BIBLIOMETRIC ANALYSIS OF COVID-19 VACCINE RESEARCH OUTPUT IN 2020: A GLOBAL PERSPECTIVE

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The paper attempts to ascertain global research output on Covid-19 Vaccine on the basis of data retrieved from SCOPUS database. The total research output included 383 publications. The VOS-viewer and Microsoft Excel were used for data analysis and visualization. The most productive countries, institutions, authors and sources are identified in this study. The study also identifies the top funding organizations in this area of research. The top most cited papers on Covid-19 Vaccine are recognized. The United States is most productive country with 122 papers and 1157 citations to these papers. United States and United Kingdom are leading collaborators who produced maximum papers (15) in collaboration. The Harvard Medical School from United States is leading institute in terms of institutional research output. Bottazi, M.E. from Baylor College of Medicine, United States has been found most prolific author with 7 papers and 108 citations to his papers. Among most productive sources titles used for the publication of Covid-19 Vaccine research, *Nature* is found most productive journal with 25 papers followed by *Science* with 17 papers. The National Institutes of Health from United States is leading funding organization. The keyword *Human* was maximum used word with 320 occurrences followed by *Virus Vaccine* (316) and *Coronavirus Infection* (300).

Keywords: Covid-19 Vaccine; Coronavirus; Bibliometrics; Scopus; VOS-viewer; Visualization; Collaboration.

INTRODUCTION

Coronavirus disease 2019 (Covid-19) is third coronavirus which was detected in human body after Severe Acute Respiratory Syndrome Coronavirus (SARS-Cov) and Middle East Respiratory Syndrome Coronavirus (MERS-Cov) (Hadi et al., 2020). It is a highly transmittable and pathogenic viral infection disease, which originated in Wuhan, China and spread throughout the world (Shereen et al., 2020). Covid-19 is the fifth documented pandemic after 1918 flu pandemic. The World Health Organization (WHO) officially termed the new virus as Coronavirus disease 2019(Covid-19) on 12 February 2020 (Liu et al., 2020). It spreads rapidly

from one person to another via respiratory droplets produced while coughing and sneezing (Hafeez et al., 2020). At present, there is no specific clinically approved drug or vaccine available for the treatment of Covid-19. Many institutes and companies are working to find a clinically approved medication or vaccine. However, scientists estimate that it can take 12-18 months to get a clinically approved vaccine for the treatment of Covid-19 (Alanagreh et al., 2020).

As on October 06, 2020, total 35,709,549 Covid-19 cases have been reported around the world with death of 1,046,073 people. 26,878,157 people have recovered from this disease and 7,785,319 total active cases are reported on the same date. (Worldometer, 2020).

BIBLIOMETRICS

Bibliometrics methods are used as a tool for qualitative and quantitative analysis of the published scientific research records. It helps to evaluate research performance of individual researchers, institutions and countries in a certain field (O'Neill et al., 2020). The analysis of institutions and authors enables identification of the knowledge frontier (Wang et al., 2014). The bibliometrics also helps to understand academic collaboration at national and international level (Zhang et al., 2020). Therefore, the main aim of present study is to evaluate global research output on Covid-19 Vaccine. In order to get the clear picture of Covid-19 Vaccine research, this study uses visualization technique along with bibliometrics. The study will help to identify top

contributors (countries, institutes, authors) on Covid-19 Vaccine research. As funding is important for any research, so this study will also recognize top funding organizations in this field of research.

REVIEW OF LITERATURE

Bibliometric is characterized as the application of mathematics and statistical methods for the quantitative and qualitative analysis of scientific research output. A number of bibliometric studies have been done to analyze the global research output in different subject areas. Recently a few studies have been done to analyze the global publications on coronavirus. In their bibliometric study (Sahu et al., 2020) on research trends in coronavirus, found that United States is most productive country while University of Hong Kong appeared as a most productive institute. The Journal of Virology was most productive source in terms of total publications and citations.

