Mapping the Research output on Coronavirus: A Scientometric Study

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Abstract

This study presents the global level perspective of Coronavirus research output during the period of 1989 to March 2020 and these analyses included year wise research growth, global publication share and patterns of research communication channels and the most productive journals. Data was extracted from the Web of Science citation database using the search string of "Coronavirus" OR "Covid 19" and limited to Open Access Publications during 1989 to 2020, a total of 7381 publications were retrieved. The highest numbers of publications (561) were published in 2019, which have received 848 citations. Thus this article can be concluded by collaborative author's productivity dominates compared to the single author's contribution. On the basis of literature analysis around the world, it is found that the 7381 publications came from 127 countries. United States (USA) is the most productive country with 2801 publications (37.9% and received 107738 Citations. India (80) has to improve in the field of Coronavirus research in future. The research articles published in peer-reviewed journals of Open Access will create a global impact on the Country, Institutions with subdivision and scientists. These contributions will help the research community to get required information for the research and encourage the researcher in the field of Coronavirus.

Keywords: Scientometric Mapping, Coronavirus, Citations,

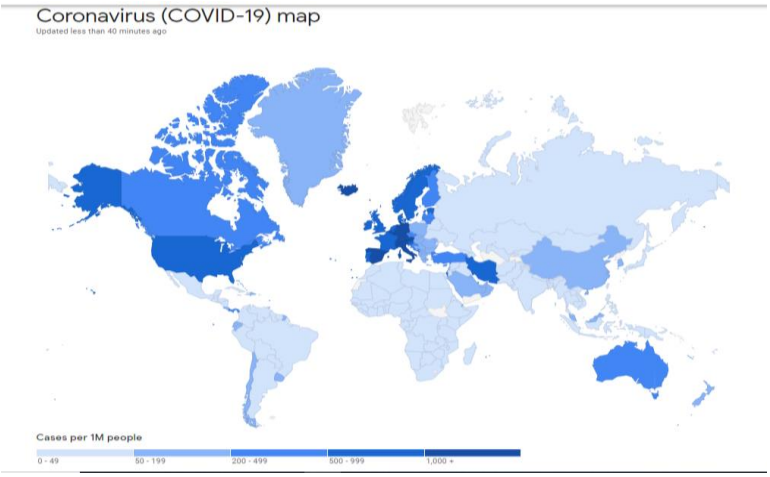
1.0 Introduction

Scientometric approaches is measuring and mapping research activities and outputs, used to (i) track the temporal and spatial development of research fields and topics, (ii) assess the productivity and impact of researchers and research institutions, as well as (iii) study patterns in gender balance in academia, interdisciplinary, and peer review processes. Scientometrics is "the study of the measurement of scientific and technological progress" (Garfield, 1979b). Its origin is in the quantitative study of science policy research, or the science of science, which focuses on a wide variety of quantitative measurements, or indicators, of science at large. They can also be used to measure research collaborations, to map scientific networks and to monitor the evolution of scientific fields. Scientometric indicators give policy-makers objective.

About Coronavirus

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus. Most people infected with the COVID-19 virus will experience mild to moderate

respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness. The best way to prevent and slow down transmission is be well informed about the COVID-19 virus, the disease it causes and how it spreads. Protect yourself and others from infection by washing your hands or using an alcohol based rub frequently and not touching your face. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it's important that you also practice respiratory etiquette (for example, by coughing into a flexed elbow). At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments. 1015403 confirmed by Coronavirus and deaths is 53030 people (WHO 2020).



2.0 Related literature

Bhardwaj, R. K. (2014). Dengue is a disease primarily characterized by headache, eye pain, skin rash, debilitating muscle, and sudden high fever. Presently, no vaccine is available to counter this disease. The best anti-dote is intrusion strategies to limit the spread of virus. This paper is an attempt to make a scientometric assessment of research on dengue during 2001–12. The data of this study is obtained from Scopus (http://www.scopus.com) multidisciplinary database, and analyzed from different angles. The study reveals that there were 9618 publications within the period under study. During the period 2001–12 annual growth rate was 13.4 percent, compared to 14.31 percent in the period 2001–2006, and 12.48 percent in 2007–2012. USA is found to be the leading country on dengue research. USA has contributed 24.88 percent of world publications. Mahidol University, Thailand, is the most productive institution which has con contributed the highest number of publications (353 papers; 6502 citations; h-

index value 40). Guzmán, María Guadalupe from Instituto de Medicina Tropical Pedro Kouri, was found to be the most productive author in the field of dengue research.

Gupta, B. M., Bala, A., KK, M. A., & Gupta, R. (2014). Analyses were done on the Indian publication outputs on liver disorder research during 2003-2012, on several parameters, including contribution and citation impact of the most productive countries, India's overall contribution, its growth pattern, citation impact, the share of international collaboration, identification of the significant participating countries in India's international collaboration, contribution and impact of different types of liver disorders, productivity and impact of leading Indian institutions and authors, and pattern of communication of Indian output in most productive journals. **Materials and Methods**: The Scopus Citation Database has been used to retrieve the data for 10 years (2003-2012) by searching with the keyword 'liver,' in the combined Title, Abstract, and Keywords field. **Results:** The Indian publication's output in the liver disorder research consisted of 2380 articles during 2003-2012, which increased from 143 articles in 2003 to 378 articles in 2012, witnessing an annual average growth rate of 11.92%. The average citation impact per article registered by the Indian publications for liver disorder research was 4.68 during 2003-2012, which decreased from 6.43 during 2003-2007 to 3.71 during 2008-2012. The international collaborative share of India in the overall liver disorder research was 15.34% during 2003-2012, which increased from 12.65% during 2003-2007 to 16.84% during 2008-2012. **Conclusions:** Keeping in view the severity of liver disorders in India, there is a need to increase the investment in Research and Development (R and D) to bring about improvements in supportive care and a need to set up a Hepatitis Registry. Efforts must be made to develop state- and government-supported prevention and control strategies, including conducting mass awareness programs, formulation of universal guidelines for immunization, promotion of partnerships, development of an evidence-based policy, and development of programs for prevention of transmission, along with better financial and social support initiatives.

3.0 Structure of RESEARCH DESIGN

The research design is analytical that adopts detailed analysis of secondary data using a range of bibliometric and scientometric tools, techniques and formula along with standard statistical techniques.

3.1 OBJECTIVES OF THE STUDY

According to the World Health Organization, COVID-19 is the infectious disease caused by the most recently discovered coronavirus. This new virus and disease were unknown before the outbreak began in Wuhan, China, in December 2019. In view of this research activities are being carried out around the world to cope with the issues related to this Virus. A scientometric study in this area will help the scientists to understand the progress in research and development. In particular, the study was confined to the following:

- To examine the growth of literature on Coronavirus during the period 1989-2020;
- To identify the country-wise research contribution in Publications and Citations;
- To identify the worldwide Coronavirus research in context of subject areas;
- To identify the highly productive institutions and Citations in Coronavirus research;
- To identify the most productive authors with Citations;
- To identify the most productive journals with Impact Factor;
- To Identification of core journals in the field of Coronavirus and the application of Bradford's law as an indicator of the dispersion of scientific literature,
- To identify the Highly Cited Papers and Cited References in Coronavirus Research;
- To identify the Chronological evolution of number of Papers in the field of Coronavirus;
- To find the Authorship pattern and Most productive authors and Highly Cited authors;
- To find out the Bibliographical form wise distribution of Publications.

