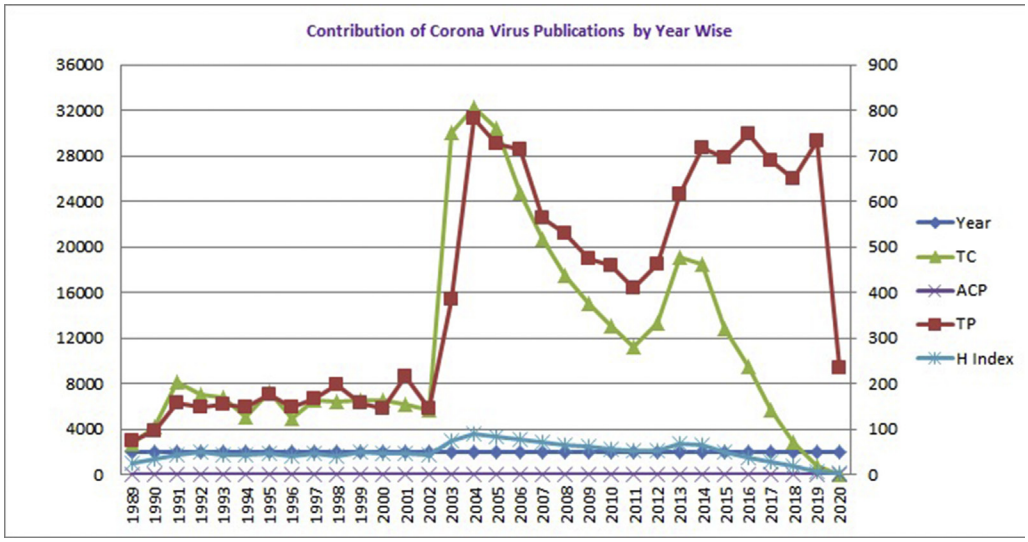

FIGURE 22.1 Contribution of Corona Virus Research Publications by Year Wise. *ACP*, Average Citations per Paper; *h-index*, Hirsch index; *TC*, Total Citations; *TP*, Total Publications.

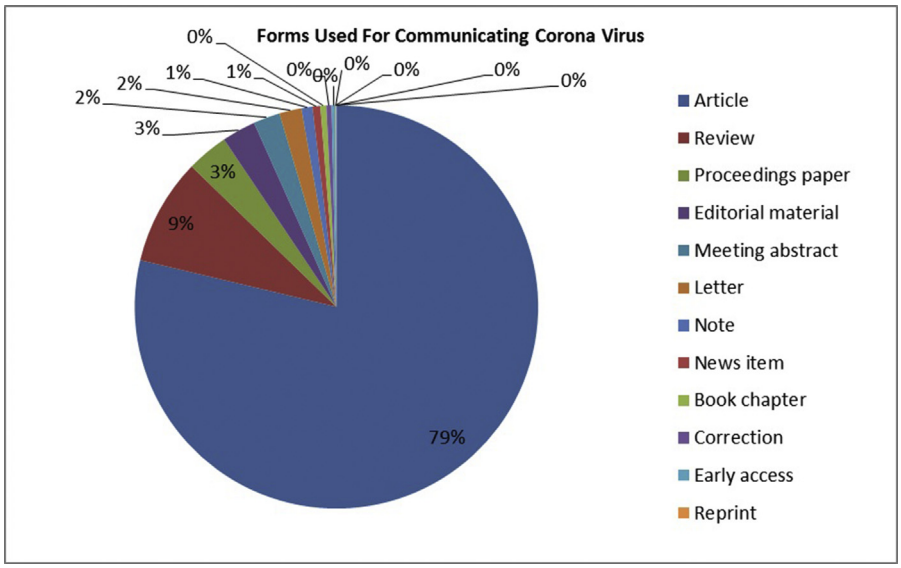

FIGURE 22.2 Forms Used For Communicating Corona Virus.

diseases, 1490 (11.784%) publications; immunology, 1477 (11.646%); microbiology, 1405 (11.078%); biochemistry and molecular biology, 1113 (8.776%); and biotechnology and applied microbiology, 718 (5.661%); multidisciplinary sciences, 581 (4.581%); medicine research experiment, 569 (4.486%) etc.

Table 22.2 Forms of publication of coronavirus research.