The study (Ram, 2020) analyzed coronavirus research for a period of 50 years. It analyzed the most productive countries, institutions, authors, international collaborations; most cited papers and frequently used keywords. The analysis revealed that United States, China and United Kingdom were most productive countries in coronavirus research. The study also found that United Kingdom had the maximum internationally collaborated publications. Another study analyzed the Covid-19 publications that were published in Scopus database during January-March 2020. The study found that China produced highest number

of publications and University of Hong Kong, Hong Kong was most productive institute. Analysis revealed that majority of the papers had international collaborations (Siwach, 2020). In their study Ram and Nisha (2020) analyzed the highly citied papers in coronavirus research, based on the data retrieved from Scopus database. They found that most of the highly cited articles are related to the Journal of Virology. The University of Hong Kong, Hong Kong produced the most number of highly cited papers. Hamidah et al., (2020) analyzed the Covid-19 research publications from 2019 to 2020 using VOS-viewer software; found that China contributed maximum number of publications. The keywords coronavirus, pandemic and impact were most frequently used words. The literature suggests that a bibliometric evaluation of the Covid-19 vaccine publications is missing. These all studies are exclusively related to Covid-19 only. In the literature no other similar study has been found that evaluates the Covid-19 vaccine publications. So, there is a need to fill the gap considering the significance of the research area.

OBJECTIVES OF THE STUDY

The main objectives of the study are:

1. To find out the most productive countries, institutions, authors and sources.

2. To assess the collaborative network of countries on Covid-19 Vaccine research.

3. To identify the top funding organizations on Covid-19 Vaccine research.

4. To find out the core subject categories, frequently used keywords and highly cited papers on Covid-19 Vaccine research.

METHODOLOGY

The data for this study has been retrieved from SCOPUS (www.scopus.com) database on 11 September 2020, using the terms: "Covid-19 Vaccine" OR "Covid 19 Vaccine" OR "Coronavirus Disease 2019 Vaccine" in combination with article title, abstract and keywords. As a result of these terms 383 publications on Convid-19 Vaccine were retrieved from the database. The first Covid-19 case was identified in Wuhan, China in December 2019, so all papers on Covid-19 Vaccine have been published in 2020. The results were downloaded as a Comma-Separated Values (CSV)file under the headings 'Author Name', 'Document Title', 'Year', 'Source Title', 'Citation', 'Document Type', 'Subject Area', 'Author Affiliation' and 'Funding Organization'. VOS-viewer (version 1.6.14) and MS Excel were used to analyze the document types, countries, institutes, authors, sources, international collaboration, core subjects, keywords, funding organizations and highly cited articles. The Scimago Institutes Ranking (www.scimagoir.com) has been used to identify the H Index of the sources. Figure 1 portrays the type of publications on Covid-19 Vaccine. The publications were identified into 8 types. The majority of the papers were articles 41.51%, reviews 22.98%, note 16.71%, editorials 10.70% and letter 4.44%. The overall data of all publications from is shown in figure 1 below.
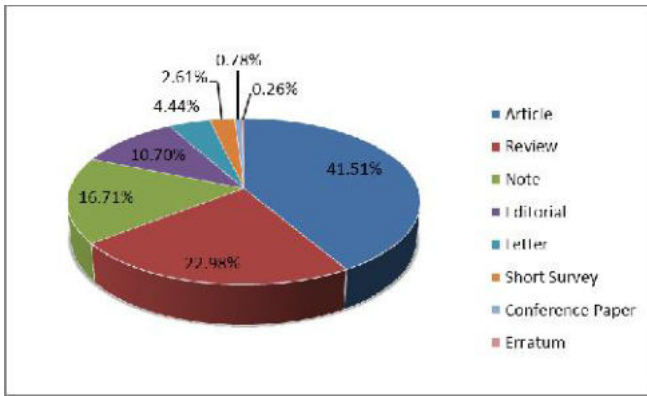
Figure 1: Type of Publications on Covid-19 Vaccine Research

LIMITATIONS OF THE STUDY

1. The data for this paper was extracted from Scopus database only. It does not cover all the publications on Covid-19 Vaccine.