3.2 MATERIAL AND METHODS

The data for this study has been obtained from Web of Science multidisciplinary database and It was originally produced by the Institute for Scientific Information and is currently maintained by Clarivate Analytics. Web of Science is a multidisciplinary bibliographic database that provides information from approximately 21294 Journals and is used to map world wide science and technology data including medical Sciences. With the aim of covering all the available citations on the subject, the above mentioned database was searched using the following term: 'Coronavirus' and 'COVID-19' with topic field. Only Open Access

Publications were taken to the study. Having applied the above method, a total of 7381 records were collected during 1989- 2020 (March) and data were tabulated using Histcite and Biblioshiny. The coded variables were as follows: year of publication, number of authors contributing to the articles and country/institute to which they belong, the names of journal in which articles were published, the subject areas covered by these journals, Highly Cited Papers, Cited References, Bibliographical forms and language of the article.

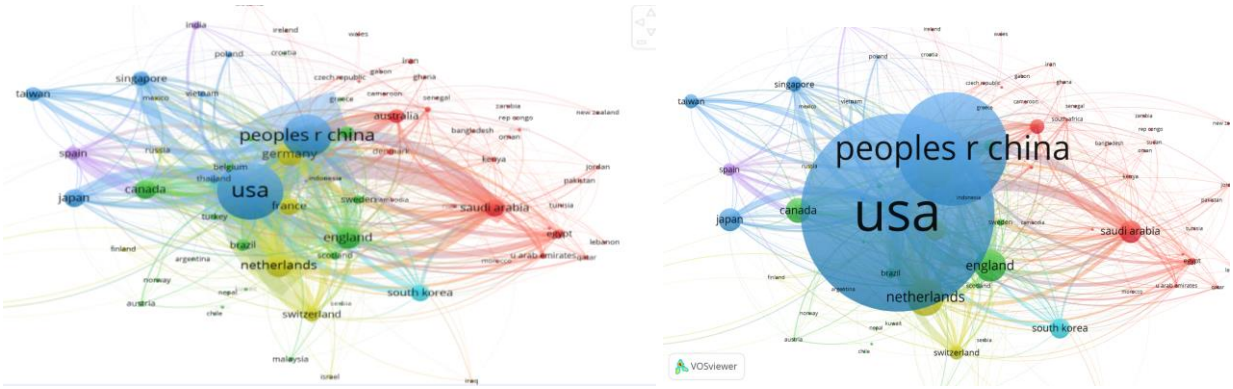
Description	**Results**
Documents	7381
Sources (Journals, Books, etc.)	958
Keywords Plus (ID)	8964
Author's Keywords (DE)	6808
Period	1989 - 2020
Average citations per documents	31.08
Authors	24076
Author Appearances	52070
Authors of single-authored documents	274
Authors of multi-authored documents	23802
Single-authored documents	360
Documents per Author	0.307
Authors per Document	3.26
Co-Authors per Documents	7.05
Collaboration Index	3.39

4.1 DATA ANALYSIS AND INTERPRETATIONS

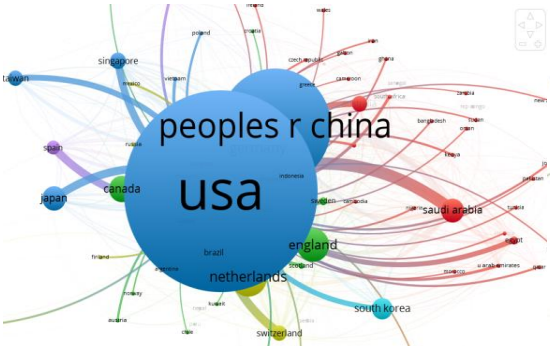
Geographical wise distribution of Publications and Citations

On the basis of literature analysis around the world, it is found that the 7381 publications came from 127 countries. Table 1 illustrates that United States (USA) is the most productive country with 2801 publications (37.9% and received 107738 Citations and invented the medicine to prevent coronavirus in the month of march 2020. The second highest publications output shared by China 1598 publications; 21.7 % and received 43600 Citations followed by Netherlands with 529 publications; 7.2 %, which have accounted 31827 Citations, UK with 519 publications; 7.0 %, and 22995 Citations, Germany 500 publications6.8%, and 24691citations. Besides this, Italy has a share of 161 Publications 2.2 %, and 3498 Citations with 17th position according to publications and maximum number of people affected by Coronavirus during the period of December to March of 2020 and India with 80

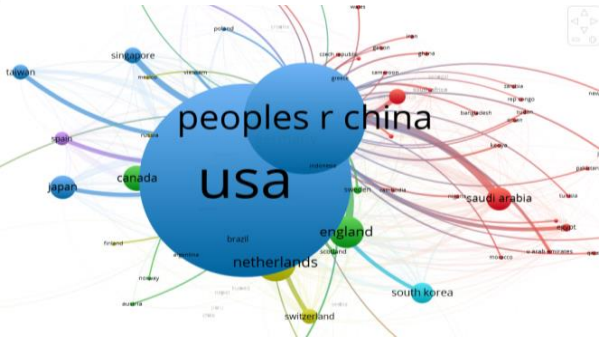
publications; 1.1 % have recorded 899 citations and concentrate in the area of research in coronavirus.



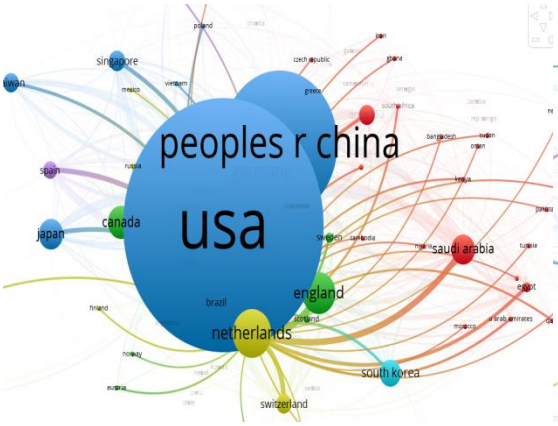
Country wise distribution of Citations during 1989-2020



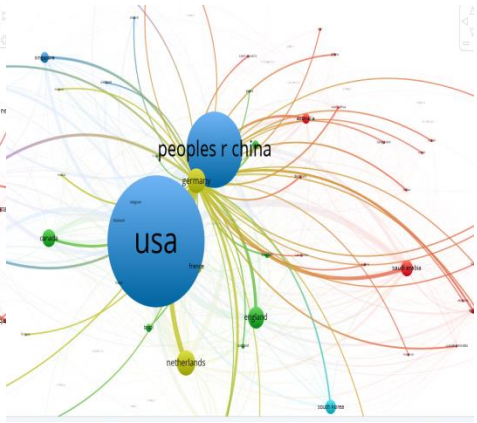
Citation of USA



Citation of People R China



Citation of Netherland



Citation of People Germany

Table 1 shows Geographical wise distribution of Publications and Citations

#	Country	Publication	%	TLCS	TGCS
1	USA	2801	37.9	36841	107738
2	Peoples R China	1598	21.7	16957	43600
3	Netherlands	529	7.2	11471	31827
4	UK	519	7.0	6034	22995
5	Germany	500	6.8	9303	24691