Document types	Publications	% of 12,726
Articles	10,358	82.128
Reviews	1122	8.896
Proceedings papers	439	3.481
Editorial materials	357	2.831
Meeting abstracts	281	2.228
Letters	234	1.855
Notes	115	0.912
News items	83	0.658
Book chapters	63	0.500
Corrections	54	0.428
Early access	41	0.325
Reprints	5	0.040
Correction additions	3	0.024
Data papers	1	0.008
Retracted publications	1	0.008

Table 22.3 Language-wise distribution of worldwide coronavirus research.

Languages	Publications	% of 12,726
English	12,285	97.407
French	87	0.69
German	81	0.642
Spanish	36	0.285
Chinese	31	0.246
Hungarian	23	0.182
Polish	16	0.127
Portuguese	13	0.103
Russian	10	0.079
Dutch	9	0.071
Turkish	9	0.071
Italian	4	0.032
Czech	2	0.016
Korean	2	0.016
Danish	1	0.008
Greek	1	0.008
Japanese	1	0.008
Slovenian	1	0.008
Welsh	1	0.008

Table 22.4 Distribution of articles among subdisciplines.

Web of Science categories	Publications	% of 12,683
Virology	3993	31.483
Veterinary Sciences	1908	15.044
Infectious Diseases	1490	11.748
Immunology	1477	11.646
Microbiology	1405	11.078
Biochemistry and Molecular biology	1113	8.776
Biotechnology and Applied microbiology	718	5.661
Multidisciplinary Sciences	581	4.581
Medicine Research experiment	569	4.486
Medicine general internal	436	3.438
Cell biology	412	3.248
Pharmacology pharmacy	409	3.225
Public environmental and occupational Health	373	2.941
Biochemical Research Methods	353	2.783
Biophysics	311	2.452
Genetics and heredity	220	1.735
Respiratory system	213	1.679
Chemistry, Medicinal	202	1.593
Pediatrics	176	1.388
Pathology	172	1.356
Biology	151	1.191
Chemistry, Multidisciplinary	138	1.088
Parasitology	133	1.049
Neurosciences	131	1.033
Agriculture and dairy Animal Science	109	0.859

3.5 The 25 major productive journals of coronavirus

Table 22.5 reveals the top productive sources preferred by the authors of the world in the field of CoV research. The *Journal of Virology* ranks first in terms of publications, i.e., 1130 publications with 8.96% of total publications, followed by *Virology*, 479 publications with 3.798%; *Advances in Experimental Medicine and Biology*, 246 publications with 1.951%; *Emerging Infectious Diseases*, 245 publications with 10,096 citations; *PLos One*, 239 publications with 4339 citations; *Archives of Virology*, 232 publications with 4428 citations; *Virus Research*, 231 publications with 5415 citations; *Veterinary Microbiology*, 190 publications with 3908 citations; *Viruses Basel*, 170 publications with 1940 citations; *Journal of Virological Methods*, 168 publications with 3100 citations; *Journal of Clinical Microbiology*, 137 publications with 7022 citations; *Antiviral Research*, 133 publications with 2605 citations; *Journal of Medical Virology*, 131 publications with 4326 citations; and *Proceedings of the National Academy of Sciences of the United States of America*, 122 publications with 12,867 citations.

Table 22.5 The 25 major productive journals of coronavirus research.

Source titles	TP	TC	ACP	h-index	% of 12,726
Journal of Virology	1130	55,178	48.83	104	8.96
Virology	479	18,088	37.76	66	3.80
Journal of General Virology	276	9820	35.58	54	2.19
Advances in Experimental Medicine and Biology	246	1539	6.23	15	1.95
Emerging Infectious Diseases	245	10,096	40.87	52	1.94
PLos One	239	4339	17.98	34	1.90
Archives of Virology	232	4428	19	37	1.84
Virus Research	231	5415	23.44	37	1.83
Veterinary Microbiology	190	3908	20.46	34	1.51
Viruses Basel	170	1940	11.41	24	1.35
Journal of Virological Methods	168	3100	18.34	29	1.33
Journal of Clinical Microbiology	137	7022	51.26	49	1.09
Antiviral Research	133	2605	19.59	28	1.06
Journal of Medical Virology	131	4326	32.77	37	1.04
Proceedings of the National Academy of Sciences of the USA	122	12,867	105.47	67	0.97
Journal of Infectious Diseases	119	4227	35.52	38	0.94
Journal of Clinical Virology	117	3066	26.21	33	0.93
Avian Diseases	115	2787	24.23	29	0.91
Vaccine	109	2560	23.49	29	0.86
Virology Journal	107	1966	18.37	25	0.85
Virus Genes	100	1984	19.84	24	0.79
Biochemical and Biophysical Research Communications	97	3426	35.69	35	0.77
Journal of Biological Chemistry	91	4850	53.3	43	0.72
Nidoviruses: Toward Control of SARS and Other Nidovirus Diseases	89	369	4.15	10	0.71
PLos Pathogens	87	4234	48.67	39	0.69

TP, Total Publications; *TC,* Total Citations; *ACP*, Average Citations per Paper; *h-index,* Hirsch index.