2. A single publication in Scopus database may fall under various subjects. So, the total publications under all subjects exceed the actual number of publications considered for this study during the period.

3. Recently published high quality publications may have less number of citations as citations increase over a period of time.

RESULTS AND DISCUSSIONS

A total number of 79 countries contributed in Covid-19 Vaccine publications during the period of study. Top 10 countries in Covid-19 Vaccine research along with percentages of total output, total citations, average citations per paper, total link strength have been identified. The United States produced maximum 122 (31.85%) documents and received 1157 citations from these documents. The United Kingdom got the second place with 50 (13.05%) publications followed by China 46 (12.01%) and India 35 (9.14%). It was seen that China received the maximum (15.43) average citations per paper. The overall data of top ten leading countries is shown in table 1.

The collaboration network of countries, created through VOS-viewer, is shown in figure 2. The countries producing minimum number of three documents were taken into account. Out of 79 countries, 35 met the threshold. The countries with strong total links have been selected. The

Table 1: Top 10 Most Productive Countries on Covid-19 Vaccine Publications

Country	TP	% of 383	TC	ACPP	Total Link Strength
United States	122	31.85	1157	9.48	58
United Kingdom	50	13.05	235	4.7	38
China	46	12.01	710	15.43	22
India	35	9.14	226	6.46	20
Germany	17	4.44	155	9.12	20
Italy	16	4.18	61	3.81	19
Switzerland	15	3.92	37	2.47	15
Canada	12	3.13	50	4.17	13
South Korea	11	2.87	139	12.64	12
Australia	10	2.61	14	1.4	11
TP=Total Publications; TC=Total Citations; ACPP; Average Citations per Paper					

United States and United Kingdom are leading countries which produced maximum (15) publications in collaboration. The researchers from United States also have strong links with Chinese researchers, who produced 10 papers in collaboration.
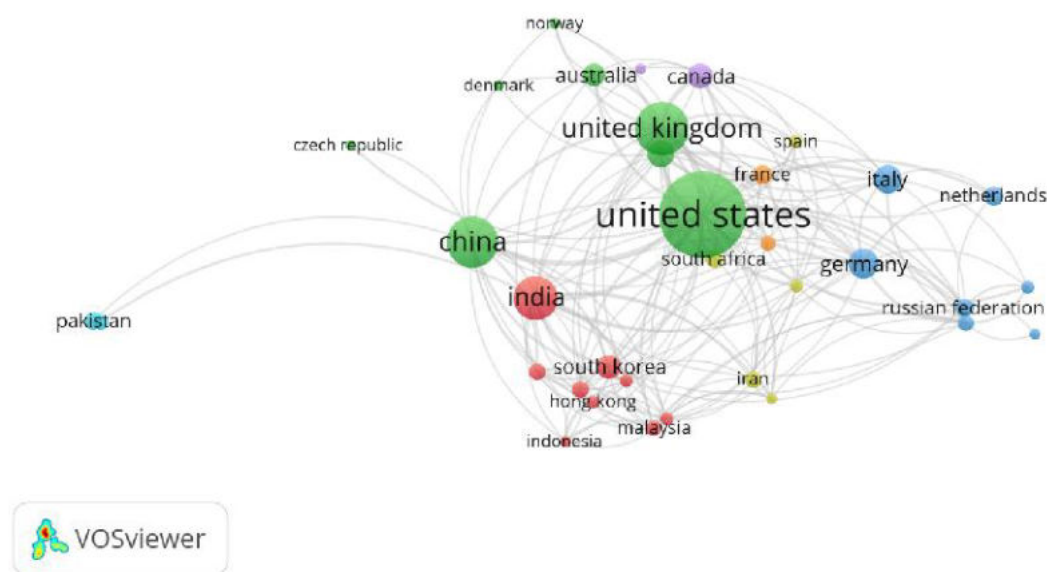

Figure 2: Network of Collaborative Countries in Covid-19 Vaccine Research

The results reveal that total number of 1081 institutes contributed for the publication of 383 documents on Covid-19 Vaccine. In case of top 10 leading institutes, 6 institutes are from United States, 3 from China and 1 from England. Harvard Medical School from United States has produced maximum documents (11) in number. The University of Washington from United States got the second place with 10 publications. The overall data of top 10 institutes is given in table 2.

