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Vijay Kumar Bharati

Mahatma Gandhi Kashi Vidyapith, Varanasi UP, India, bharati.bhu@gmail.com

Mahender Pratap Singh

Babasaheb Bhimrao Ambedkar University (A central University), Lucknow, UP, India,
mpsinghdliis@gmail.com

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Global Research Productivity on Coronavirus: A Bibliometric Mapping and Visualization

Vijay Kumar Bharati¹
Prof. M. P. Singh²

Abstract

Coronavirus, a pandemic threat to human beings, has awakened huge concern worldwide, but no bibliometric studies have been conducted on Coronavirus research during 2011-Feb.2020. The aim of this study is to map research productivity on the Coronavirus based on the articles indexed in the Scopus database. The articles related to Coronavirus dated from 2011 to Feb. 2020 were retrieved from the Scopus database. A total of 7558 papers were retrieved for this study which indexed by the Scopus database during 2010-Feb. 2020. The most productive year is recognized 2015 with 1012 (13.38 %) articles while Maximum AGR 40.38 percent was recorded in the year. The USA ranked first with 2373 publications, followed by China with 1378 publications while The Journal of Virology published the highest 330 articles followed by PLoS One with 224 articles. Dusten, C. is ranked topmost productive corresponding author (first position) with 108 articles followed by Memish, Z.A. with 107 articles. Medicine subject identified as the top subject for publishing paper on Coronavirus followed by Immunology and Microbiology. The title Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia received the highest 1346 citations, followed by Immune Signaling by RIG-I-like Receptors with 818 citations.

Keyword: Coronavirus; Virology; Immunology; Epidemic; Bibliometric; Scientometric, COVID-19

1. BACKGROUND:

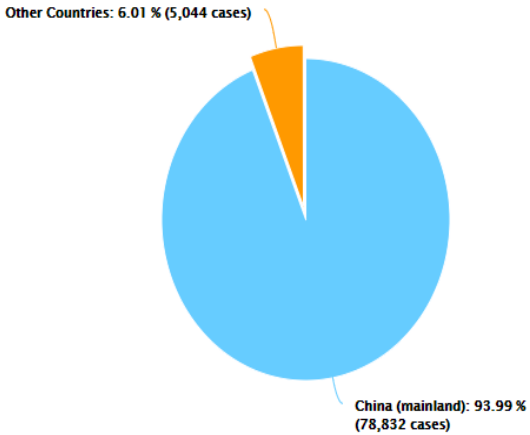
Now a day a novel Coronavirus (COVID-19) has been detected in 60 locations internationally, including in the United States, Iran, and South Korea etc. Wuhan Coronavirus (COVID-19) was first identified in the Chinese city of Wuhan in 2019. There are currently 86,992 confirmed cases and 2,979 deaths from the coronavirus COVID-19 outbreak as of February 28, 2020. The number of deaths and patients affected by the novel coronavirus is increasing day by day. Coronaviruses are a group of viruses that contain a number of subdivisions that cause potentially fatal diseases in mammals and birds, but in humans, they are commonly spread through air droplets of fluid produced by infected individuals. The coronavirus derives its name from the 'crown' of a specific corona or sugar-protein that projects from the envelope surrounding the particle in the 1960s. Encoding the makeup of the virus is the longest genome of any RNA-based virus - a single edge of nucleic acid is approximately 26,000 to 32,000 bases long. There are four known genus in the family, named alpha coronavirus, beta coronavirus, gamma coronavirus and delta coronavirus. Wuhan Coronavirus (COVID-19) was first identified in the Chinese city of Wuhan in 2019. There are various types of

¹Assistant Librarian, Central Library, MGKVP, Varanasi; Ph.D. Scholar, DLIS, BBAU, Lucknow (UP) India ,
Email: bharati.bhu@ gmail .com (Corresponding Author)

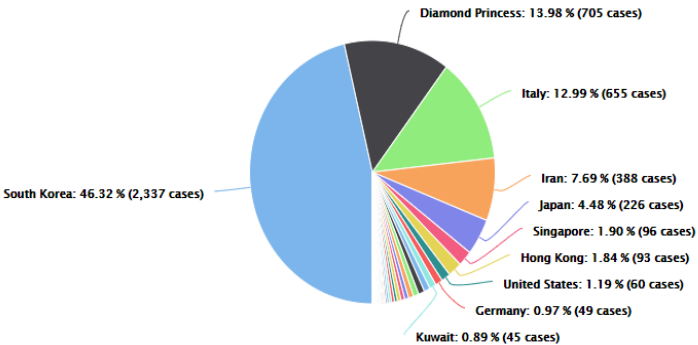
² Professor, Department of Library and Information Science ,Babasaheb Bhimrao Ambedkar Central University,
Lucknow (UP) India, Email: mpsinghdliis@gmail.com

coronavirus which was confirmed time to time. Severe acute respiratory syndrome (SARS-CoV) SARS was first recognized in 2003 as a specific strain of coronavirus. The source of the virus has never been clear, although the first human infection could be detected in the Chinese province of Guangdong in 2002. The virus became an epidemic, causing more than 8,000 infections of influenza-like illness in 26 countries, killing 800. Middle East Respiratory Syndrome (MERS-CoV) MERS was first identified in Saudi Arabia in 2012 among people exhibiting symptoms of diarrhea such as fever, cough, shortness of breath and sometimes gastrointestinal problems. An animal source for the virus has not been officially confirmed, although evidence indicates dromedary camels as a potential reservoir of infection. Its infections can be compared to a bad cold, which can cause upper to upper respiratory problems such as a runny nose and sore throat.