6	Canada	374	5.1	4175	14368
7	Japan	339	4.6	2529	7504
8	Saudi Arabia	324	4.4	4774	9891
9	France	297	4.0	3977	10208
10	South Korea	289	3.9	1079	3553
11	Australia	211	2.9	1809	7361
12	Singapore	207	2.8	2765	7841
13	Taiwan	203	2.8	1933	5697
14	Switzerland	191	2.6	2221	6978
15	Spain	185	2.5	2365	6228
16	Unknown	167	2.3	799	2717
17	Italy	161	2.2	1012	3498
18	Brazil	151	2.0	274	1341
19	Egypt	101	1.4	840	2339
20	Sweden	97	1.3	679	3788
21	Belgium	82	1.1	431	2277
22	India	80	1.1	195	899
23	Thailand	64	0.9	532	1366
24	Denmark	50	0.7	378	1818
25	U Arab Emirates	44	0.6	439	1025

On the basis of literature analysis globally, it is found that the 229596 for 7381 publications and average citation per paper is 21.11 came from 127 countries. Table 2 illustrates that United States (USA) is the highest number of citation of the country with 107738 Citations for 2801 publications and ACPP is 58.46. The second highest number of Citations shared by China 43600 Citations for 1598 publications and the ACPP is 27.28 followed by Netherlands which have accounted 31827 Citations for 529 publications and ACPP is 60.16, UK with 22995 Citations for 519 publications and ACPP is 44.31, Germany 500 24691citations for 500 publications and ACPP is 49.38. Besides this, Italy with 3498 Citations and share of 161 Publications with 17th position according to Citations and ACPP is 21.73, India with 899 citations for 80 publications and ACPP is 11.24 recorded and concentrate in the area of research in coronavirus. The study found that 29 countries are recorded 1000 and above citations and 36 countries with 500 above Citations.

Institution wise distribution of Publications (4779)

Among the highly productive institutions, top 12 most productive institutions contributed on coronavirus research have published more than 2000 publications out 7380 and received 92857 citations (Each 100 Publications) and 60 Institutions are recorded 5220 publications with minimum of 50 each and received 208890 Citations. Table 3 depicts below shows that highest

numbers of publications are contributed by University of Hong Kong from China with 374 publications and recorded 18554 Citations. Second highest productive Institution is by Chinese Academy of Science with 217 Publicaitons and Received 6437 Citations followed by University of Utrecht from Netherland with 199 publications and received 9735 Citations. 4779 Institutions recorded 7381 publications and received 229596.

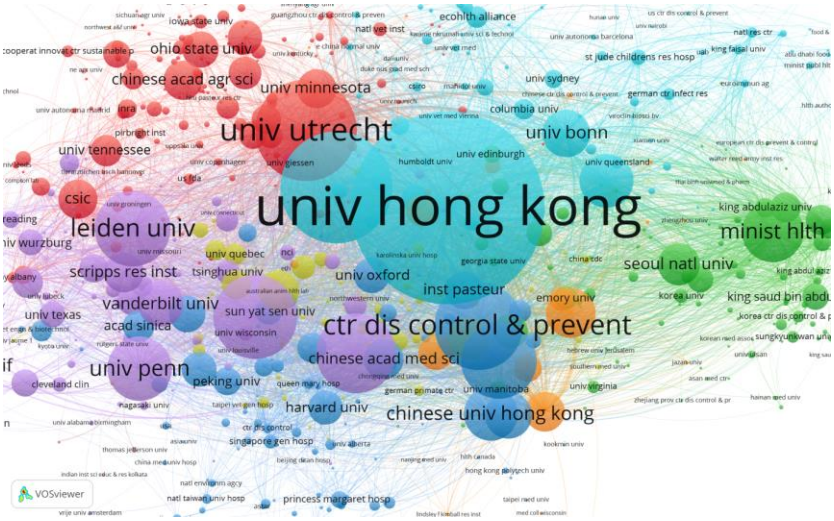


Figure shows that Institution wise distribution of Citations

Among the country wise collaboration of Coronavirus research covered by the study tops United States of America with highest number of publications (China 359, UK 133, Saudi Arabia 127, Germany 125, Canada 108, Netherland 96, Australia 70, Switzerland 64, France 63, Japan 51, Singapore 39, Italy 28, India 20 and so on) followed by China (UK 70, Germany 57, Australia 49, France 23, Singapore 42, Canada 32, Netherland 26 Publications), Germany (Netherland 96, Switzerland 64, Spain 30, Italy 19 Publications).

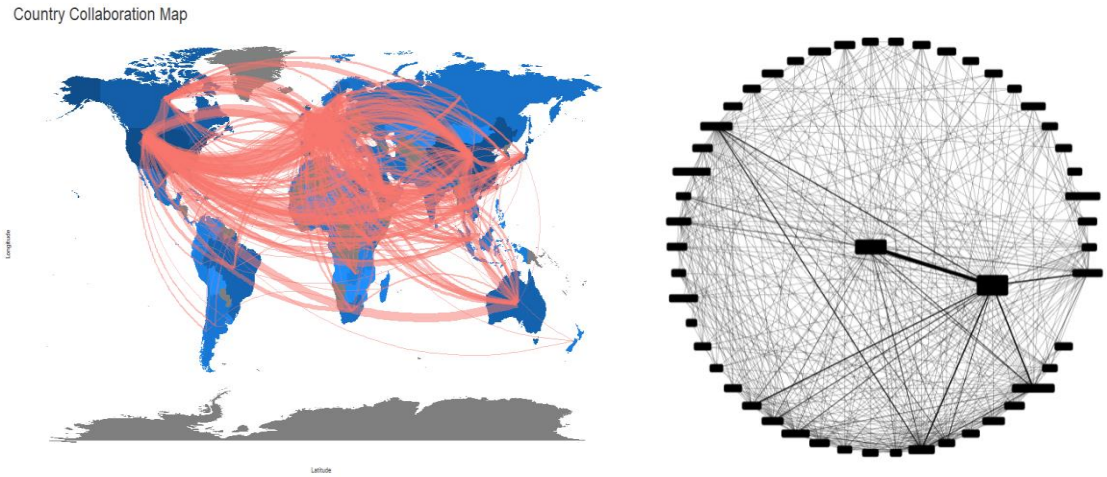


Figure shows that Country wise collaboration Network

Institution wise distribution of Publications and Citations

Among the top 16 have registered more than 2000 citations and 129 Institutions recorded 1000 above Citations. Highest number of Citations is registered by University of Hong Kong from China with 18554 (5.1%) and ACPP is 49.61 followed by University of Utrech with 9735 Citations for 199 Publications and ACCP is 48.92, Leiden University with 9515 and ACPP is 64.29, Centre for Disease Control and Prevention with 170 8945 Citations and ACPP is 52.61, university of N Carolina with 7554 Citations and ACPP is 46.34.

