Research on Corona Virus Prior to the Outbreak of COVID 19: A Bibliometric Study

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Abstract

The outbreak of CIOVID-19 is an unprecedented and most disastrous phenomenon for the human society. In a very short span of time it became irrepressible across the globe, reaching almost every geographical location on the earth. Although, the scientific community was well aware about the existence of the corona virus mutations through previous researches conducted, and literature available regarding other traits of the same virus, it was indeed horrifying to encounter the infection caused by the deadly virus. The present study explores research on corona virus prior to the outbreak of COVID-19 to find out the dynamics of research in terms of different bibliometric parameters of publications. This study analyses different dimensions of research on Corona virus quantitatively and makes an observation of global contributions using Scientometrics indicators and other statistical tools.

Keywords: Bibliometrics; Corona Virus; COVID-19; Research publications.

Introduction

It was the last week of December 2019, and a diminutive news of yet another viral infection flashed on various news portals across the globe. Many scrolled down, some ignored and most of the human population was unaware that an unprecedented pandemic is knocking the doors of each one of us. But with a rapid haste, turning down all the speculations the ailment disembarked. "A novel Corona virus, 2019-nCoV, has been identified as the cause of an outbreak of respiratory illness that originated in Wuhan, China, and which has spread to several other countries around the world"(https://www.biomedcentral.com/collections/coronavirus). It changed the definition of survival and served some 'new normals' for the existing generations. But one thing was triggered as a result of this outburst and that was 'research', on the probable causes, about the derogatory effects and towards the life saving measures. The prior research conducted on the different traits of the same virus and existing body of knowledge would have been a sigh of respite for the medical science fraternity to save the humankind by at least minimising the loss. Reportedly, More than 70000 research articles are published through different publishing houses after the pandemic but, a considerable number of research outcomes are also listed in various databases prior to the outbreak.

Objectives of the Study

- To find out the Year wise Distribution of Publications available prior to COVID-19

outbreak;

- To calculate the Relative Growth Rate and Doubling Time of Publications;
- To discover the Language Distribution and Bibliographic Forms of Publications;
- To list out the Core Journals associated with Publications;
- To locate the Highly Cited Research Papers among Publications;
- To find out the Most Productive Authors of the Publications available prior to COVID-19 outbreak and imply an Authorship Pattern;
- To search for the Most Frequently Appearing Keyword in the Publications;
- To dig out the list of Most Productive Countries contributing to the Publications;
- To find out the list of Most Productive Institutions contributing to the Publications available prior to COVID-19 outbreak.

Methodology Adopted

This study analyses research publications on Corona virus and makes an observation of global contributions in this field of research. The available literature published on Corona virus has been gathered, tabulated and analyzed in a quantitative manner. For the purpose, some Scientometrics indicators and few other statistical tools are used in this piece of work. The publications data has been retrieved from Scopus indexing database using the keyword "Corona virus" and selecting a period of ten years from 2010 to 2019. A total of 7754 records of published articles were analysed with MS-Excel on various scintometric parameters. Those are listed as, range, mean and frequency distribution in no particular order.

Tabulation, Analysis and Discussions

Year-wise Distribution of Publications

There is an enormous numerical difference between the amounts of literature published in the Pre COVID-19 and Post COVID-19 time spectrum. But this fact cannot be mistreated that, the former have acted as a supplementary document for the later. Many suggestive research outputs are available since the 19th century on this very issue. In this study though, the growth of publications on Corona Virus over a period of last ten years (2010-2019) indexed in Scopus has been considered for the analysis purpose. The results thus obtained are tabulated in table 1 along with the numbers of research papers published in the respective years

Table 1: Year wise Distribution of Publications.