Table 2: Top 10 Leading Institutes on Covid-19 Vaccine Publications

Name of the Institute	TP	% of 383	Rank	Country
Harvard Medical School	11	2.87	1	United States
University of Washington	10	2.61	2	United States
University of Oxford	10	2.61	3	England
Baylor College of Medicine	8	2.09	4	United States
Fudan University	8	2.09	5	China
Johns Hopkins University	7	1.83	6	United States
Massachusetts Institute of Technology	7	1.83	7	United States
Chinese Center for Disease Control and Prevention	7	1.83	8	China
Tongji Medical College	6	1.57	9	China
National Institutes of Health(NIH)	6	1.57	10	United States
TC=Total Publications				

Table 3 reveals top 10 prolific authors who have published their papers on Covid-19 Vaccine. A total of 1387 authors contributed in total research output (383 publications) during the period of study. The top 10 leading authors along with total publications, total citations, and average citations per paper and authors affiliations were identified. Bottazzai, M.E. from Baylor College of Medicine, Houston, United States has contributed highest 7 publications. Results revealed that Hotez, P.J. has contributed second highest publications (6) followed by Qin, C. (5), Baden, L.R. (4), Chen, W. (4) and Kochhar, S. (4). Bottazzi, M.E. and Hotex, P. J. both received highest 108 citations for their publications. Bao, L. from Ministry of Health of People's Republic of China got the maximum (29) average citations per paper.

Table 3: Top 10 Prolific Authors in Covid-19 Vaccine Publications

Author	TP	TC	ACPP	Rank	Institute of the Author
Bottazzi, M.E.	7	108	15.43	1	Baylor College of Medicine, Houston, United States
Hotez, P.J.	6	108	18	2	Center for Vaccine Development, Houston, United States
Qin, C.	5	93	18.6	3	Ministry of Health of People's Republic of China, Beijing, China
Baden, L.R.	4	00	00	4	Division of Infectious Diseases, Boston, United States
Chen, W.	4	74	18.5	5	Wuhan Institute of Biological Products Co., Ltd., Wuhan, China
Kochhar, S.	4	00	00	6	University of Washington, Seattle, United States
Morrissey, S.	4	00	00	7	National Institute on Aging, Baltimore, United States
Rubin, E.J.	4	00	00	8	Harvard University, Cambridge, United States
Allen, E.	3	23	7.67	9	University of Oxford, Oxford, United Kingdom
Bao, L.	3	87	29	10	Ministry of Health of People's Republic of China, Beijing, China
TC=Total Publications; Total Citations; Average Citations per Paper					

A total of 202 sources contributed for Covid-19 Vaccine publications. The top 10 sources on Covid-19 Vaccine research along with total publications, total citations, citations per paper, publisher, country and H index of these journals have been identified (Table 4). *Nature* published 25(6.53%) papers which are highest in term of research output on Covid-19 Vaccine and received 110 citations. It is followed by *Science* 17(4.44%), *Vaccine* 17 (4.44%), *Lancet* 13(3.39%), *Lancet Infectious Diseases* 8(2.09%) and *Nature Communications* 7(1.83%). However, in terms of citations, *Science* received highest (205) citations. The *Nature Communication* received the maximum (14.43) citations per paper. It was seen that H Index is highest (1159) for *Nature* journal. The overall data of top ten leading sources is displayed in table 4.