Table 2 shows that Institution wise distribution of Publications and Citations

#	Institution	Publications	%	TLCS	TGCS
1	University Hong Kong - China	374	5.1	8119	18554
2	Chinese Acad Sci - China	217	2.9	2584	6437
3	University Utrecht - Netherland	199	2.7	4079	9735
4	Ctr Dis Control & Prevent	170	2.3	2992	8945
5	University N Carolina	163	2.2	3453	7554
6	University Iowa	154	2.1	2382	5238
7	Leiden University	148	2.0	2936	9515
8	NIAID	146	2.0	2201	7531
9	University Penn	125	1.7	2181	5132
10	Minist Health	120	1.6	2418	4530
11	Erasmus MC	105	1.4	2480	6905
12	Chinese University Hong Kong	104	1.4	955	2781
13	Fudan University	96	1.3	1116	2387
14	University So California	95	1.3	1889	5471
15	University Bonn	93	1.3	2431	5682
16	University Toronto	92	1.2	1230	3698
17	Vanderbilt University	89	1.2	1832	4498
18	Seoul Natl University	82	1.1	385	1233
19	University Washington	81	1.1	742	3256
20	Natl Inst Infect Dis	80	1.1	783	1967
21	University Minnesota	78	1.1	940	2898
22	Chinese Academy Med Science	77	1.0	822	2340
23	New York Blood Ctr	77	1.0	1193	2441
24	Scripps Res Inst	77	1.0	916	3013
25	Chinese Acad Agr Science	76	1.0	369	1521
26	CSIC	76	1.0	1357	3114
27	Inst Pasteur	73	1.0	1650	3488
28	Ohio State University	73	1.0	735	2414
29	Natl Taiwan University	71	1.0	516	1514
30	University Oxford	70	0.9	591	2055

Bibliographical form wise distribution of Publications

A total 6022 publications (81.6%) are articles published in Open Access Journals. Reviews are 540 (7.3%), followed by Editorial Material with 285 (3.9%), letters 174 (2.4),

Proceedings paper with 72 (1.0%) and remaining less than one percent of Publications are published different forms. The study found that coronavirus publications are shared in 17 forms.

Table 3 shows Bibliographical form wise distribution of Publications

#	Document Type	Publications	%	TLCS	TGCS
1	Article	6022	81.6	68913	200206
2	Review	540	7.3	4726	19905
3	Editorial Material	285	3.9	677	2325
4	Letter	174	2.4	1109	2092
5	Article; Proceedings Paper	72	1.0	547	2064
6	News Item	56	0.8	44	90
7	Meeting Abstract	54	0.7	5	15
8	Note	53	0.7	668	1731
9	Correction	40	0.5	32	98
10	Article; Early Access	38	0.5	0	58
11	Editorial Material; Early Access	18	0.2	0	4
12	Review; Early Access	11	0.1	0	3
13	Review; Book Chapter	7	0.1	57	867
14	Letter; Early Access	6	0.1	0	0
15	Article; Book Chapter	2	0.0	20	137
16	Reprint	2	0.0	1	1
17	Article; Data Paper	1	0.0	0	0

Source Title wise distribution of Publications and Citations

In the study, highly productive open access journals of Coronavirus research papers were identified, and it was found that these journals collectively contributed immensely. A total 7381 publications in Coronavirus research were published in 958 journals. Table 6 indicated below shows the impact of the most productive journals. Journal of Virology is the highly productive journal with 1120 (15.2) publications and recorded 54882 Citations (17333 Cited references), followed by Virology with 279 (3.8%) publications and received 7917 Citations (4576 Cited references, Emerging Infectious Diseases with 246 (3.3%), PLoS ONE with 238 (3.2%) publications, Viruses Basel with 174 (2.4%).

It is found that NEW ENGLAND JOURNAL OF MEDICINE has the highest impact factor (70.67) followed by LANCET (59.10), Nature (43.07), BMJ-BRITISH MEDICAL JOURNAL (27.60), LANCET INFECTIOUS DISEASES (27.51), NUCLEIC ACIDS RESEARCH (11.15). The remaining less than 10 Impact factor journals are listed in the below table.

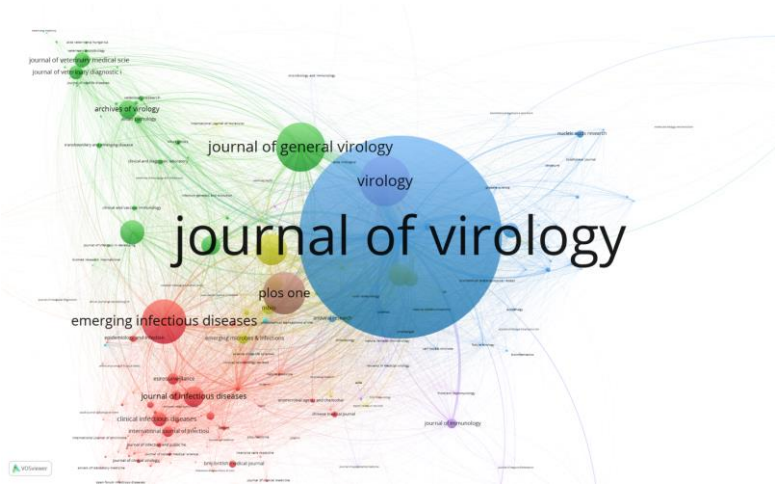


Figure shows journal wise distribution of publications and Citations

Table 4 shows Source title wise distribution of Publications and Citations

#	Journal	IF	Publications	%	TLCS	TGCS	TLCR
1	JOURNAL OF VIROLOGY	4.32	1120	15.2	25423	54882	17333
2	VIROLOGY	2.66	279	3.8	3624	7917	4576
3	JOURNAL OF GENERAL VIROLOGY	2.81	273	3.7	3807	9854	2868
4	EMERGING INFECTIOUS DISEASES	7.42	246	3.3	4602	10097	1554
5	PLOS ONE	2.78	238	3.2	0	4354	2270
6	VIRUSES-BASEL	3.81	174	2.4	599	2012	3552
7	JOURNAL OF CLINICAL MICROBIOLOGY	4.96	135	1.8	1541	6495	725
8	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	9.58	121	1.6	4942	12953	1452
9	JOURNAL OF INFECTIOUS DISEASES	5.19	112	1.5	1557	4081	889
10	VIROLOGY JOURNAL	2.46	107	1.4	0	1989	1289
11	ARCHIVES OF VIROLOGY	2.26	102	1.4	835	1945	755
12	PLOS PATHOGENS	6.16	87	1.2	0	4268	1441
13	JOURNAL OF VETERINARY MEDICAL SCIENCE	1.14	85	1.2	348	998	330
14	JOURNAL OF BIOLOGICAL CHEMISTRY	4.11	84	1.1	1616	4513	1103
15	SCIENTIFIC REPORTS	4.12	82	1.1	0	838	921
16	CLINICAL INFECTIOUS DISEASES	9.12	80	1.1	921	4885	426
17	JOURNAL OF VETERINARY DIAGNOSTIC INVESTIGATION	0.93	78	1.1	406	1636	231
18	MBIO	6.74	66	0.9	0	2717	888
19	EUROSURVEILLANCE	5.98	64	0.9	63	1885	240
20	INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES	3.54	61	0.8	456	1014	283

In the study, highly cited journals of Coronavirus research were identified, and it was found that these journals collectively recorded highest number of citations. A total of 229596 Citations recorded by 958 journals. Journal of Virology with 54882 Global Citation Score (LCS 25423) followed by PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA with 12953 Citations (LCS 4942), EMERGING INFECTIOUS DISEASES with 10097 Citations, JOURNAL OF GENERAL VIROLOGY with

9854 Citations (LCS 3807), NEW ENGLAND JOURNAL OF MEDICINE with 7918 (LCS 4319), VIROLOGY with 7917 Citations (LCS 3624).

Scattering of Journals in Bradford Zone

The table presents the data of cumulative number of Journals, Publications and Citations to assess the distribution of Bradford plot. The distribution of these three zones is given in Table 4. In context of present literature on Coronavirus, it is found that 7 journals constitute first zone have 2465 articles, next zone with 59 journals have 2489 articles and much larger group of 892 journals have 2427 articles. Bradford postulated the division into three equal zones of one third article is each zone. Based on the Bradford law, each zone should follow a linear geometric expression in the form of 1: n : n2 . On analysis of the data, it is found that the literature on neural network does not follow this rule and each zone represents the Bradford expression as 7: 59:892 which does not fit into the expression.