3.6 Organization-wise collaboration

Table 22.6 and Fig. 22.3 reveal the ranking of 25 top research organizations in the world based on their highest research articles. According to the WoS database the University of Hong Kong contributed the highest number of publications to the field, i.e., 517 publications with 28,869 citations, followed by the Chinese Academy of Sciences, 391 publications with 10,999 citations; the National Institutes of Health (NIH), USA, 312 publications with 16,051 citations; and in the 25th place is the University of London, 146 publications with 6606 citations.

Table 22.6 Organizational collaboration.

Sl No	Organizations enhanced	TP	TC	ACP	h-index	% of 12,726
1	University of Hong Kong	517	28,869	55.84	84	4.10
2	Chinese Academy of Sciences	391	10,999	28.13	55	3.10
3	National Institutes of Health (NIH), USA	312	16,051	51.45	69	2.47
4	University of California System	308	14,396	46.44	55	2.44
5	Utrecht University	304	15,301	50.33	67	2.41
6	University of North Carolina	260	9945	38.25	56	2.06
7	Centers for Disease Control Prevention, USA	252	12,638	49.95	51	2.00
8	Chinese University of Hong Kong	225	6292	27.96	44	1.78
9	University of North Carolina Chapel Hill	212	8375	39.5	54	1.68
10	University of Pennsylvania	200	6635	33.18	47	1.59
11	University of Texas System	200	6905	34.53	48	1.59
12	University of Iowa	198	6190	31.26	43	1.57
13	Consejo Superior De Investigaciones Cientificas (CSIC)	186	7787	38.97	48	1.48
14	Leiden University	185	11,483	62.07	56	1.47
15	NIH National Institute of Allergy Infectious Diseases (NIAID)	178	8605	48.34	52	1.41
16	University of Southern California	173	9107	52.64	55	1.37
17	Johns Hopkins University	172	4752	27.63	35	1.36
18	Chinese Academy of Agricultural Sciences	171	3022	17.67	26	1.36
19	Erasmus University Rotterdam	166	6335	37.93	40	1.32
20	University of Toronto	165	6302	37.96	40	1.31
21	Erasmus Medical Center	158	10,492	65.58	49	1.25
22	Ohio State University	155	4716	30.04	41	1.23
23	Centre National De La Recherche Scientifique (CNRS)	148	4429	29.53	39	1.17
24	Prince of Wales Hospital	148	4797	32.41	37	1.17
25	University of London	146	6606	44.94	42	1.16

TP, Total Publications; *TC*, Total Citations; *ACP*, Average Citations per Paper; *h-index*, Hirsch index.

3.7 Most productive authors in coronavirus research

Table 22.7 and Fig. 22.4 show the highly productive authors of CoV research output during the study period, their highest number of papers, irrespective of what is reflected in the WoS citation database. Yuen K.Y. contributed 212 (1.681%) publications, followed by Perlman S., 179 (1.419%); Baric R.S., 159 (1.261%); Drosten C., 147 (1.166%); Weiss S.R., 129 (1.023%); Woo P.C.Y., 128 (1.023%); etc.

3.8 International linkages of coronavirus research

The international distribution of articles is presented in Table 22.8, which gives the country-wise distribution of contributions. Out of the total 12,726 research articles, the