Year	No. of Publications	%
2010	562	7.24
2011	517	6.66
2012	577	7.44
2013	809	10.43
2014	939	12.10
2015	1004	12.94
2016	917	11.82
2017	830	10.70
2018	807	10.40
2019	792	10.21
Total	**7754**	

From the above table it could be clearly observed that during the period under study, a total of 7754 publications were published globally, with average publications of 775 articles per year. A maximum of 1004(12.94%) numbers of articles are published in the year 2015 followed by 939(12.10%) numbers in 2014. A minimum of 517(6.66%) and 562(7.24%) contributions were made in 2011 and 2010 respectively. As a result it could be understood that the corona virus related literature increased from 562 in the year 2010 to the highest number 1004 in 2015. A sharp increasing trend in number of publications was noticed from 2011 to 2015 and a decreasing trend continued from 2016 to 2019. The following figure (figure 1) represents the tabular data in a graphic layout.
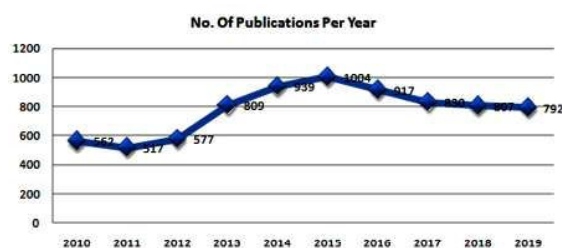

Fig. 1: Year wise growth of Publications on Corona Virus

The Relative Growth Rate and Doubling Time of Publications

"The Relative Growth Rate (RGR) is defined as the increase in number of articles per unit of time". The growth rate of Corona virus literature is determined by "calculating the relative growth rates and doubling time for publications". "The mean Relative Growth Rate (RGR) over a specific period of time Ra= (lnw2−lnw1) / (t2−t1), Where, Ra= Relative Growth Rate, lnw2=Natural log of total publications at time t2, w1=Natural log of total publications at time t1) and t2 - t1 = unit of

difference between the initial time and final time"

Doubling Time is time period that the rate of growth in publication frequency doubles. There is a direct equivalence exist between relative growth

rate and doubling time. The doubling time of publications Dt (P) = 0.693/RGR

The Relative Growth Rate (Ra) of Corona virus literature is positive during 2012 to 2015 and

Table 2: Relative Growth Rate and Doubling Time for Corona virus Publications.

Year	No. of articles (f)	Cumulative (cf)	w1	w2	Ra= (lnw2−lnw1)/ (t2−t1)	Dt=0.693/R(A)
2010	562	562	—	6.331502	—	—
2011	517	1079	6.331502	6.248043	-0.08346	-8.30348
2012	577	1656	6.248043	6.357842	0.109799	6.31151
2013	809	2465	6.357842	6.695799	0.337957	2.050559
2014	939	3404	6.695799	6.844815	0.149017	4.65049
2015	1004	4408	6.844815	6.911747	0.066932	10.35382
2016	917	5325	6.911747	6.821107	-0.09064	-7.64565
2017	830	6155	6.821107	6.721426	-0.09968	-6.95212
2018	807	6962	6.721426	6.693324	-0.0281	-24.6601
2019	792	7754	6.693324	6.674561	-0.01876	-36.9358
Total	7754	—	—	—	0.34306	-61.1308
Average	775.4	—	—	—	0.034306	-6.11308

negative form 2016 to 2019. . The highest and the lowest Ra were observed in 2012 and 2018 respectively. Similarly the doubling time (Dt) was highest in the year 2015 and lowest in 2019.

Language Distribution and Bibliographic Forms of Publications

Languages are carriage of communication. The more common the language of the information is, vaster is the circulation. Therefore, in almost every Scientometric study, the language wise distribution of papers is an essential factor to be considered. In the current study as well, the language factor was taken into account for the analysis purpose. Again the categorisation has been made in two major languages, English and Chinese. All other languages(28) are grouped under the 'others' category as the contributions were very slender. The data thus gathered are tabulated in table 3.

Table 3: Language wise Distribution of Publications.