Source wise distribution of H-Index, G-index, M-index

Table presents the H-index, G-index and Index of Journals in Coronavirus. It is found that there were 4 Journals, which have recorded more than 50 H-index. The highest number of indexes of Journal is Journal of Virology with (H-index-104, G-index-142, M-index –3.25) followed by Virology (H-index is 48, G-index is 67, M-index is 1.85), Journal of General Virology ((H-index is 54, G-index is 81, M-index is 1.68), Emerging Infectious Diseases (H-index is 56, G-index is 86, M-index is 2.96), PLOS ONE (H-index is 35, G-index is 50, M-index is 2.33). The study found than G-index of values is higher than H-index value.

Table 5 shows that Source wise distribution of H-Index, G-index, M-index

Source	h_index	g_index	m_index	TC	NP	PY_start
JOURNAL OF VIROLOGY	104	142	3.25	54882	1120	1989
VIROLOGY	48	67	1.85	7917	279	1995
JOURNAL OF GENERAL VIROLOGY	54	81	1.69	9854	273	1989
EMERGING INFECTIOUS DISEASES	56	86	2.95	10097	246	2002
PLOS ONE	35	50	2.33	4354	238	2006
VIRUSES-BASEL	24	37	2	2012	174	2009
JOURNAL OF CLINICAL MICROBIOLOGY	48	75	1.55	6495	135	1990
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	68	113	2.13	12953	121	1989
JOURNAL OF INFECTIOUS DISEASES	36	60	1.24	4081	112	1992
VIROLOGY JOURNAL	25	38	1.47	1989	107	2004

ARCHIVES OF VIROLOGY	24	39		1945	102	
PLOS PATHOGENS	39	64	2.44	4268	87	2005
JOURNAL OF VETERINARY MEDICAL SCIENCE	17	27	0.57	998	85	1991
JOURNAL OF BIOLOGICAL CHEMISTRY	41	66	1.58	4513	84	1995
SCIENTIFIC REPORTS	15	23	1.87	838	82	2013
CLINICAL INFECTIOUS DISEASES	38	69	1.80	4885	80	2000
JOURNAL OF VETERINARY DIAGNOSTIC INVESTIGATION	21	37	0.7	1636	78	1991
MBIO	28	51	2.54	2717	66	2010
EUROSURVEILLANCE	22	43	2.44	1885	64	2012
INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES	18	30	1.06	1014	61	2004
EMERGING MICROBES & INFECTIONS	12	20	1.33	527	59	2012
BMC INFECTIOUS DISEASES	19	30	1.05	1027	57	2003
JOURNAL OF IMMUNOLOGY	32	49	1.52	2533	56	2000
JOURNAL OF MEDICAL VIROLOGY	7	13		219	45	
AVIAN PATHOLOGY	25	42	0.86	1817	42	1992

Highly Cited Papers in Coronavirus

Seven papers have received more than 1000 citations, besides this the citations count has been taken as the number of citations received by each paper since these were published till March 2020. Table presents the pattern of frequently cited papers. It is found that there were 18 papers, which have received more than 500 citations.

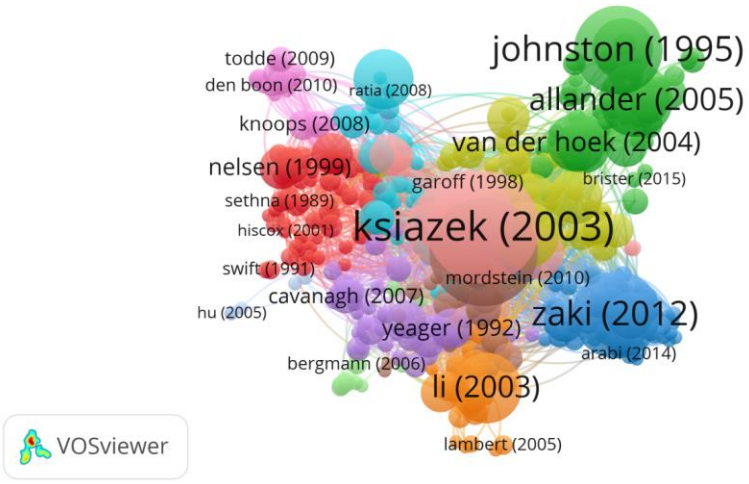


Figure shows that highly cited papers in coronavirus

The most cited paper "A novel coronavirus associated with severe acute respiratory syndrome, NEW ENGLAND JOURNAL OF MEDICINE. 2003 MAY 15; 348 (20): 1953-1966 by Ksiazek TG, Erdman D, Goldsmith CS, Zaki SR, Peret T, et al. " has received 1844 citations followed by Identification of a novel coronavirus in patients with severe acute respiratory

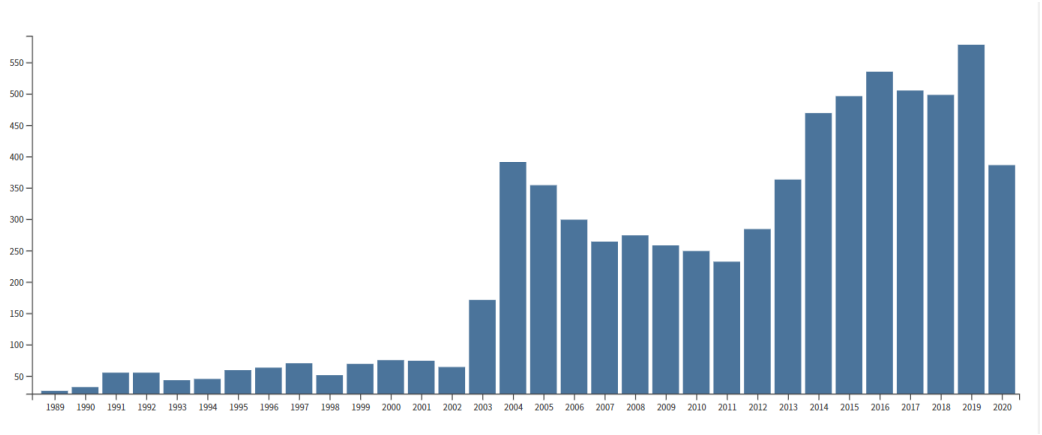
syndrome NEW ENGLAND JOURNAL OF MEDICINE. 2003 MAY 15; 348 (20): 1967-1976 by Drosten C, Gunther S, Preiser W, van der Werf S, Brodt HR, et al. with 1756 Citations.