Distribution of cases worldwide



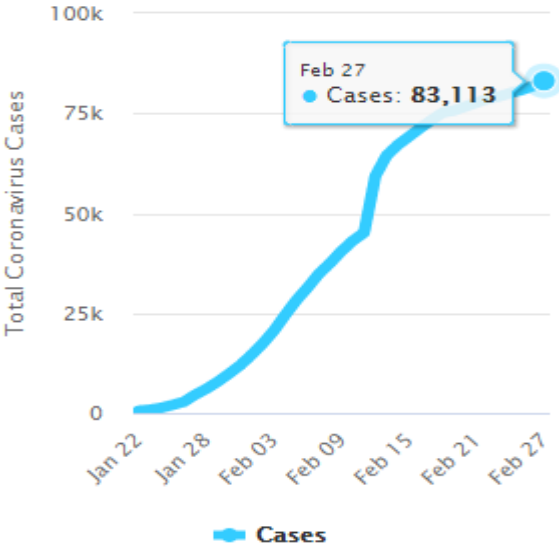
Distribution of cases outside of mainland China



Source: Worldometer - www.worldometers.info

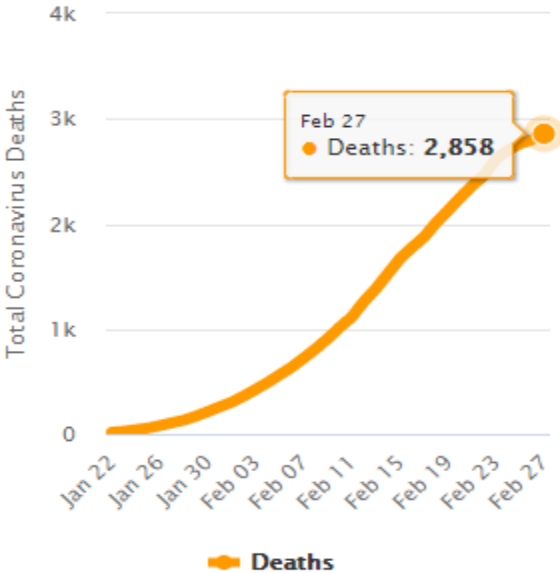
Total Cases

(Linear Scale)



Total Deaths

(Linear Scale)



By the end of February, the novel coronavirus outbreak in China alone has confirmed more than 2728 deaths and 78832 cases on its mainland. South Korea ranks second on the list of infections with 2337 cases, including 13 deaths, while Iran has the highest number of deaths after China. Even today, the condition of 18 percent people in the total active cases remains very serious, while 82 party people are in mild condition. Diseases from this new type of coronavirus were first detected in December. India has so far registered 3 positive cases, all of which are from Kerala. Bibliometrics is a study in which a process is used to evaluate the position and development trend of a particular subject with the help of mathematical, statistical and measurement methods. Bibliometrics are being used to examine various dimensions of research progress in the area of the subject concerned. E. J. Garfield (1979) considers, Scientometrics as a measure of the scientific and technological progress of any subject. Its calculation is based on quantitative measurement of a subject or a variety of indicators.

2. LITERATURE REVIEW:

The literature review is an integral part of any research work, through which we explore the previous research work on that topic and prepare the outline of the research that is going on ahead. **Sweileh (2018)** presented a bibliometric analysis of peer-reviewed literature in transgender health (1900 - 2017). The data were retrieved using the Scopus database on transgender health published from 1900 to 2017. In total, 5772 peer-reviewed documents were obtained. English (5008; 86.8%) was the most frequently encountered language. VOSviewer was used to map frequently encountered author keywords and collaborative countries, while ArcGIS 10.1 was used to map the geographical distribution of the retrieved documents. Professor Gooren, L.J.G. was the most active author in this field with 104 (1.88%) publications. **Al-Jabi (2017)** did a bibliometric analysis of Global research trends in West Nile Virus (WNV) from 1943 to 2016. The aim of the current study is to bibliometric analyse the quantity and quality of publications indexed in Scopus from different countries to reveal the characteristics of global research output regarding WNV. The data was retrieved from the Scopus database and the study focused on identifying WNV publication trends with regard to publication year, publication type, prolific countries, the language of publication, as well as, prolific journals, citations, and collaboration patterns. A total of 4729 publications were considered in this study, which was published between 1943 and 2016. The USA was on the top to publish WNV research with 2304 (48.7%) publications, followed by France with 224 (4.7%) publications. Further, it is found that the Emerging Infectious Diseases is the most productive journal with 227 articles, followed by the Journal of Virology with 162 publications. **Díaz , Cortey, Olvera, & Segales (2016)** evaluated research productivity outcomes on swine diseases. In this study, a database of 137 pig infectious agents was constructed, including its taxonomic division, zoonotic potential, status as an emerging pathogen and whether it was OIE-listed. They used bibliometric indicators to evaluate research productivity outcome on swine diseases. The H-index and the total number of citations were calculated for those pathogens, the location of the affiliation of the first author of each paper included in the H-index core was registered and, for the ten pathogens with the highest H-index, evolution over time was measured. **Zyoud (2016)** presented a bibliometric analysis on Global research trends of Middle East respiratory syndrome coronavirus. The data was retrieved from the Scopus database for MERS-CoV publications published between 2012 and 2015. He ranked year of publication, publication type, patterns of international collaboration, research institutions, journals, impact factor,