Table 4: Top 10 Most Productive Sources in Covid-19 Vaccine Publications

Source	TP	% of 383	TC	CPP	Rank	Publisher	Country	H Index
Nature	25	6.53	110	4.4	1	Nature Publishing Group	United Kingdom	1159
Science	17	4.44	205	12.06	2	American Association for the Advancement of Science	United States	1124
Vaccine	17	4.44	15	0.88	3	Elsevier BV	Netherlands	175
Lancet	13	3.39	112	8.62	4	Elsevier Ltd.	United Kingdom	747
Lancet Infectious Diseases	8	2.09	7	0.88	5	Lancet Publishing Group	United Kingdom	217
Nature Communications	7	1.83	101	14.43	6	Nature Publishing Group	United Kingdom	298
Nature Reviews Immunology	7	1.83	82	11.71	7	Nature Publishing Group	United Kingdom	371
Human Vaccines And Immunotherapeutics	6	1.57	76	12.67	8	Landes Bioscience	United States	50
JAMA Journal Of The American Medical Association	6	1.57	4	0.67	9	American Medical Association	United States	654
American Journal Of Tropical Medicine and Hygiene	5	1.31	8	1.6	10	American Society of Tropical Medicine and Hygiene	United States	144
TP=Total Publications; TC=Total Citations; CCP= Citations per Paper								

The authorship pattern in Covid-19 Vaccine research is shown in table 5. The maximum papers 268 (69.97%) were result of collaborative efforts while a good number of publications i.e. 104 (27.15%) were produced by single authors. It was found that 3 (0.78%) papers were produced by institute as an author while no author was found in the case of 8 (2.09%) papers.

Table 5: Authorship Pattern in Covid-19 Vaccine Publications

Authorship Pattern	Single Author	Collaborative	Institute as an Author	No Author Available	Total
No. of Articles	104	268	3	8	383
Percentage	27.15	69.97	0.78	2.09	100

In case of top 10 funding organizations, 4 are from United States, 2 from China, 2 from United Kingdom, 1 from European Commission and 1 from European Union. The National Institutes of Health, United States has funded maximum (19) publications on Covid-19 Vaccine. The National Natural Science Foundation of China got the second place by funding to 12 publications. The overall data of top 10 funding organizations is shown in table 6.

Table 6: Top 10 Funding Organizations in Covid-19 Vaccine Research

Organization	No. of Publications	% of 383	Rank	Country
National Institutes of Health	19	4.96	1	United States
National Natural Science Foundation	12	3.13	2	China
National Institute of Allergy and Infectious Diseases	10	2.61	3	United States
Bill and Melinda Gates Foundation	8	2.08	4	United States (private foundation)
Science and Technology Major Project of Guangxi	5	1.30	5	China
Engineering and Physical Sciences Research Council	4	1.04	6	United Kingdom
European Research Council	4	1.04	7	European Commission
Wellcome Trust	4	1.04	8	United Kingdom
Horizon 2020 Framework Programme	3	0.78	9	European Union
Merck	3	0.78	10	United States

Table 7 lists the subject-wise distribution of Covid-19 Vaccine publications. The highest publications 221 (57.70%) belonged to 'Medicine' subject. The subject 'immunology and Microbiology' grabbed the second rank with 144 (29.77) publications. It is followed by Biochemistry, Genetics and Molecular Biology 93 (24.28%), Pharmacology, Toxicology and Pharmaceutics 52 (13.58%), Multidisciplinary 47 (12.27%) and Veterinary 21 (5.48%). The overall data of top 10 subjects is shown in table 7.