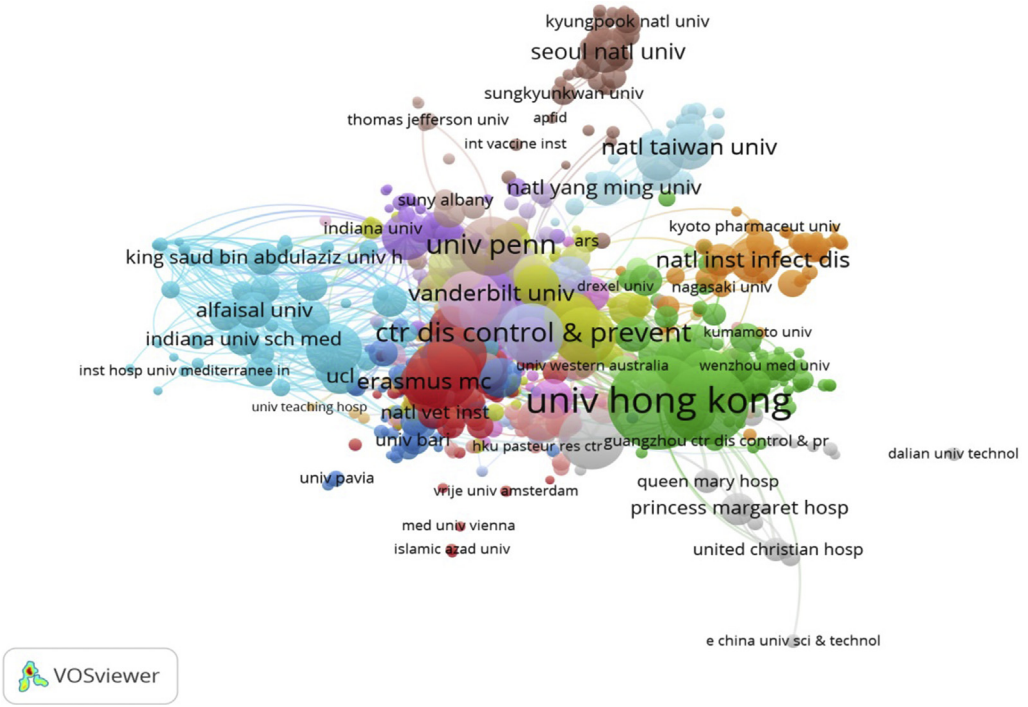

FIGURE 22.3 Organizational collaboration network.

United States contributed the highest number of research articles with 4524 publications with 35.871% share, followed by China, 2667 publications (21.147%); Germany, 882 publications (6.993%); England, 782 publications (6.2%); Netherlands, 728 publications (5.772%); Canada, 707 publications (5.606%); Japan, 586 publications (4.646%); and many countries contributed below 0.5% share, with India contributing 125 publications (0.991) during 1989–2020 (Fig. 22.5).

Table 22.9 reveals the rank list of top 25 highly funding institutions in the world based on their highest publications, citations, average citations per publication, and h-index. According to the WoS database, the United States Department of Health and Human Services contributed the highest publications to the field of CoV research, i.e., 2192 publications, followed by the NIH, USA, 2146 publications (17.016%); NIH National Institute of Allergy Infectious Diseases (NIAID), 1082; National Natural Science Foundation of China, 606 (4.805%); NIH National Institute of Neurological Disorders Stroke (NINDS), 276 (20,188%); Ministry of Education Culture Sports Science and Technology Japan MEXT, 161 (1.277%); European Union, 156 (1.237%); NIH National Institute of General Medical Sciences (NIGMS), 128 (1.015%); and NIH National Cancer Institute (NCI), 116 (0.92%).

Table 22.7 Most prolific authors in coronavirus research.

Authors	Number of Publications	% of 12,726
Yuen K.Y.	212	1.681
Perlman S.	179	1.419
Baric R.S.	159	1.261
Enjuanes L.	159	1.261
Drosten C.	147	1.166
Weiss S.R.	129	1.023
Woo P.C.Y.	128	1.015
Rottier P.I.M.	125	0.991
Chan Kh.	119	0.944
Lau S.K.P.	119	0.944
Memish Z.A.	110	0.872
Saif L.J.	110	0.872
Snijder E.J.	110	0.872
Holmes K.V.	99	0.785
Jiang S.B.	97	0.769
Peiris J.S.M.	97	0.769
Liu D.X.	92	0.729
Stohlman S.A.	88	0.698
Denison M.R.	85	0.674
Haagmans B.L.	83	0.658
Zhang Y.	83	0.658
Lai M.M.C.	82	0.65
Thiel V.	82	0.65
Taguchi F.	81	0.642
Talbot P.J.	78	0.618