h-index, language, and times cited. A total of 883 research publications were published across the world on MERS-CoV. The USA was on the top with 319 articles published over 4 years, followed by KSA (113 articles). The total citations calculated 8,015, with an average of 9.01 citations per each publication. The h-index was 48 for MERS-CoV publications. Further, it is observed that the USA have the highest h-index (32), followed by KSA (26) and Netherland produced the greatest publications with (72.7 %) followed by the UK (71 %). **Rosas, Kagan, Schouten, Slack and Trochin (2011)** sort out a bibliometric analysis of research by the NIH/NIAID HIV/AIDS clinical trials networks. The data is retrieved from the National Institute of Allergy and Infectious Diseases (NIAID) HIV/AIDS extramural clinical trials network available during 2006-2008. They scrutinised beyond citation counts to encompass normative assessments across journals and fields, visualization of co-authorship and evaluate the presence of publications in reviews and combinations. Further, they observed the research output of the networks in terms of the occurrence of papers in the scientific journal order ranked on the basis of journal impact measures, enactment of publications on old-style bibliometric measures, and impact of publications in comparisons with similar publications worldwide, adjusted for journals and fields. They also examined collaboration and interdisciplinary across the inventiveness, through linkage study and showing of co-authorship outlines. **Zheng , Yan, Cui, Guan & Takano (2009)** concluded a bibliometric analysis on John Cunningham Virus. The data was collected from Sci-expanded and PubMed database. They ranked highly-productive authors, highly-cited authors, top ten journals and most productive countries, etc. They further examined the highly-cited articles were subjected to co-citation and chronological analysis with highly-frequent MeSH words for co-occurrence analysis. A Total of 1785 articles were retrieved from Sci-expanded and 1506 from Pubmed on John Cunningham Virus. The USA, Japan and Italy were the largest three productive countries on John Cunningham virus. Temple University published maximum 128 papers and ranked the first, followed by the University of Tokyo. Khalili K and Yogo Y became the core authors due to more than 20 documents produced. Journal of Neurovirology published more than 15 papers and ranked the first. Padgett, B.L. and Berger, J.R. were the first two highly-cited authors. Journal of Virology and Journal of Neurovirology respectively ranked the first two highly-cited journals. **Glover & Bowen (2004)** concluded a bibliometric analysis of research published in Tropical Medicine and International Health from 1996-2003. They reported the bibliometric profile of Tropical Medicine and International Health using the subjects of the articles published and the geographical distribution of the authors. In this paper they also highlighted the most common subject areas of papers published during 1996-2003 and provided a list of the most cited papers. **Macias (2000)** presented a bibliometric analysis on AIDS in Haiti. The data was collected from AIDSLINE database for the period 1980 to 1998 on Haitian AIDS research. He tried to identify the patterns of the growth in AIDS literature, as well as the types of documents published, authorship, institutional affiliations of authors, and subject content. He indicated that most documents were published in periodicals. The United States, Haiti, and Canada were the main productive countries on Haitian AIDS research. Further, he reported that the mostly AIDS papers are focused on epidemiology, complications, and trends issues.

3. STATEMENT OF PROBLEM:

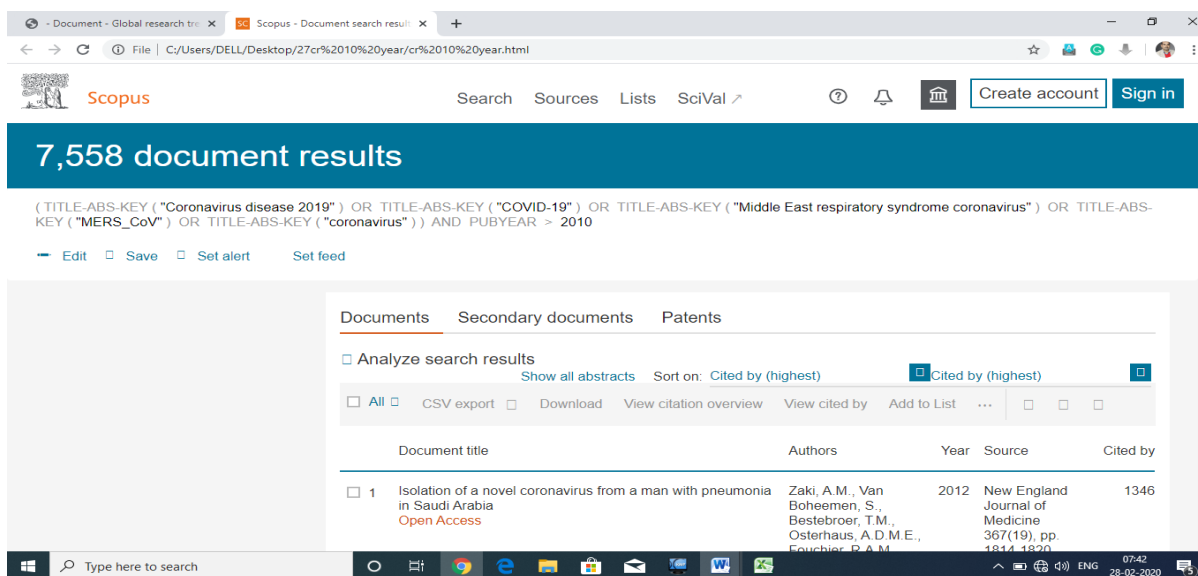
The present research paper is entitled “Global research productivity on Coronavirus: A bibliometric mapping and visualization”. The number of people affected by day-to-day coronaviruses is increasing, so the literature reviewed on the research done on it. After the literature survey on Coronavirus , it is found that there are several studies has been done on the scholarly literature of various viruses but no bibliometric study has been published on Coronavirus with the Scopus database from 2011 –Feb. 2020. Therefore, this topic has been taken for study.