Table 6 shows that highly cited papers in Coronavirus

#	Date / Author / Journal	LCS	GCS	LCR	CR
1	899 Ksiazek TG, Erdman D, Goldsmith CS, Zaki SR, Peret T, et al. A novel coronavirus associated with severe acute respiratory syndrome, NEW ENGLAND JOURNAL OF MEDICINE. 2003 MAY 15; 348 (20): 1953-1966	862	1844	3	33
2	900 Drosten C, Gunther S, Preiser W, van der Werf S, Brodt HR, et al., Identification of a novel coronavirus in patients with severe acute respiratory syndrome, NEW ENGLAND JOURNAL OF MEDICINE. 2003 MAY 15; 348 (20): 1967-1976	884	1756	0	13
3	905 Rota PA, Oberste MS, Monroe SS, Nix WA, Campagnoli R, et al., Characterization of a novel coronavirus associated with severe acute respiratory syndrome, SCIENCE. 2003 MAY 30; 300 (5624): 1394-1399	732	1491	7	23
4	354 JOHNSTON SL, PATTEMORE PK, SANDERSON G, SMITH S, LAMPE F, et al., COMMUNITY STUDY OF ROLE OF VIRAL-INFECTIONS IN EXACERBATIONS OF ASTHMA IN 9-11 YEAR-OLD CHILDREN BRITISH MEDICAL JOURNAL. 1995 MAY 13; 310 (6989): 1225-1229	15	1334	2	31
5	3592 Zaki AM, van Boheemen S, Bestebroer TM, Osterhaus ADME, Fouchier RAM, Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia, NEW ENGLAND JOURNAL OF MEDICINE. 2012 NOV 8; 367 (19): 1814-1820	918	1308	7	25
6	906 Marra MA, Jones SJM, Astell CR, Holt RA, Brooks-Wilson A, et al., The genome sequence of the SARS-associated coronavirus, SCIENCE. 2003 MAY 30; 300 (5624): 1399-1404	611	1276	9	32
7	1681 Allander T, Tammi MT, Eriksson M, Bjerkner A, Tiveljung-Lindell A, et al., Cloning of a human parvovirus by molecular screening of respiratory tract samples, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA. 2005 SEP 6; 102 (36): 12891-12896	130	1034	2	26
8	1007 Li WH, Moore MJ, Vasilieva N, Sui JH, Wong SK, et al. Angiotensin-converting enzyme 2 is a functional receptor for the SARS coronavirus, NATURE. 2003 NOV 27; 426 (6965): 450-454	483	979	10	30
9	983 Guan Y, Zheng BJ, He YQ, Liu XL, Zhuang ZX, et al. Isolation and characterization of viruses related to the SARS coronavirus from animals in Southern China, SCIENCE. 2003 OCT 10; 302 (5643): 276-278	439	901	2	8
10	276 NICHOLSON KG, KENT J, IRELAND DC RESPIRATORY VIRUSES AND EXACERBATIONS OF ASTHMA IN ADULTS, BRITISH MEDICAL JOURNAL. 1993 OCT 16; 307 (6910): 982-986	14	798	1	25

Year wise distribution of Publications and Citations

A total 7381 publications were made during 1989-2020, which have received 229596 Global Citation Scores. Table 7 shows that the highest numbers of publications (561) were published in 2019, which have received 848 citations. The second highest publications (1295) occurred in the year 2011, followed by 535 publications in the year 2016 followed by (505) in the year 2017 and 325 publications in the year of 2020 (only 3 moths) due to Coronavirus affected by the world during the period and WHO advised to invent the medicine for the virus.



A total 7381 publications, which have recorded 229596 Global Citation Scores and ACCP is 31.11. Table shows that the highest numbers of Citations 20872 recorded in 2004 and ACPP is 53.38 followed by 19266 Citations in 2005 and ACPP 54.42, 18277 Citations in 2003 and the highest ACCP is 106. Upto 2018 the range of citations is 1123 to 20872.

Table 7 shows Year wise distribution of Citations and ACPP

#	Year	Publications	%	TLCS	TGCS	ACPP		Year	N	Mean TCPA	Mean TCPY	Citable Years
1	2004	391	5.3	7370	20872	53.38		1989	26	43.19	1.39	31
2	2005	354	4.8	7046	19266	54.42		1990	32	**68.75**	2.29	30
3	2003	171	2.3	7755	18277	106.88		1991	55	**68.18**	2.35	29
4	2014	469	6.4	5118	14250	30.38		**1992**	**55**	**74.71**	2.67	28
5	2013	363	4.9	5122	14104	38.85		1993	43	65.47	2.42	27
6	2006	299	4.1	4279	13610	45.52		1994	45	55.8	2.15	26
7	2007	264	3.6	3862	12372	46.86		1995	59	65.54	2.62	25
8	2008	274	3.7	2843	10615	38.74		1996	63	39.54	1.65	24
9	2012	284	3.8	2796	10068	35.45		1997	70	50.33	2.19	23
10	2015	496	6.7	3404	9839	19.84		1998	51	52.08	2.37	22
11	2009	258	3.5	2502	9533	36.95		1999	69	50.14	2.39	21
12	2010	249	3.4	2388	8639	34.69		2000	75	61.23	3.06	20
13	2011	232	3.1	1463	7613	32.81		2001	74	49.28	2.59	19
14	2016	535	7.2	2774	7593	14.19		2002	64	55.67	3.09	18
15	2000	75	1.0	1987	4592	61.23		**2003**	**171**	**106.88**	**6.29**	17
16	2017	505	6.8	1090	4547	9.00		2004	391	53.38	3.34	16
17	1992	55	0.7	1326	4109	74.71		2005	354	54.42	3.63	15
18	1995	59	0.8	1114	3867	65.54		2006	299	45.52	3.25	14
19	1991	55	0.7	1137	3750	68.18		2007	264	46.86	3.60	13
20	2001	74	1.0	1367	3647	49.28		2008	274	38.74	3.23	12
21	2002	64	0.9	1381	3563	55.67		2009	258	36.95	3.36	11
22	1997	70	0.9	1224	3523	50.33		2010	249	34.69	3.47	10
23	1999	69	0.9	976	3460	50.14		2011	232	32.81	3.65	9
24	1993	43	0.6	639	2815	65.47		2012	284	35.45	4.43	8
25	1998	51	0.7	962	2656	52.08		2013	363	38.85	**5.55**	7
26	2018	497	6.7	689	2544	5.12		2014	469	30.38	**5.06**	6
27	1994	45	0.6	1014	2511	55.80		2015	496	19.84	3.97	5
28	1996	63	0.9	989	2491	39.54		2016	535	14.19	3.55	4
29	1990	32	0.4	966	2200	68.75		2017	505	9.00	3.00	3
30	1989	26	0.4	551	1123	43.19		2018	497	5.11	2.56	2

31	2019	561	7.6	218	848	1.51		2019	561	1.51	1.51	1
32	2020	325	4.4	447	634	1.95		2020	325	1.95		0
	Total	**7381**	**100.00**	**76799**	**229596**	31.11						

A total 7381 publications, which have recorded the range of Average Citation Per Article is 1.51 to 106.88 and Average Citation Per year 1.39m to 6.29. Table shows that the highest numbers of Average Citations per Article with 106.88 in the year of 2003 followed by 1992 with 74.71, 1190 with 68.75 and 1991 with 68.18. The Highest number of Average Citations Per Year is 2003 with 6.29 followed by 201 with 5.55 and 2014 with 5.06 Citations.

Single Vs Multiple Authors

The table shows the details about the single and multi-authored papers. Out of total of 7381, the maximum number of contributions i.e. 7022 (95.14%) have been contributed by multiple authors and followed by the minimum number of contributions i.e. 359 (4.86%) by single author.

Table 8 shows single Vs Multiple Author Contribution of Publications

Authorship Pattern	Publications	%
Single Author	359	4.86
Multiple Authors	7022	95.14
Total	7381	100.00

The table shows the details about the degree of collaboration. Degree of collaboration is a prominent area of research in bibliometric or Scientometric studies which indicate tends in single and joint authorship during 1989 to March 2020, as shown in above Table. The average degree of collaboration is 0.64. The degree of collaboration is calculated by using the following formula (K. Subramanyam, 1982):

The formula is Where

C= Degree of Collaboration
Nm = Number of multiple authors
Ns = Number of single authors

$$C = \frac{N_m}{N_m + N_s}$$

$$C = \frac{7022}{7022+359} = 0.99$$

In the present study the value of C is C= 0.99

As a result, it was found that the degree of collaboration in the subject of Coronavirus is 0.99, which openly indicates its dominance upon multiple contributions.