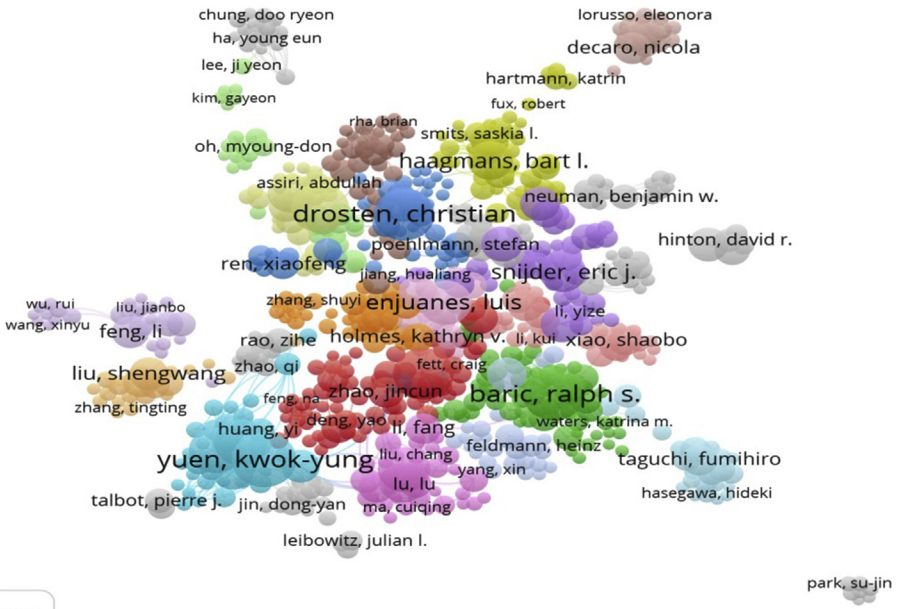

FIGURE 22.4 Authors coauthorship network.

Table 22.8 International linkages of coronavirus research.

Countries/regions	Number of publications	% of 12,726
The United States	4524	35.871
People's Republic of China	2667	21.147
Germany	882	6.993
England	782	6.2
Netherlands	728	5.772
Canada	707	5.606
Japan	586	4.646
France	567	4.496
South Korea	426	3.378
Saudi Arabia	409	3.243
Taiwan	403	3.195
Italy	361	2.862
Singapore	338	2.68
Australia	330	2.617
Spain	328	2.601
Switzerland	298	2.363
Brazil	217	1.721
Sweden	171	1.356
Belgium	160	1.269
Egypt	136	1.078
Scotland	126	0.999
India	125	0.991
Thailand	102	0.809
Poland	91	0.722
Turkey	90	0.714

4. Results and Findings

A total of 12,726 papers on CoV research published between 1989 and 2020 were retrieved from WoS database. The number of publications has gradually increased, and in 2004, a total of 782 papers were published, which was followed by a significant increase to 734 in 2019. It is indicated that this field has been attracting more attention since the current CoV outbreak. The increasing trend in the number of papers per year is illustrated in Table 22.1. The forms of publishing CoV research include articles published in the scholarly journals, conferences and seminar proceedings, reviews, editorial materials, book chapters, meeting abstracts, etc. The study observed a total of 12,726 publications in CoV research. The worldwide publications on CoV (COVID-19) have been primarily in the English language, followed by French with 87 (0.69%) papers, and there are 25 top