Table 7: Top 10 Subject-Wise Distribution of Covid-19 Vaccine Publications

Subject Area	Total No. of Publications	Percentage	Rank
Medicine	221	57.70	1
Immunology and Microbiology	114	29.77	2
Biochemistry, Genetics and Molecular Biology	93	24.28	3
Pharmacology, Toxicology and Pharmaceutics	52	13.58	4
Multidisciplinary	47	12.27	5
Veterinary	21	5.48	6
Engineering	17	4.45	7
Physics and Astronomy	15	3.92	8
Materials Science	14	3.66	9
Chemistry	13	3.39	10

The co-occurrence network of keywords is shown in figure 3. A total number of 2984 keywords have been used in 383 publications. Keywords occurring minimum in 20 documents were taken into account. Out of 2984 keywords, 105 met the threshold. The keywords with greatest total links have been selected for inclusion in VOS-viewer map of keywords. In this VOS-viewer map of keywords, size of the circles reveals the frequency of occurrences of keywords while distance reveals the association among these keywords.
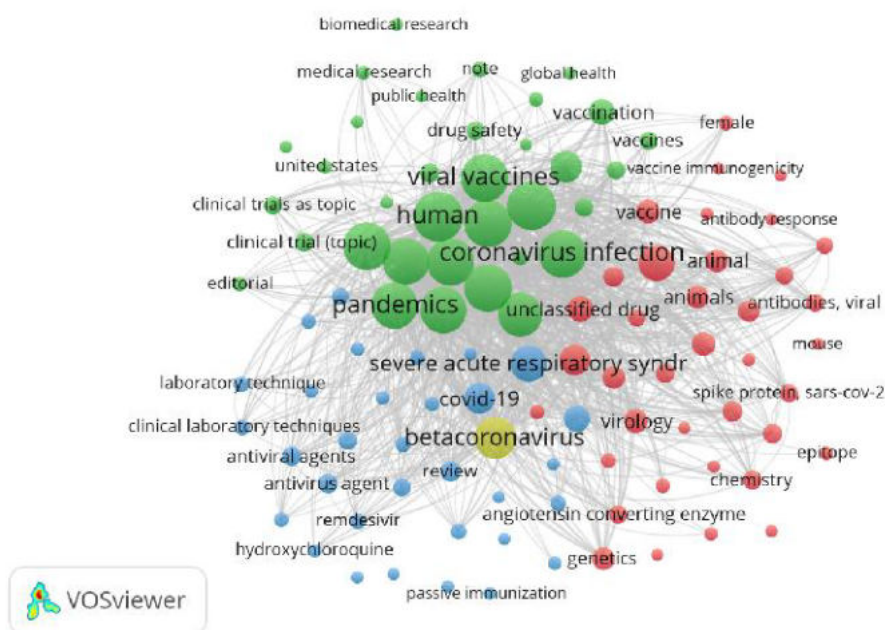

Figure 3: Co-occurrence network of keywords (minimum number of 20 occurrences)

The 30 most frequently used keywords in Covid-2019 Vaccine publications are displayed in table 8. Since Covid-2019 is related to human beings, so it is quite obvious that the word *Human* was most used keyword with 320 occurrences. *Virus Vaccine* was found second most used keyword with 316 occurrences. The keyword *Coronavirus Infection* got the third rank with 300 occurrences followed by *Coronavirus Infections* (297 occurrences), *Pandemic* (296 occurrences), *Viral Vaccines* (292 occurrences) and *Covid-19* (291 occurrences). The overall data of 30 most used keywords is shown in table 8.