Language	No. of Publications (%)
English	94.86
Chinese	1.49
Others(28)	4

The above table shows most of the research (94.86%) are published in English language. The next prolific language of publication of Corona virus research is Chinese (1.49%) followed by the rest 4% articles published in 28 other languages. A graphical

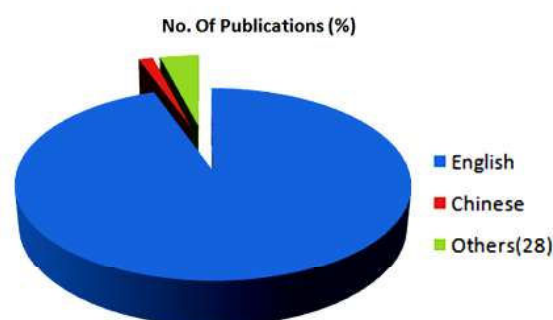representation has been provided below in figure 2 for comprehensible understanding.

Fig. 2: Language wise distribution of Publications.

"The selection of an appropriate outlet often has an influence on the visibility and impact of an article. Consequently, it is interesting to analyse which type of publication format the researchers prefer for conveying their ideas and insights to the research community"(Heiling & Vob, 2014) The records on Corona virus prior to COVID-19, as retrieved from Scopus are again segregated into types of bibliographic forms they belong to. The collected data are decidedly diversified and fitted in 12 different categories such as journal articles, reviews, letters, news, editorials, notes, book chapters, short surveys, conference papers, erratum, book and conference reviews. Table 4 has listed out the outcome in descending order of the numbers of records in a tabular form.

Table 4: Bibliographic Forms of Publications.

Type of Publication	Number of Records	% Age
Article	5704	73.56
Review	977	12.59
Letter	245	3.16
Editorial	238	3.06
Note	237	3.05
Book Chapter	141	1.81
Short Survey	98	1.26
Conference Paper	70	0.90
Erratum	34	0.43
Book	5	0.06
Conference Review	3	0.03
Article in Press	2	0.02
Total	**7754**	

It is visibly clear from the above table, that, most of the publications, i.e. 5704(73.56%) are published as journal articles in different Scopus indexed journals. Following which, with a remarkable difference, review papers are falling at the second place with 977(12.59%) numbers of records. Rest of only 13.78% of the literatures are found in the form of other document types. Other notable preferred formats includes Letters (245 records, 3.16%), Editorials (238 records, 3.06%), and Notes (237 record, 3.05%). Counting from the least, Conference reviews and News feeds (Articles in Press) are the lowest contributors with 3(0.03%) and 2(0.02%) respectively. The above data has been shown below in a diagrammatic format in figure 3.
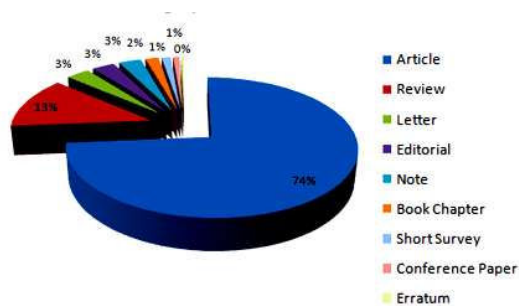

Fig. 3: Bibliographic Forms of Publications.

Core Journals Publishing Corona Virus Literature:

The preeminent indicator to evaluate any journal and measure the productivity of the same is 'Impact Factor' which quantifies the excellence of a journal and replicates its frequency as well as citation matrix. Two of the most significant scientometric measures are the journal itself and the most cited articles for depicting the journal quality. However, Conference Papers, Editorials, and Periodicals are also the highly useful when scholarly communication and current information dissemination. Again, scientists and researchers engaged in scientific research necessitate these publications a lot. Therefore, this study has listed out the top 20 journals which have published corona virus related documents irrespective of their forms. Table 5 can be referred to view the list in a descending order.

Table 5: Top 20 Core Journals in Publishing Corona Virus Literature.