Authorship Pattern

The table shows the details about the authorship pattern of publications are published during the period of study in Coronavirus publications.The number of articles contributed by a Multiple Authors were greater than the number of Single authored articles. There was a significant increase in multi-authored papers. The highest number of multi-authored articles included four authors with 793 publications five authors with 790, six authors with 729 Publications and single author contributed only 359 publications. These results make clear that team research is a significant aspect in scientific development. However, some questions should be addressed to understand the nature of these research teams.

Table 9 shows Authorship Pattern of research in Coronavirus

Authorship Pattern	Publications	%
Single Author	359	4.86
Double Authors	658	8.91
Three Authors	778	10.54
Four Authors	793	10.74
Five Authors	790	10.70
Six Authors	729	9.88
Seven Authors	588	7.97
Eight Authors	527	7.14
Nine Authors	435	5.89
Ten and above Authors	1724	23.36
Total	7381	100.00

Indexes of Authors in Coronavirus Research

Table presents the H-index, G-index and Index of Journals. It is found that there were 32 authors, which have recorded more than 30 H-index. The highest number of indexes of author Yuen KY with (H-index-57, G-index-103, M-index –3.17) followed by Chan KH (H-index is 50, G-index is 84, M-index is 2.78), Baric RS ((H-index is 46, G-index is 73, M-index is 1.58). The study found than G-index of values is higher than H-index value of most productive Authors.

Table 10 shows that H-index, G-index and Index of Auhors

Author	h_index	g_index	m_index	TC	NP	PY_start
YUEN KY	57	103	3.166666667	11490	173	2003
CHAN KH	50	84	2.777777778	7245	96	2003
BARIC RS	46	73	1.586206897	5980	133	1992
DROSTEN C	45	96	2.5	9344	114	2003
WOO PCY	45	83	2.647058824	6966	105	2004
LAU SKP	45	80	2.647058824	6503	100	2004

ROTTIER PJM	44	75	1.517241379	5998	102	1992
SNIJDER EJ	44	83	1.419354839	7092	98	1990
ENJUANES L	43	65	1.34375	4952	111	1989
PEIRIS JSM	43	74	2.388888889	5802	74	2003

Ranking of Authors based on Publications

It can be observed from the Table that the author Yuen KY got the first rank with 173 (2.3%) Publications. Perlman S shared second rank with 140 (1.9%) Publications, Baric RS shared the third rank with 133 (1.8%) Publications, Drosten C shared fourth rank with 115 (1.6%) publications, Enjuanes L with 111publications, Woo PCY with 105 Publications, Rottier PJM with 102 publications and Lau SKP with 100 publications on Coronovirus research. The study found that 8 authors recorded 979 (100 and above each) publications and 32 authors recorded 2568 (50 and above each) publications. It also found 30 authors contributed one third of publication in coronavirus.

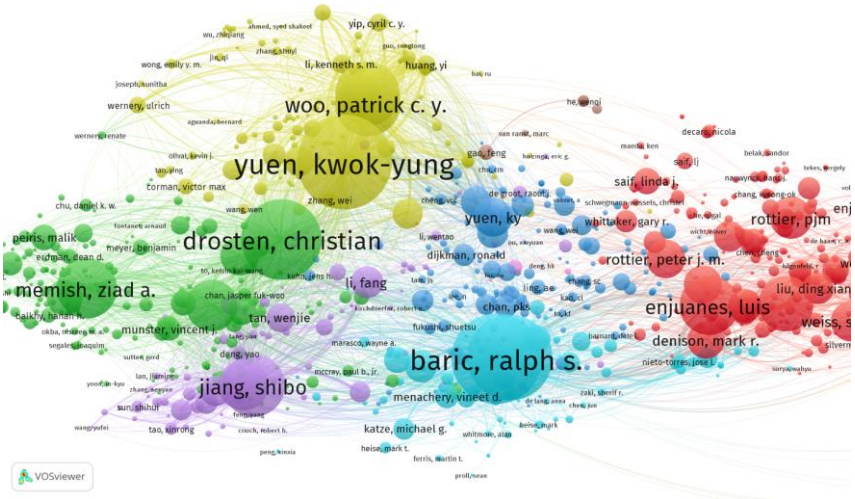


Figure shows that ranking of authors based Citations

Table 11 shows that ranking of authors based on Publications

#	Author	Publications	%	TGCS	TLCR
1	Yuen KY	173	2.3	11490	3288
2	Perlman S	140	1.9	4836	2426
3	Baric RS	133	1.8	5980	2533
4	Drosten C	115	1.6	9344	1430
5	Enjuanes L	111	1.5	4952	2325
6	Woo PCY	105	1.4	6966	2342
7	Rottier PJM	102	1.4	5998	1529
8	Lau SKP	100	1.4	6503	2242
9	Snijder EJ	98	1.3	7092	1821
10	Chan KH	96	1.3	7245	1444

11	Weiss SR	82	1.1	3197	1519
12	Jiang SB	79	1.1	2545	1689
13	Memish ZA	78	1.1	4158	898
14	Peiris JSM	74	1.0	5802	827
15	Haagmans BL	73	1.0	3405	1108
16	Liu DX	69	0.9	1820	1444
17	Denison MR	68	0.9	3526	1330
18	Holmes KV	64	0.9	4412	975
19	Thiel V	64	0.9	4248	1116
20	Du LY	63	0.9	2044	1426

Highly Cited Authors

Table 7 shows that these 84 authors have recorded more than 2000 Citations during 1989-2020. It was identified that 12 authors have received more than 5000 Citations. The highest number of Citations recorded by Yuen KY with 11490 Citations (173 publications) and ACPP is 66.42 followed by Drosten C with 9344 Citations (115 Publications) and ACPP is 8.25, Osterhaus ADME with 7980 Citations (49 publications) and ACPP is 162.89. The study found that most of the authors published less number of publications but recorded highest number of Citations and Average Citations Per Paper. The remaining authors of Citations, Publications and ACPP are displayed in the below table.

Subject wise distribution of Publications in Coronavirus

The world open access research output in Coronavirus research during 1989–2020 has been published in context of 122 subjects according to Web of Science Subject catagories. Table 4 shows that the highest number of publications output coming from Virology 2509 publications (33.97%) followed by Infectious Diseases with 1126 publications (15.24%), Microbilogy with 946 (12.81%), Immunology with 899 (12.17%). The study found that 25 subject categories recorded more than 50 publications and 16 covers more than 100 publications.

Table 12 shows that subject wise distribution of publications on Coronavirus

Subject Areas	**records**	**%**
Virology	2509	33.965
Infectious diseases	1126	15.243
Microbiology	946	12.806
Immunology	899	12.170
Veterinary sciences	630	8.528
Multidisciplinary sciences	534	7.229
Biochemistry molecular biology	484	6.552
Biotechnology applied microbiology	418	5.659
Medicine general internal	329	4.454

Public environmental occupational health	257	3.479
Cell biology	223	3.019
Medicine research experimental	158	2.139
Pharmacology pharmacy	145	1.963
Biophysics	134	1.814
Parasitology	117	1.584
Biochemical research methods	105	1.421

Funding Agencies wise distribution of Publications in Coronavirus Research

Table 5 shows that the UNITED STATES DEPARTMENT OF HEALTH HUMAN SERVICES leads the table with (1740) 23.56% of publications being featured in the funding agency followed by the NATIONAL INSTITUTES OF HEALTH NIH USA with (1706) 23.10% publications, NIH NATIONAL INSTITUTE OF ALLERGY INFECTIOUS DISEASES NIAID with (826) 11.18% of publications, NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA with (415) 5.62 % of Publications, NIH NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS STROKE NINDS with (156) 2.11 % of publications. Less than 2 % of articles are funded by the remaining funding agencies such as NIH NATIONAL INSTITUTE OF GENERAL MEDICAL SCIENCES NIGMS, EUROPEAN UNION EU and other funding agencies are displayed in the below table. The study found that 4042 funding agencies are supported for Coronavirus Research.