Table 8: 30 Most Frequently used Keywords in Covid-19 Vaccine Publications

Keyword	Occur-rences	Total Link Strength	Rank	Keyword	Occur-rences	Total Link Strenght	Rank
Human	320	9984	1	Priority Journal	130	4672	16
Virus Vaccine	316	9949	2	Nonhuman	123	4964	17
Coronavirus Infection	300	9791	3	COVID-19	121	3371	18
Coronavirus Infections	297	9716	4	Unclassified Drug	94	3525	19
Pandemic	296	9531	5	Vaccination	94	2946	20
Viral Vaccines	292	9510	6	SARS-CoV-2	90	3009	21
COVID-19 Vaccine	291	9473	7	Article	79	3056	22
Humans	289	9367	8	Virology	79	3178	23
Virus Pneumonia	278	9194	9	Vaccine	73	2441	24
Pandemics	277	9175	10	Animal	70	2931	25
Pneumonia, Viral	277	9186	11	Animals	70	2931	26
Coronavirus Disease 2019	249	8394	12	Coronavirus	67	2463	27
Betacoronavirus	236	8116	13	Genetics	67	2740	28
Severe Acute Respiratory Syndrome Coronavirus 2	174	6611	14	Neutralizing Antibody	60	2591	29
Immunology	173	6303	15	Coronavirus Spike Glycoprotein	57	2616	30

The highly cited top 10 publications on Covid-19 Vaccine are shown in table 9 along with author, source and citations. The article "Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures" achieved the highest (200) citations. This work was collaborative efforts of 4 authors (Wang Y., Wang Y., Chen Y., and Qin Q.,). The second rank of highly cited article is assigned to "The COVID-19 vaccine development landscape" having 167 citations. The article was produced by collaborative efforts of 7 authors (Thanh Le T., Andreadakis Z., Kumar A., Gómez Román R., Tollefsen S., Saville M., Mayhew S.) The overall data of 10 most cited articles is displayed in table 9.

Table: 9 Highly Cited Top 10 Articles on Covid-19 Vaccine

Title	Author	Source	Citations	Rank
Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures	Wang Y	Journal of Medical Virology	200	1
The COVID-19 vaccine development landscape	Thanh Le T	Nature Reviews Drug Discovery	167	2
Characterization of the receptor-binding domain (RBD) of 2019 novel coronavirus: implication for development of RBD protein as a viral attachment inhibitor and vaccine	Tai W	Cellular and Molecular Immunology	127	3
Developing covid-19 vaccines at pandemic speed	Lurie N	New England Journal of Medicine	113	4
SARS-CoV-2 Vaccines: Status Report	Amanat	Immunity	110	5
Targets of T Cell Responses to SARS-CoV-2 Coronavirus in Humans with COVID-19 Disease and Unexposed Individuals	Grifoni A	Cell	108	6
Virology, epidemiology, pathogenesis, and control of covid-19	Jin Y	Viruses	106	7
A human monoclonal antibody blocking SARS-CoV-2 infection	Wang C	Nature Communications	80	8
The SARS-CoV-2 Vaccine Pipeline: an Overview	Chen W	Current Tropical Medicine Reports	67	9
COVID-19, an emerging coronavirus infection: advances and prospects in designing and developing vaccines, immunotherapeutics, and therapeutics	Dhama K	Human Vaccines and Immunotherapeutics	67	10

CONCLUSION

The present study used bibliometric and visualization technique to analyze the literature on Covid-19 Vaccine as indexed in SCOPUS database. MS Excel and VOS-viewer softwares have been used to analyze data and to show its visualization. The United States grabbed first rank by contributing 122(31.85%) papers with 1157 citations. The study revealed that United States and United Kingdom are leading collaborator in producing Covid-19 Vaccine papers. The analysis revealed that the top ten institutes produced 20.9% papers. The Harvard Medical School, United States grabbed first rank with 11(2.87) papers. The author Bottazzi, M.E. from Baylor College of Medicine,

Houston, United States got the first rank by contributing 7 papers. The top 10 sources produced 29% papers. *Nature* grabbed the first rank with 25 papers. The top ten organizations funded 18.76% papers. The National Institutes of Health, United States grabbed first rank with funding to 19 papers. The highest papers were related to medicine subject 221(57.70%) followed by immunology and microbiology with 144 (29.77%). The keyword *Human* was maximum used word with 320 occurrences followed by *Virus Vaccine* (316 occurrences), *Coronavirus Infection* (300 occurrences), *Coronavirus Infections* (297 occurrences) and *Pandemic* (296 occurrences). The study found that highest cited paper is "Unique epidemiological and clinical features of the emerging

2019 novel coronavirus pneumonia (COVID-19) implicate special control measures" with 200 citations.