4. OBJECTIVES:

- (i) To examine the year wise growth of the literature on Coronavirus;
- (ii) To find out the annual growth rate and related growth rate & doubling time of the documents;
- (iii) To find out the top ten productive countries published papers on coronavirus.
- (iv) To identify the top ten authors in Coronavirus research;
- (v) To find out the number of publications by source type on Coronavirus ;
- (vi) To identify the most prominent subject area on Coronavirus ;
- (vii) To study the visualization of the most collaborative countries and
- (viii) To show the visualization of the keywords clustering analysis on Coronavirus;
- (ix) To find out the highly cited documents title with citation count.

5. METHODOLOGY:

In this study, data were extracted from the Scopus database developed by Elsevier in the Netherlands. ((TITLE-ABS-KEY("Coronavirus disease 2019") OR TITLE-ABS-KEY("COVID-19") OR TITLE-ABS-KEY("Middle East respiratory syndrome coronavirus") OR TITLE-ABS-KEY("MERS_CoV") OR TITLE-ABS-KEY("coronavirus")) AND PUBYEAR > 2010) are used in one query. Total of 7558 papers were retrieved for this study which indexed by Scopus database during 2010 to Feb 2020. Microsoft Excel is used for graphical representation of the data for document type and funding agencies etc. and VOSviewer science mapping framework (Van Eck & Waltman, 2020) is used for analyzing the research trends; collaboration among countries visualization, author keywords occurrence visualization and author citations.



6. DATA ANALYSIS AND INTERPRETATION:

Total 7558 records have been extracted from the Scopus database published on Coronavirus during 2011- Feb.2020. The received data is interpreted and calculated on the basis of the prescribed objectives with the help of MS –Excel, and VoSViewer.

6.1 : Year-wise ranking with Coronavirus articles during the period from 2011 to Feb. 2020

Standard Competition Ranking	Year	Total	(%)
1 st	2015	1012	13.38
2 nd	2014	946	12.51
3 rd	2016	928	12.27
4 th	2017	839	11.10
5 th	2018	817	10.80
6 th	2019	813	10.75
7 th	2013	810	10.71
8 th	2012	577	7.63
6 th	2011	517	6.84
10 th	Feb.2020	299	3.99

Table 6.1 shows the no. of articles that are published in particular year on Coronavirus. The Most productive year is recognized 2015 with 1012 (13.38 %) articles followed by the year 2014 with 946 (12.51%) publications while the year 2016 counted as 3rd position with 928 (12.27 %) articles. Further, it is also calculated that up to Feb. 2020, 299 (3.99 %) papers have been published.

6.2 Annual Growth Rate of Coronavirus Publication:

The table no 6.2 provides a detail calculation of Annual Growth Rate of Coronavirus publication. The formula used for AGR calculation is given by Kumar and Kaliyaperumal in 2015. The following formula is used for AGR Calculation:

$$\text{AGR} = \frac{W_2 - W_1}{W_1} \times 100$$

In this formula AGR represent Annual Growth Rate, W2 present the end value of the publication and W1 present the first/ initial value of the publication

Year	Initial /First Value of Publication W1	End Value of the Publication W2	AGR
2011	0	517	Not define
2012	517	577	11.60
2013	577	810	40.38
2014	810	946	16.79
2015	946	1012	6.97
2016	1012	928	-8.30
2017	928	839	-9.59
2018	839	817	-2.62
2019	817	813	-0.48
Feb.2020	813	299	Not Calculated

Annual growth rate is calculated by above-mentioned formula. It is found that the maximum AGR 40.38 percent was recorded in the year 2013 followed by 16.79 percent in 2014 during 2011-2020. Further, it is also seen that the minimum (-) 0.48 percent AGR recorded in the year 2019 followed by (-) 02.62 in 2018. The AGR for 2020 is not calculated due to incompleteness of the year.

6.3. Relative Growth Rate(RGR) on the Coronavirus Research and Doubling Time:

Relative growth rate on the Coronavirus research publications are calculated by a certain formula. It shows the relative growth rate on Coronavirus publication during a year. The RGR for all publication has been calculated on the basis of a derived model. This model is developed by Mahapatra. RGR is calculated through the cumulative number of publications in the specified year and the Doubling Time is calculated directly to RGR.