Journal Title	Number of Documents	%age	JIF	SJR Rank
Journal of Virology	376	4.84	4.324	2.404
PLoS ONE	231	2.97	2.74	1.023
Viruses	165	2.12	3.816	1.786
Emerging Infectious Diseases	157	2.02	7.422	2.942
Virus Research	130	1.67	2.736	3.977
Archives of Virology	121	1.56	2.261	2.406
Virology	120	1.54	4.324	1.265
Veterinary Microbiology	116	1.49	3.03	1.138
Journal of General Virology	92	1.18	2.809	1.39
Virology Journal	87	1.12	4.324	2.406
Journal of Virological Methods	85	1.09	1.746	0.73
Antiviral Research	78	1	4.909	1.656
mBio	73	0.94	6.747	3.849
Scientific Reports	72	0.92	4.011	1.414
Vaccine	71	0.91	3.269	1.683
BMC Veterinary Research	70	0.9	1.792	0.848
PLoS Pathogens	64	0.82	6.158	3.909
Journal of Medical Virology	63	0.81	2.021	0.86
Virus Genes	61	0.78	1.776	0.732
Eurosurveillance	58	0.74	5.983	3.01
Other (1562)	5464	70.46	--	--
Grand Total	7754	100	--	--

The Corona virus research documents have been published in 1582 journals during the period 2010–2019. Table reflects that The *Journal of Virology* has highest number of publications (376 records, 4.84%) on Corona virus followed by *PLoS* ONE (231 record, 2.97%), *Viruses* (165 record, 2.12%), *Emerging Infectious Diseases* (157 record, 2.02%), *Virus Research* (130 records, 1.67%), *Archives of Virology*

(121 record, 1.56%), *Virology* (120 record, 1.54%), *Veterinary Microbiology* (116 record, 1.49%), *Journal of General Virology* (92 record, 1.18%), and Virology Journal (87 record, 1.12%). It is revealed that 20% of the research publications have been placed in these top-10 core journals in this field. The following figure (fig-4) might supplement in understanding the records.
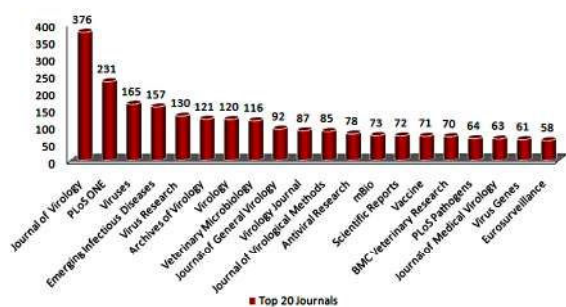

Fig. 4: Top 20 Journals.

Highly Cited Papers

During the study, while arranging the documents according to the numbers of citations they have received, it was found that a paper entitled "*Isolation of a novel corona virus from a man with pneumonia in Saudi Arabia*" published in the *New England Journal of Medicine* in the year 2012 has been cited highest number of times (1343 citations). Following this, the journal *Immunity* published an article entitled "*Immune Signalling*" *by RIG-I-like Receptors* in the year 2011 has 818 citations. Another paper entitled "*Hospital outbreak of Middle East Respiratory Syndrome corona virus*" published in the same journal in 2013 has received 575 numbers of citations.

Most Productive Authors contributing to Corona Virus Literature:

A pivotal share of the obligation has to be given to the contributor of the document as well. As in, the researchers and the authors of such biological narrations accounts on passing the information through generations. Had not they conserve record and share the research outputs to future scientific community, the current pace of the investigation and development would not have been possible. In this segment, the most productive authors are listed as per the numbers of contributions they have made during the stipulated time period. Table 6 presents the most prolific authors in the field of Corona Virus ranked on the frequency of research publications.

Table 6: Most Productive Authors of the Corona Virus Literature.