REFERENCES

1. Alanagreh, L., Alzoughool, F., & Atoum, M. (2020). The human coronavirus disease COVID-19: Its origin, characteristics, and insights into potential drugs and its mechanisms. *Pathogens*, *9*(5), 331.https:// doi.org/10.3390/ pathogens9050331

2. Hadi, A. G., Kadhom, M., Hairunisa, N., Yousif, E., & Mohammed, S. A. (2020). A review on COVID-19: Origin, spread, symptoms, treatment, and prevention. *Biointerface Research in Applied Chemistry*, *10*(6), 7234-7242.https:// doi.org/10.33263/briac106.72347242

3. Hafeez, A., Ahmad, S., Siddqui, S. A., Ahmad, M., & Mishra, S. (2020). A review of COVID-19 (Coronavirus Disease-2019) diagnosis, treatments and prevention. *Eurasian Journal of Medicine and Oncology*, *2*(4), 116-125.https://doi.org/ 10.14744/ejmo.2020.90853

4. Hamidah, I., Sriyono, & Hudha, M. N. (2020). A bibliometric analysis of Covid-19 research using VOSviewer. *Indonesian Journal of Science & Technology*, *2*(5), 34-41.
   http://ejournal.upi.edu/index.php/ijost/

5. Liu, Y., Kuo, R., & Shih, S. (2020). COVID-19: The first documented coronavirus pandemic in history. *Biomedical Journal*. https:// doi.org/ 10.1016/j.bj.2020.04.007

6. O'Neill, C. J., Cassar-Gheiti, A. J., & Harty, J. A. (2020). Arthroplasty and global research output: A bibliometric analysis. *Journal of Orthopaedics*, *17*, 187-192.https:// doi.org/10.1016/ j.jor.2019.06.017

7. Ram, S. (2020). Coronavirus research trends: A 50–Year bibliometric assessment. *Science &*

Technology Libraries, *39*(2), 210-226.https:// doi.org/10.1080/0194262x.2020.1742270

8. Ram, S., & Nisha, F. (2020). Highly cited articles in coronavirus research: A bibliometric analysis. *DESIDOC Journal of Library & Information Technology*, *40*(4), 218-229.https://doi.org/ 10.14429/djlit.40.4.15671

9. Sahu, M. K., Chetan, G. K., & Panda, S. P. (2020). Research trends on Coronavirus (Covid-19): A bibliometric analysis between 2010– March 2020. *Library Philosophy and Practice (e-journal)*. https://digitalcommons.unl.edu/libphilprac/4219

10. Shereen, M. A., Khan, S., Kazmi, A., Bashir, N., & Siddique, R. (2020). COVID-19 infection: origin, transmission, and characteristics of human coronaviruses. *Journal of Advanced Research*, 24, 91-98. https:// doi.org/10.1016/ j.jare.2020.03.005

11. Siwach, A. K. (2020). Bibliometrics of COVID-19 publications in first three months of 2020. *Library Philosophy and Practice (e-journal)*.https://digitalcommons.unl.edu/libphilprac/ 4274

12. Wang, B., Pan, S.-Y., Ke, R.Y., Wang, K., & Wei, Y.M. (2014). An overview of climate change vulnerability: A bibliometric analysis based on Web of Science database. *Natural Hazards*, *74*(3), 1649–1666.https://doi.org/ doi/ 10.1007/s11069-014-1260-y

13. Worldometer (2020, October 6). *COVID-19 Coronavirus pandemic*. https:// www.worldometers.info/coronavirus/

14. Zhang, Y., Pu, S., Lv, X., Gao, Y., & Ge, L. (2020). Global trends and prospects in microplastics research: A bibliometric analysis. *Journal of Hazardous Materials*, 1-13. https:// doi.org/ 10.1016/j.jhazmat.2020.123110

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