The RGR will be calculated by the following formula:

$$\text{Relative Growth Rate (RGR)} = \frac{W_2 - W_1}{T_2 - T_1}$$

In this formula, RGR represent the relative growth rate, W1 is finding out by Log^e value of initial no. of publication, W2 is finding out by Log^e value of end number of publication, T1 represent the initial year and T2 represents the end year

The Doubling time of the publications: The doubling time of the publication on Coronavirus research is calculated by the following formula:

$$\text{Doubling Time (Dt)} = \frac{0.693}{R}$$

Whereas 0.639 is the constant value in the formula and R represent the relative growth rate (RGR) in the concerned year.

Year	Initial Value of Publications	New added Publications	End Value of Publication	W1	W2	RGR	Dt
2011	0	517	517	0	6.24	0	0
2012	517	577	1094	6.24	6.99	0.75	0.92
2013	1094	810	1904	6.99	7.55	0.56	1.23
2014	1904	946	2850	7.55	7.95	0.40	1.73
2015	2850	1012	3862	7.95	8.25	0.30	2.31
2016	3862	928	4790	8.25	8.47	0.22	3.15
2017	4790	839	5629	8.47	8.63	0.16	4.33
2018	5629	817	6446	8.63	8.77	0.14	4.95
2019	6446	813	7259	8.77	8.88	0.11	6.33
Feb.2020	7259	299	7558	8.88	8.93	0.05	13.86

The table no. 6.3 shows the value of the relative growth rate of publications on Coronavirus research. The calculation has been made by the above-mentioned formula. The maximum 0.75 RGR was recorded in the year 2012 followed by 0.56 RGR recorded in 2013 and the minimum 0.11 RGR recorded in the year 2019. Further, the calculation has been made for doubling time for the publications of Coronavirus research. It is found that the doubling time of the publication is increasing year by year. Maximum 6.33 Dt is calculated in the year 2019 followed by 4.95 in the year 2018. Minimum 0.92 Dt is recorded in the year 2012 followed by 1.23 in the year 2013. The relative growth rate and doubling time for the year 2010 to Feb.2020 is shown in table no.6.3.

6.4.Ten most productive countries with Coronavirus articles during the period from 2011 to Feb. 2020.

Standard Competition Ranking	Country	Total	(%)
1 st	United States	2373	31.39
2 nd	China	1378	18.23
3 rd	United Kingdom	567	7.50
4 th	South Korea	487	6.44
5 th	Saudi Arabia	460	6.08
6 th	Germany	441	5.83
7 th	France	348	4.60
8 th	Netherlands	344	4.55
6 th	Canada	294	3.88
10 th	Japan	279	3.69

The Table 6.4 shows the ten most productive countries with Coronavirus articles during the period from 2011 to Feb. 2020. The retrieved articles were published from 144 countries, of which the USA ranked first with 2373 publications, followed by China with 1378 publications and United Kingdom with 567 publications in that order. Japan is ranked at 10th position while India ranked at 19th position

with 137 publications. Seventy-Nine countries, including Kuwait, Nepal Philippines, published fewer than ten articles.

6.5.Ten most productive journals with Coronavirus articles during the period from 2011 to Feb. 2020.

Standard Competition Ranking	Journal	Total	(%)
1st	Journal Of Virology	330	4.36
2nd	Plos One	224	2.96
3rd	Viruses	170	2.24
4th	Emerging Infectious Diseases	161	2.13
5th	Virus Research	125	1.65
6th	Archives Of Virology	119	1.57
7th	Virology	116	1.53
8th	Veterinary Microbiology	112	1.48
6th	Journal Of General Virology	90	1.19
10th	Antiviral Research	77	1.01

Table No.6.5 shows the ranking of the top ten most productive journals with Coronavirus articles during the period from 2011 to Feb. 2020. It is observed that the retrieved papers were published in 159 journals. The Journal of Virology secured the first position with 330 articles among 159 Journals followed by PLoS One with 224 articles and The Viruses is ranked third positing with 170 articles while Antiviral Research ranked the tenth position with 77 articles.