Author's Name	No. of Contributions	% Age
Drosten C.	105	1.35
Baric R.S.	100	1.28
Memish Z.A.	93	1.19
Zhang Y.	90	1.16
Zhang J.	87	1.12
Li Y.	86	1.1
Perlman S.	83	1.07
Wang Y.	76	0.98
Yuen K.-Y.	74	0.95
Zhao J.	67	0.86
Wang H.	66	0.85
Enjuanes L.	64	0.83
Wang X.	62	0.80
Haagmans B.L.	62	0.80
Jiang S.	62	0.80
Chen Y.	62	0.80
Wang J.	61	0.79
Chen J.	58	0.75
Tan W.	57	0.74
Wang Q.	56	0.72
Other(26071)	48288	-
Total	**49759**	-

The above table lists out the most frequently appearing author's name in the database. Including the entire contributor's name from the list it was found that a total of 49759 authors have contributed to the literature relating to the corona virus research prior to COVID-19 outbreak. Top 20 of them are placed in the table though along with their publication strength. At the first place appears Christian Drosten a German virologist with 105 numbers of publications during that period which counts 1.35% of the total records. Following him, an American, Ralph S Baric gains the second position having 100(1.28%) publications. Dr Ziad A. Memish, who is currently the deputy minister of health for public health in Saudi Arabia and recently designated as Director, WHO Collaborating Centre for Mass Gathering Medicine has published 93(1.19%) numbers of corona virus related documents in the stipulated time span.

Authorship Pattern:

Authorship pattern for the literature in corona virus has also been examined in this piece of work. As, author productivity and authorship pattern both parameters are important for scientometric studies and it is extremely helpful to know the pattern of

research collaborations in any field of research. Many more research works are though carried out by thousands of scholars, scientists and authors in corona virus research, the authorship pattern presented from 7754 resources, from the year 2010-2019 was of prime focus at this point. Most of articles contain the author's name but from 7754 resources, 78 didn't have any author name on them for record, at least in the database. The following table 6 throws light on authorship pattern of corona virus research publications.

Table 7: Authorship Pattern.

Authorship Pattern	No. of Records	% Age
Single Author	697	8.98
Two Authors	897	11.56
Three Authors	768	9.90
Four Authors	742	9.56
Five Authors	733	9.45
Six Authors	725	9.35
Seven Authors	635	8.18
Eight Authors	520	6.70
Nine Authors	452	5.82
Ten Authors	362	4.66
More than Ten Authors	1145	14.76

The total number of articles published is 7754 and they were contributed by 26792 authors. Out of these 9.08% of the articles are single authored. It shows that single author's share is very substantial. And two number of author produce 897(11.6%) publication, which is more than the top ten authorship pattern. Followed by third number of author produce 768(10%) of total outcomes. And from above table, single and two number of author publication was increased and rest of three, four, five, six, seven, eight, nine, and ten author articles was in decreasing trend. And there is an article which was written by 171 Author. And its Degree of collaboration (DC) is 0.90, which showing multiple author dominating over single author. The following figure shows a diagrammatic representation of the tabulated data.
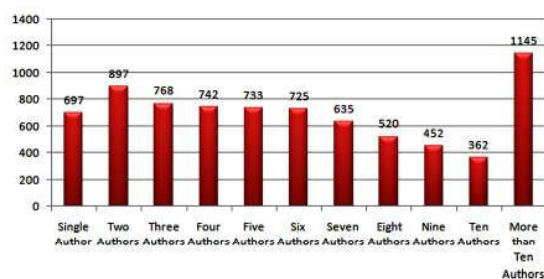

Fig. 5: Authorship Pattern.

Most Frequent Keyword appeared in the Publications

Keywords search has been the most practised phenomena when any database or search engine browsing is concerned. These specific words which direct the user to find the relevant and desired content, are either provided by the creators of the document of by the publication team while recording the metadata. The recent trend of the research field could also be identified from these keywords. Frequency of a keyword in any kind of research may evaluate the awareness and effectiveness of the term (concept). Another aspect is used of unique word also reflect the author's and scientist interest in the research and that word called 'Key Word' are one of the best indicators to understand the thought content of the papers, methodologies used and areas of research. In almost each scientomatric study the 'keywords' are factor of major interest. In this study, a list of top 20 terms which appeared the maximum numbers of time has been prepared and tabulated in table 7.

Table 8: Top 20 Most frequently used 'Keywords.