Table 13 shows that funding agencies wise distribution of Publications

Funding Agencies	Publications	%
UNITED STATES DEPARTMENT OF HEALTH HUMAN SERVICES	1740	23.555
NATIONAL INSTITUTES OF HEALTH NIH USA	1706	23.095
NIH NATIONAL INSTITUTE OF ALLERGY INFECTIOUS DISEASES NIAID	826	11.182
NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA	415	5.618
NIH NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS STROKE NINDS	156	2.112
NIH NATIONAL INSTITUTE OF GENERAL MEDICAL SCIENCES NIGMS	121	1.638
EUROPEAN UNION EU	118	1.597
MINISTRY OF EDUCATION CULTURE SPORTS SCIENCE AND TECHNOLOGY JAPAN MEXT	109	1.476
GERMAN RESEARCH FOUNDATION DFG	98	1.327
NIH NATIONAL CANCER INSTITUTE NCI	94	1.273

5. 0 FINDINGS AND CONCLUSION

Based on the analysis undertaken the present study reveals the following findings:

Country wise distribution: On the basis of literature analysis around the world, it is found that the 7381 publications came from 127 countries. The study found that 29 countries are recorded 1000 and above citations and 36 countries received 500 above Citations. United States (USA) is the highest number of citation of the country with 107738 Citations for 2801 publications and ACPP is 58.46. The second highest number of Citations shared by China 43600 Citations for 1598 publications and the ACPP is 27.28 followed by Netherlands which have accounted 31827 Citations for 529 publications and ACPP is 60.16, UK with 22995 Citations for 519 publications and ACPP is 44.31

Year wise distribution of Publications and Citations: A total 7381 publications were made during 1989-2020, which have received 229596 Global Citation Scores. The highest numbers of publications (561) were published in 2019, which have received 848 citations and the highest numbers of Citations 20872 recorded in 2004 and ACPP is 53.38. 325 publications in the year of 2020 (upto march) due to Coronavirus affected by world widely during the period and WHO advised to invent the medicine for the virus.

H – Index: Total number of publications is 7381 and 229596 times cited by others scientist, its average citation value is 31.11. The overall years h – index value is 160.

Authorship Pattern: The highest number of articles contributed by a Multiple Authors were greater than the number of Single authored articles. There was a significant increase in multi-authored papers. The highest number of multi-authored articles included four authors with 793 publications five authors with 790, six authors with 729 Publications and single author contributed only 359 publications. These results make clear that team research is a significant aspect in scientific development. However, some questions should be addressed to understand the nature of these research teams.

Ranking of Authors based on Publications and Citations: It can be observed that the author Yuen KY got the first rank with 173 (2.3%) Publications. Perlman S shared second rank with 140 (1.9%) Publications, Baric RS shared the third rank with 133 (1.8%) Publications. The study found that 8 authors recorded 979 (100 and above each) publications and 32 authors recorded 2568 (50 and above each) publications. It also found 30 authors contributed one third of publication in coronavirus. 84 authors have recorded more than 2000 Citations during 1989-2020. It was identified that 12 authors have received more than 5000 Citations. The highest

number of Citations recorded by Yuen KY with 11490 Citations (173 publications) and ACPP is 66.42. The study found that most of the authors published less number of publications but recorded highest number of Citations and Average Citations Per Paper.

Bibliographical form wise distribution of Publications (17): A total 6022 publications (81.6%) are articles published in Open Access Journals. Reviews are 540 (7.3%). The study found that coronavirus publications are shared in 17 forms.

Source Title wise distribution of Publications and Citations (7381): A total 7381 publications in Coronavirus research were published in 958 journals. Journal of Virology is the highly productive journal with 1120 (15.2) publications and recorded 54882 Citations (17333 Cited references). It is also found Highly Impact Factor Journals, NEW ENGLAND JOURNAL OF MEDICINE has the highest impact factor (70.67) Medical Journals are having high Impact compare with other discipline. Bradford Law is not fit for this study. It found the Journal of Virology indexed the paper from 1989-2020 and the highest number of publications published in 2005 with 78, 2007 with 75 and 2004 and 2008 with 65 publications respectively.

Institution wise distribution of Publications, Citations and Collaboration: Among the highly productive institutions, 12 institutions contributed on more than 2000 publications out of 7381 and received 92857 citations (Each 100 Publications) and 60 Institutions are recorded 5220 publications with minimum of 50 each and received 208890 Citations. Table 3 depicts below shows that highest numbers of publications are contributed by University of Hong Kong from China with 374 publications and recorded 18554 Citations.

Subject wise distribution of Publications in Coronavirus: The world open access research output in Coronavirus research during 1989–2020 has been published in context of 122 subjects according to Web of Science Subject catagories. The highest number of publications output coming from Virology 2509 publications (33.97%) . The study found that 25 subject categories recorded more than 50 publications and 16 covers more than 100 publications.

Other Major Findings

- The study found that 7381 publications out of 13430 are published in open Access Journals.
- It found that 52039 authors are contributed in the field of Coronavirus and they referred 314027 publications as references.

- It found that nearly 130000 citations are self Citations of authors.
- It found that 76799 citations are cited within the collection.
- It found that 636 (within three month) published in the year of 2020.
- It found that Open Access Journals are dominating compare with commercial Journals.

The research articles published in peer-reviewed journals of Open Access will create a global impact on the Country, Institutions with subdivision and scientists. These contributions will help the research community to get required information for the research and encourage the researcher in the field of Coronavirus. Perhaps, the institutions as well as authors will get an opportunity to collaborate with regional, national and international research institutions and scientists. Web of Science is one of most important research tools for collecting information for the research in all the subject domains. It provides the required information in various forms like articles, research reports, conference papers, bibliographic information etc. This is very much useful not only for the information manager in finalizing the subscription list of periodicals but also for the research scholars as they tend to know the countries that are leaders in their respective field of research.

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12. **Surulinathi, M, Balasubramani, R, & Kalisdha.** Continent wise Analysis of Green Computing Research: A Scientometric Study. *Journal of Advances in Library and Information Science 2013;2:* 39-44.
13. **Surulinathi, M, Kalisdha, A, & Subbiah, M.** A Productivity Study of Indian Music Using Scientometric Techniques. *Discovery 2013;* 4:42-47.

Important Websites

- WHO**:** https://www.who.int/health-topics/coronavirus#tab=tab_1
- H-index and M-Index: http://mcinerneylab.com/research/h-index-m-index-and-google-citations/
- A guide to the vaccines and drugs that could fight coronavirus: https://www.vox.com/science-and-health/2020/3/4/21154590/coronavirus-vaccine-treatment-covid-19-drug-cure
- Web of Science: http://apps.webofknowledge.com/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=D5IULJthHk17ESEej3j&preferencesSaved=
- Biblioshiny: https://bibliometrix.org/Biblioshiny.html
- Histcite: http://www.histcite.com
- VosViewer: https://www.vosviewer.com/