6.6 Ten most productive corresponding authors with Coronavirus articles during the period from 2011 to Feb. 2020

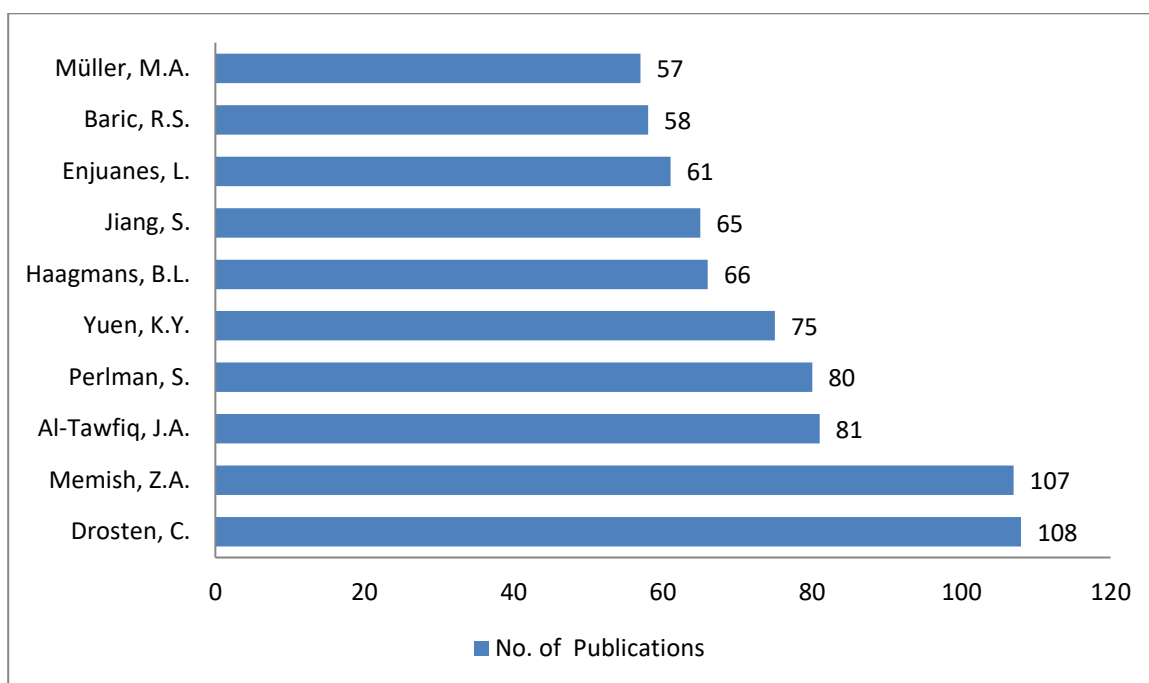
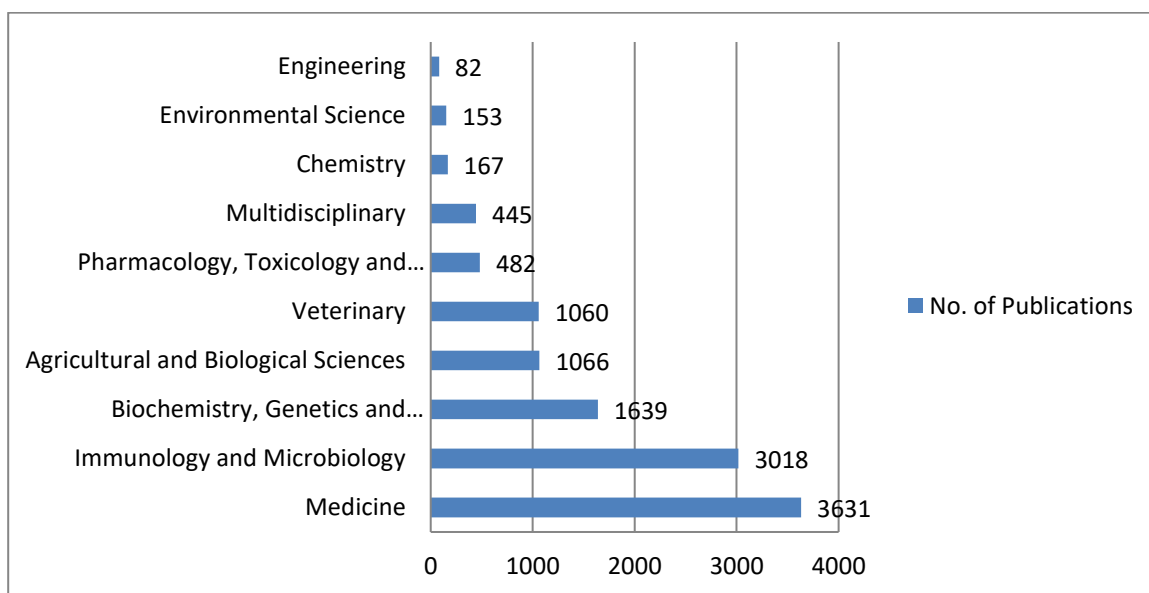


Table No 6.6 shows the top ten most productive corresponding authors with Coronavirus articles during the period from 2011 to Feb. 2020. It is found that the 158 authors have been written their papers on Coronavirus during last ten years .Out of 158, Dusten,C. is ranked topmost productive corresponding author(first position) with 108 articles followed by Memish, Z.A. with 107 articles. Further, it is also observed that Muller, M.A. secured at tenth position with the publication of 57 articles.

6.7 Ten most productive Subjects with Coronavirus articles during the period from 2011 to Feb. 2020.



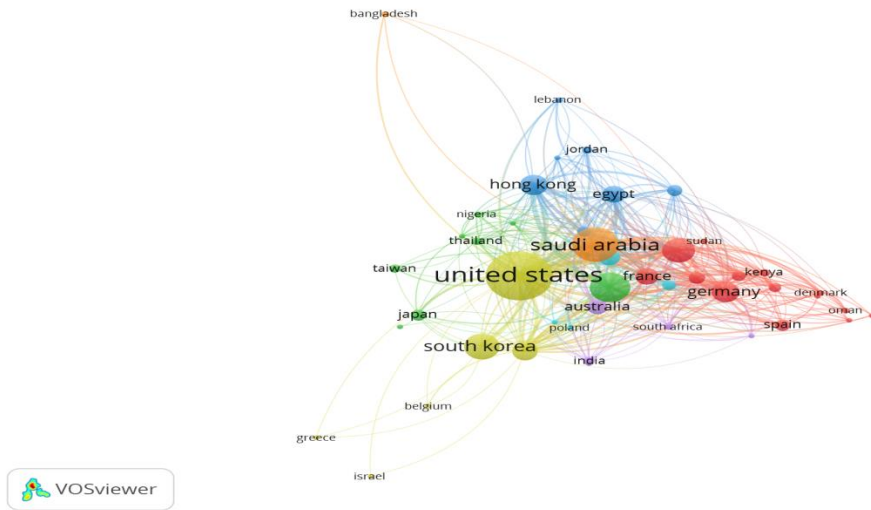
The Graphs 6.7 display the dominant subjects which are publishing more articles on the Coronavirus. After the counting subject wise publication it is found that 25 subjects published articles on Coronavirus, Of which a maximum of 3631(48.04 %) papers have been published under the Medicine subject as on top followed by 3018(39.39 %) papers in Immunology and Microbiology. Engineering subjects ranked at the tenth position with 82 publications.