Row Labels	Record	Percentage
Coronavirus	542	2.79
MERS-CoV	264	1.36
Virus	149	0.76
Porcine epidemic diarrhea virus	145	0.74
SARS	131	0.67
Infectious bronchitis virus	129	0.66
SARS-CoV	128	0.65
MERS	118	0.60
Vaccine	113	0.58
Respiratory viruses	112	0.57
Middle East Respiratory Syndrome Coronavirus	111	0.57
Middle East respiratory syndrome	109	0.56
Spike protein	94	0.48
Influenza	85	0.43
Respiratory virus	78	0.40
Saudi Arabia	74	0.38
Respiratory syncytial virus	73	0.37
PEDV	68	0.35
Pneumonia	65	0.33
Viruses	64	0.32
Total (8397)	19403	

A total of 8417 keywords were found in the retrieval process. From the Table no.7, it is quite evident that, the word "coronavirus" is the most used key term provided by authors to their research output.

It appeared 542(2.79%) times in coronavirus publication retrieved from the year 2010-2019 from Scopus database. Followed by which is "MERS-CoV". It got the second place with 264(1.36%) records. The term 'Virus' has 149(0.76%) records among all of them. The following figure shows a graphical representation of the tabular data.
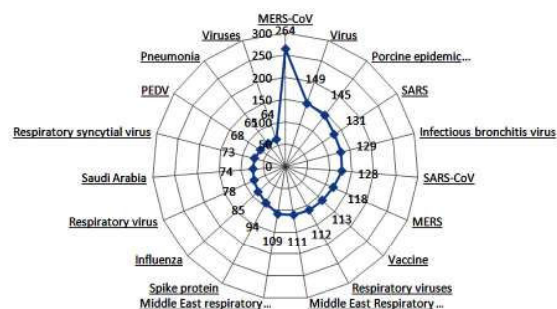

Fig. 6: Top 20 Most frequently used Keywords.

Most Productive Countries:

Most productive country is one of the most popular fields in metric studies, and the analysis is based on the author's affiliation. As the output of all countries is retrieved from Scopus, from the year 2010-2019, a list of affiliated countries has also been made. Considering the below mentioned data in table 8, the output is based on the affiliation of the first author. Again, an all author affiliation record is prepared and it was found to be 47375 numbers of authors as well as respective countries. To be an obvious result, the first author affiliation list have 7754 records and from that data, 349 (4.5%) recorded data have no information about country, which is mention as anonymous data in 3rd rank.

Table 9: Top 20 Most Productive Countries.

Considering only First Author			Considering All Authors		
Country	No. of Records	%	Country	No. of Records	%
United States	1790	23.08	United States	10922	23.05
China	1162	14.98	China	8777	18.52
Anonymous	349	4.5	South Korea	2578	5.44
United Kingdom	305	3.93	Germany	1861	3.92
South Korea	271	3.49	Saudi Arabia	1799	3.79
Germany	268	3.45	Netherlands	1539	3.24
Saudi Arabia	262	3.37	United Kingdom	1524	3.21
Japan	249	3.21	Japan	1518	3.20
Netherlands	238	3.06	France	1468	3.09
Canada	201	2.59	Hong Kong	1211	2.55
France	199	2.56	Brazil	1085	2.29
Korea	175	2.25	Canada	1031	2.17
Hong Kong	169	2.17	Italy	1006	2.12
Taiwan	165	2.12	Taiwan	898	1.89
Brazil	158	2.03	Spain	803	1.69
Italy	138	1.77	Australia	675	1.42
Australia	129	1.66	Switzerland	533	1.12
India	122	1.57	Singapore	489	1.03
Spain	113	1.45	India	472	0.99
Singapore	92	1.18	Turkey	440	0.92
Other(91)	1199	15.46	Other(136)	6746	14.23
Total 111	**7754**	**100**	**Total 156**	**47375**	**100**