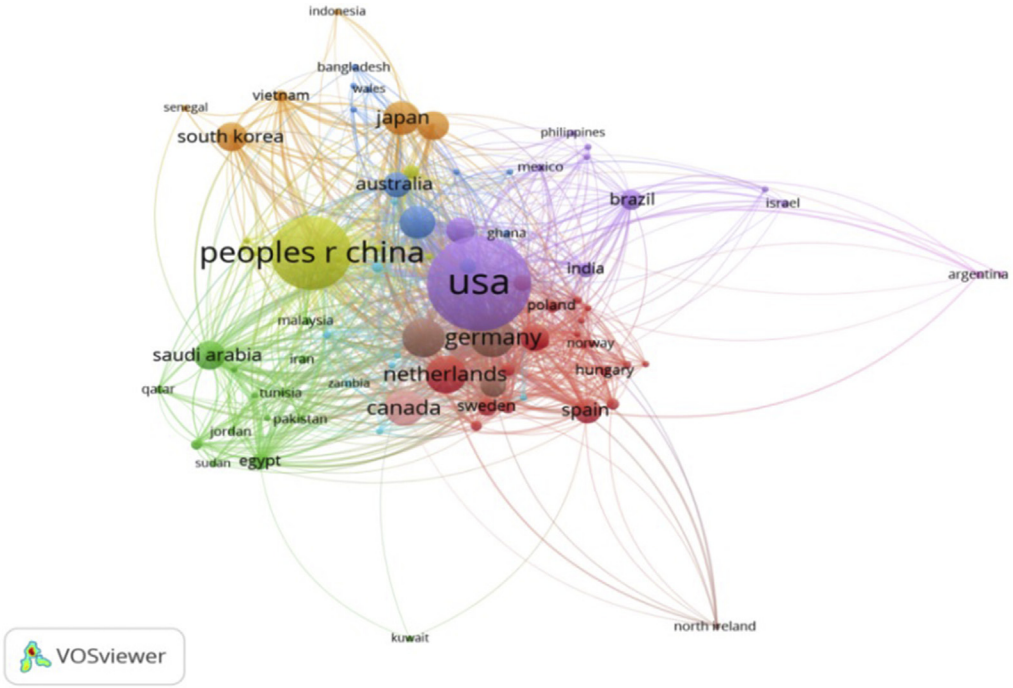

FIGURE 22.5 International collaboration network of coronavirus research.

research organizations in the world based on their highest research articles. According to the WoS database the University of Hong Kong contributed the highest number of publications to the field, i.e., 517 publications with 28,869 citations, followed by the Chinese Academy of Sciences with 391 publications with 10,999 citations and NIH, USA, with 312 publications.

Scientific studies perform a vital role in the prevention and control of an epidemic [1,14], which merits to be absolutely mobilized, deployed, and reinforced comprehensively to update our expertise knowledge and the connection among disease, humanity, and history [10,11,17,18,22–31,37]. In addition, scientific and technologic methodology and tactics need to be the pinnacle precedence in our steady fight against viruses and in getting us completely organized for prevention and control of an epidemic [2,38]. Many scientific research had been performed for CoV prevention and management, which lay the solid foundation for virus identification, vaccine improvement, formulation of prevention and control measures, and R&D of specific drugs [1,14,39]. In this regard, this chapter summarizes the scientific research publications after the epidemic outbreak and aims to provide reference and thinking for the path of medical studies on CoV in the future.

Table 22.9 Top 25 funding agencies in the field of coronavirus research.

Funding agencies	Publications	% of 12,726
United States Department of Health and Human Services	2192	17.38
INIH USA	2146	17.016
NIH National Institute of Allergy Infectious Diseases (NIAID)	1082	8.579
National Natural Science Foundation of China	606	4.805
NIH National Institute of Neurological Disorders Stroke (NINDS)	276	2.188
Ministry of Education Culture Sports Science and Technology Japan MEXT	161	1.277
European Union	156	1.237
NIH National Institute of General Medical Sciences (NIGMS)	156	1.237
German Research Foundation DFG	128	1.015
NIH National Cancer Institute (NCI)	116	0.92
United States Public Health Service	114	0.904
National Basic Research Program of China	112	0.888
National Key Research and Development Program of China	99	0.785
Medical Research Council, UK (MRC)	94	0.745
Wellcome Trust	94	0.745
NIH National Center for Research Resources (NCRR)	86	0.682
Japan Society for the Promotion of Science	83	0.658
European Commission Joint Research Centre	81	0.642
Biotechnology and Biological Sciences Research Council (BBSRC)	80	0.634
Netherlands Organization for Scientific Research NWO	75	0.595
National Science Council of Taiwan	72	0.571
National Council for Scientific and Technological Development CNPQ	66	0.523
Canadian Institutes of Health Research (CIHR)	64	0.507
Ministry of Science and Technology China	64	0.507
University of Hong Kong	64	0.507

NIH, National Institutes of Health.

5. Conclusion

Virology, epidemiology, medical features, laboratory examination, radiography, prognosis, and treatment are the research hotspots of CoV outbreak; these studies' findings play a vital role in the prevention and control of the epidemic spreading all around the world. With research on CoV nevertheless booming, new vaccine and effective medicinal drugs for CoV infection may be anticipated in the near future.

The results showed there is a direct relationship between the CoV outbreaks and the number of scientific publications in this area in the world. The quality of the researchers' productions in this area can be deliberated by scientific methods, and researchers' self-citation has affected their h-index. For healthcare researchers, policymakers, and planners, it is necessary to be aware of the results of scientific studies of strategic and vital research areas, such as CoV, to identify more appropriate therapeutic goals, make better decisions, and provide more effective solutions in the shortest time.

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