6.8 Top most productive Sources published Coronavirus articles during the period from 2011 to Feb. 2020

Standard Competition Ranking	Country	Total	(%)
1 st	Journals	7310	96.71
2 nd	Books	102	1.34
3 rd	Book Series	99	1.30
4 th	Conference Proceedings	33	0.43
5 th	Trade Publications	3	0.03
6 th	Undefined	11	0.14

Table 6.8 present most productive Sources published Coronavirus articles during the period from the 2011 to Feb.2020. The papers are identified by source type and it is found that maximum numbers7310 (96.71%) of papers are published under Journal article while 102(1.34 %) papers are published in books followed by the 99(1.30 %) in book series form. In this way, it is seen that more than 96 percent of papers were published under the journal article.

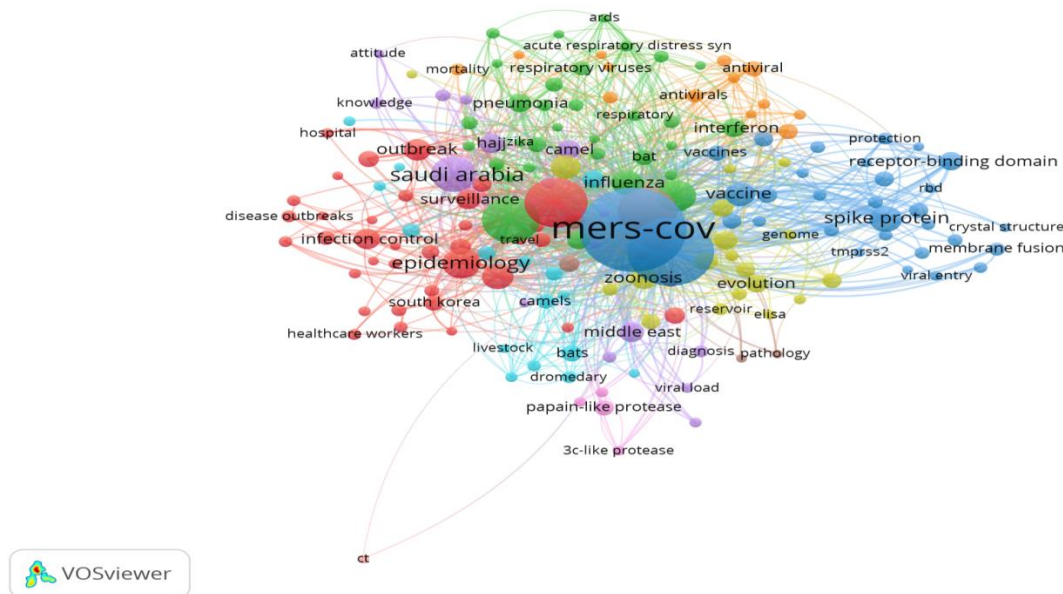
6.9 Visualization of the Most Collaborative Countries:



6.9 Network visualisation of the most collaborative countries

Figure 6.8 presents the network visualization of the most collaborative countries. It is found that the total of 59 countries published scholarly papers on Coronavirus. All the 59 countries were taken for mapping. In Figure 6.8., each circle represents a country. The collaboration can be seen by the circle, bigger the circles, larger the research publications, and more collaborative relationships among the countries. With the help of the map, it is found that the United States circle is bigger than another, it means the USA is the biggest collaborative country that has a larger number of scholarly publications followed by United Kingdom, India, China, Thailand, Spain, Australia, etc.