From the above table the above data reflect from only first Author affiliation, United states got (1st) rank among the countries contributed the Coronavirus literature with frequency 1790 (23.08%) record of total contribution on the basis of affiliating countries of first Author and again it contribute 10922 (23.05%) record of all author affiliation countries. When consider only first author China (14.98%), followed by United Kingdom (3.93%), South Korea (3.49%), Germany (3.45%), Saudi Arabia (3.37%), Japan (3.21%), Netherlands (3.06%),

Canada (2.59%) etc. those hold rank 2 to 10 whereas 91 other countries jointly account for 15.46% of the first affiliating countries. A similar trend is shown in all author country up to rank 2, after that their big deviation is observed between in both the list. From the above table it is shown that the author or researcher shown interest for published paper in wider page limit, and promulgated pages range is not healthy for a research article. The following figure (figure 7) shows a comparative chart of top 20

most productive countries when only first author's affiliation is considered and top 20 countries when all author's data are considered.
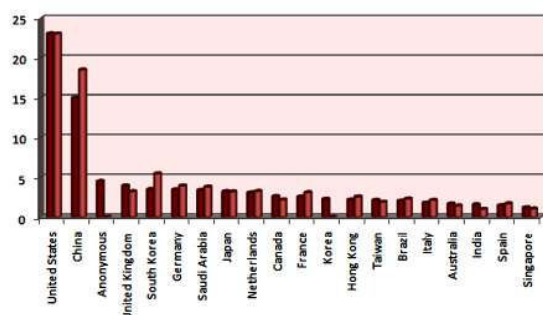

Fig. 7: Top 20 Most Productive Countries.

Table 10: Most Productive Institutions/Organisations.

Only First Author Affiliation (Name of the Institution)	No. in Articles	% Age
The University of Hong Kong, China	120	1.64
University of California, United States	79	1.08
Harbin Veterinary Research Institute, China	69	0.94
National Institutes of Health, United States	65	0.88
Seoul National University, South Korea	63	0.86
Utrecht University, Netherlands	58	0.79
University of Iowa,United States	52	0.71
Huazhong Agricultural University, China	49	0.67
Centers for Disease Control and Prevention, United States	48	0.65
Northeast Agricultural University, Harbin, China	46	0.62
Iowa State University, United States	44	0.60
National Institute for Viral Disease Control and Prevention, China	43	0.58
University of Washington, United States	40	0.54
Nanjing Agricultural University, China	39	0.53
King Saud bin Abdulaziz University for Health Sciences, Saudi Arbia	38	0.52
South China Agricultural University, China	37	0.50
University of Minnesota, United States	37	0.50
Wuhan Institute of Virology, China	36	0.49
Leiden University Medical Center, Netherlands	35	0.47
The Ohio State University, United States	35	0.47
Other(3001)	6272	85.85
Total	**7305**	**100**

of Hong Kong, china got 1st rank with 120(1.64%) records. Followed by University of California from United states got 2nd rank with 79 (1.08%) record, Harbin Veterinary Research Institute, China have 69(0.94%) publications with 3rd rank, National Institutes of Health, United States have 65(0.88%) publications, and Seoul National University, South Korea have 63(0.86%) publications of the total numbers of published document.

Most Productive Institution:/Organisations

An Institution's research metrics depend solely on the associating contributors. Considering it to be a significant indicator of the scientometrics, the affiliation information of the first author alone was taken for institutional affiliation analysis. The Table 9 indicates that the researchers' affiliation institutions' wise research productivity in the field of Coronavirus. The insights may help, for instance, to build fruitful research collaborations and reflect the global distribution of research.

In the above table, the top 20 most productive institutions and organisation which have more than 35 frequencies appeared in first author affiliation were shown. A total no of 7305 institution and organisation were found. Among them University

Conclusions

During the course of the research, many facts are revealed which were not in the glare of publicity for years. Though, there are certain limitations in the current piece of research, like time duration and keyword used, a formative speculation can definitely be drawn from it. Many documents might have not been captured as only one database (Scopus) has been considered for the study.

Variant names of the disease and the viruses could have been left out which primarily includes the research outcome on the same topic. However, such scientometric, bibliometric or review works always contributes to pave the way for further researches on the related disciplines.

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