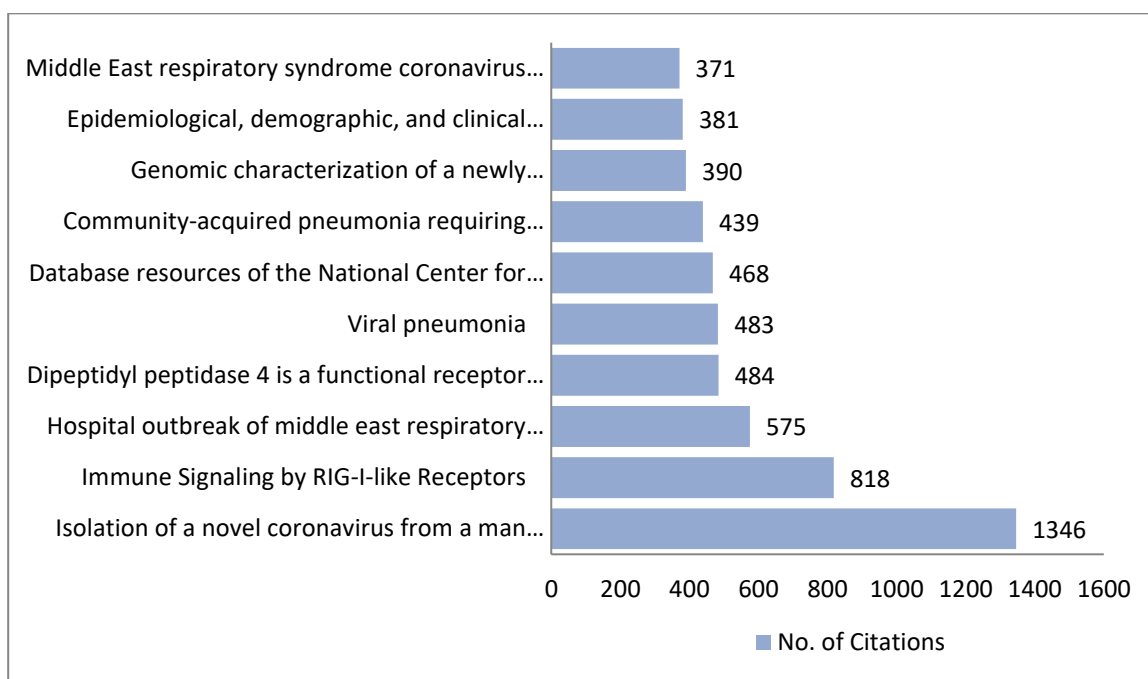
6.10 Visualisation of the Author Keywords Clustering Analysis



6.10 Network Visualisation of the Author Keywords Clustering Analysis

Figure 6.10 represents the network visualization of author keywords used in scholarly publications on Coronavirus. The map is created with VOSviewer. It is showing the density of the frequently used key terms in Coronavirus articles. Various Colors show the various regions represent research areas. The size of font and bubble reflect keywords frequency of use. A total of 2527 records were taken, however; only 178 keywords meet the threshold for visualization mapping where the minimum number of the occurrences of keywords was considered at 5. The no. of keywords can be seen by the size of the circle, bigger the circles, larger no of the research publications used these keywords. It is seen by the map that the “mers-cov” and “coronavirus” is the biggest circle; it means this term is used maximum time as keyword followed by “middle east respiratory syndro” and “epidemiology”.

6.11 Top most productive Highly Cited Documents article (Title) published on Coronavirus during the period from 2011 to Feb. 2020



The graph no 6.10 represent the top ten highly cited documents title with their citations during 2011-Feb.2020. During analysis, it is found that *Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia* received the highest 1346 citations, followed by *Immune Signaling by RIG-I-like Receptors* with 818 citations. Further, it is seen that the *Hospital outbreak of middle east respiratory syndrome coronavirus* received third-highest citation while *Middle East respiratory syndrome coronavirus neutralising serum antibodies in dromedary camels: A comparative serological study* ranked at 10th position with 371 citations.

7. FINDINGS AND CONCLUSION:

There are various types of coronavirus which was confirmed from time to time. Severe acute respiratory syndrome (SARS-CoV) SARS was first recognized in 2003 as a specific strain of coronavirus. Middle East Respiratory Syndrome (MERS-CoV) MERS was first identified in Saudi Arabia in 2012 among people exhibiting symptoms of diarrhea such as fever, cough, shortness of breath and sometimes gastrointestinal problems. In December 2019, the novel virus has been detected , named “SARS-CoV-2” and the sickness its origins has been entitled “coronavirus disease 2019” (abbreviated “COVID-19”). The number of death and patients affected by the novel coronavirus is increasing day by day. The most productive year is recognized 2015with 1012 (13.38 %) articles followed by the year 2014 with 946 (12.51%) publications while the year 2016 counted as 3rd position with 928 (12.27 %) articles. Maximum AGR 40.38 percent was recorded in the year 2013 followed by 16.79 percent in 2014during 2011-2020. Further, it is also seen that the minimum (-) 0.48 percent AGR recorded in the year 2019 followed by (-) 02.62 in 2018. The USA ranked first with 2373 publications, followed by China with 1378 publications and United Kingdom with 567 publications. The *Journal of Virology* secured the first position with 330 articles among 159 Journals followed by PLoS One with 224 articles and The *Viruses* is ranked third positing with 170 articles while Antiviral Research ranked the tenth position with 77 articles. Dusten,C. is ranked top most productive corresponding author(first position) with 108 articles followed by Memish,Z.A. with 107 articles.

Maximum of 3631 papers have been published under the Medicine subject as on top followed by 3018 papers in Immunology and Microbiology. Engineering subjects ranked at tenth position with 82 publications. *Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia* received highest 1346 citations, followed by *Immune Signaling by RIG-I-like Receptors* with 818 citations.

The above-mentioned findings show the importance of bibliometric method to illustrate global research productivity on Coronavirus. Thus, this study provides a supportive reference for virologists and epidemiologists, policy decision-makers, academics, and coronavirus researchers. As Coronavirus can be considered a current occurred disease and a new research topic, the study results characterize a ‘snapshot’ of this field at an early step in its improvement.

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