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Mapping and Visualization of Indian Research Landscape on Coronavirus disease 2019(Covid-19): A Bibliometric Study

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Structure Abstract

Purpose
This work aimed at demonstrating India's scientific contribution on Covid-19 research and analyzes the emerging research pattern using various bibliometric parameters.

Design/methodology/approach
Indian publications data on Covid-19 research were retrieved from SCOPUS database using structured query. VOSviewer & CiteSpace data visualization tools are used to generate citation, co-citation map and keyword clusters for better understanding of the research pattern. The leading institutions, most productive journal, prominent researchers are identified and analyzed further to reflect the collaborative nature.

Key Findings
Between January to September, 2020, a total of 3465 research documents were published pertaining to Covid-19. A larger share of the documents published in domain of Medicine 2185 (67.44%) followed by Biochemistry, Genetics and Molecular Biology 532(16.42%) and Pharmacology, Toxicology and Pharmaceutics 232(7.16%). The 'Diabetes and Metabolic Syndrome Clinical Research and Reviews' publish maximum research document 102(2.94%). Dr. V Wiwanitkit found to be the most prolific contributor while AIIMS, New Delhi has become the leading institution in producing the maximum research 266(7.68%). The USA, England & China are found to be the most favored countries for research collaboration

Originality/value
This study provides significant findings of Covid-19 research carried out by Indian scientists. The results are beneficial for researcher and practitioner in India and worldwide for understanding the pattern of research on Covid-19 and identifying the potential collaborator.

Keywords: Covid-19, SARS-COV-2, Citation pattern, Epidemic, Bibliometric analysis, India

Introduction

India is at the forefront of fighting the deadly epidemic Coronavirus (COVID-2019). World Health Organization (WHO) reported that the virus has originated from Wuhan city, Hubei Province of China and has spread across 190 countries worldwide. WHO declare this as the public health emergency and called it as global pandemic [1]. As on September 18, 2020, globally 30,055,710 COVID-19 cases have been reported and caused 9,43,433 deaths with highest casualty reported from USA [2]. India total coronavirus cases mounted to 52,14,677 confirmed cases while the death toll climbed to 84,372 with 78% of recovery rate till 18 September 2020 [3]. The epidemic has caused unprecedented nature of health crisis & created havoc on the Indian economy. Research publications on emerging infectious diseases are very high after an outbreak and drop drastically upon the containment of the disease [4]. USA and China have primary roles in CoV research, with the USA leading the scientific production with nearly a third of the articles[18]. Studies conducted MERS-CoV reported that USA and U.K. and have a higher quality of articles according to the value of h-index [5, 6]. During 2019-2020 epidemic has set an unprecedented milestone in virology research by the way open science is tackling with exceptional speediness this outbreak [7]. A similar kind of study was also revealed that The USA and China contributed the highest number of research documents, including the Journal of Virology. The coverage of the domain of High-impact articles was basic science and clinical medicine [8]. Studies on the COVID-19 during the first 30 days suggested that diagnosis and effective preventive and therapeutic measures were the fields in which more research is still needed [9]. Observational studies and therapeutic trials about COVID-19 are essential for developing new treatment options [10, 11]. The research volume of emerging infectious diseases is very high after an outbreak and drops drastically upon the containment of the disease [12]. An attempt was made to trace the trends of research associated with coronavirus [13, 17]. COVID-19 brings a lot of challenges and a massive burden on healthcare facilities. Countries need to urgently prepare human resources, infrastructure and facilities to treat severe COVID-19 [14]. Based on the literature reviewed of significant studies, it is found that there are limited bibliometric/scientometrics studies on covid-19 across the world particularly on the country specific analysis. Therefore, we carried out this study to bridge the knowledge gap by examining the India’s scientific contribution towards global research on COVID -19 pandemic.

In this particular study, we have analyzed the scientific literature published from India. Leading authors, Institutes and prominent journal are identified and authorship & collaborative patterns were analyzed. VOSviewer & CiteSpace applications were used to create keywords clusters, citation & co-citation map for better understanding of the research links [15, 16]. This study provides insights and understanding the India's contributions and dynamics on Covid-19 research. The present study aims to quantify and analyze India's scientific publications on Covid-19 research using various bibliometric indicators. The primary objectives are-

i. To demonstrate India's scientific contribution on Covid-19 research and analyze the research pattern
ii. To determine the leading institution across India
iii. To analyze authorship and visualize the collaborative pattern globally
iv. To identify most publishing journals, prominent contributors and most cited papers.

Materials and methods

The literature datasets are retrieved from SCOPUS bibliographic database hosted by Elsevier using a structured query. A total of 3490 records published by Indian researchers related to Covid-19 during 01 January to September, 2020. Following structured search query was formulated to retrieve the literature records.

Search query : ((TITLE-ABS-KEY(Covid-19) OR (Coronavirus) OR (Coronavirus disease 2019) OR (SARS-COV-2) OR (2019-nCov)) AND PUBYEAR > 2019 AND (LIMIT-TO (AFFILCOUNTRY,"India")) AND (EXCLUDE (DOCTYPE,"er")))

Data curation process was carried out for the removal of duplicate and irrelevant records & documents type such as 'erratum' has excluded from the sample data. Finally datasets of 3465 records were analyzed further to obtained the desired results pertain to journals, authors, institutions, citation metric and related study fields. Bibliometric parameters and statistical techniques have been extensively used for this study to analyze the data. We have also used VOSviewer & CiteSpace tools to create the citation & co-citation maps and keyword clusters for better data visualization and scientific mapping.

Results

Research Document Type & Subject wise distribution

The result indicates that larger share of the research documents published in the subject domain of Medicine 2315 (66.81%) followed by Biochemistry, Genetics and Molecular Biology subject domains 568(16.39%) and Pharmacology, Toxicology and Pharmaceutics 294(8.48%). Although a major portion of research conducted in medical and health science, however substantial amount of research work conducted in social aspect of the disease such as lockdown, social distance, impact on socioeconomic conditions of migrant workers and other aspect which are belongs to social science domain. Study found that a major chunk of the research documents are published in the form of 'Article' 1664(48.02%) followed by 'Letter' with 845(24.39%) and 'Review' 608(17.55%). It is also observed that 158(4.56%) of total documents published as 'Note' and 'Editorial' 143(4.13%) respectively. Book chapter (18), conference paper(15), short survey(9) and data paper(5) are constituent negligible percentage of the sample size.

International Collaborative Countries

Indian scientists and researchers are collaborated with international scientific communities for publishing research documents. It has been found that the United States became the most preferred collaborative partner by Indian researchers with 133(9.67%) followed by UK 100(7.27%) and China 98(7.13%). Other prominent research collaborative countries are Thailand (n=120), Italy (n=107), Australia (n=102), Saudi Arabia (n=85), Germany (n=71), Canada (n=67) and Brazil (n=66). In total, researchers from 192 countries are collaborated with India for producing 3465 research documents. Collaboration network of countries with threshold of (≥5) publications is depicted in **Figure 1.**

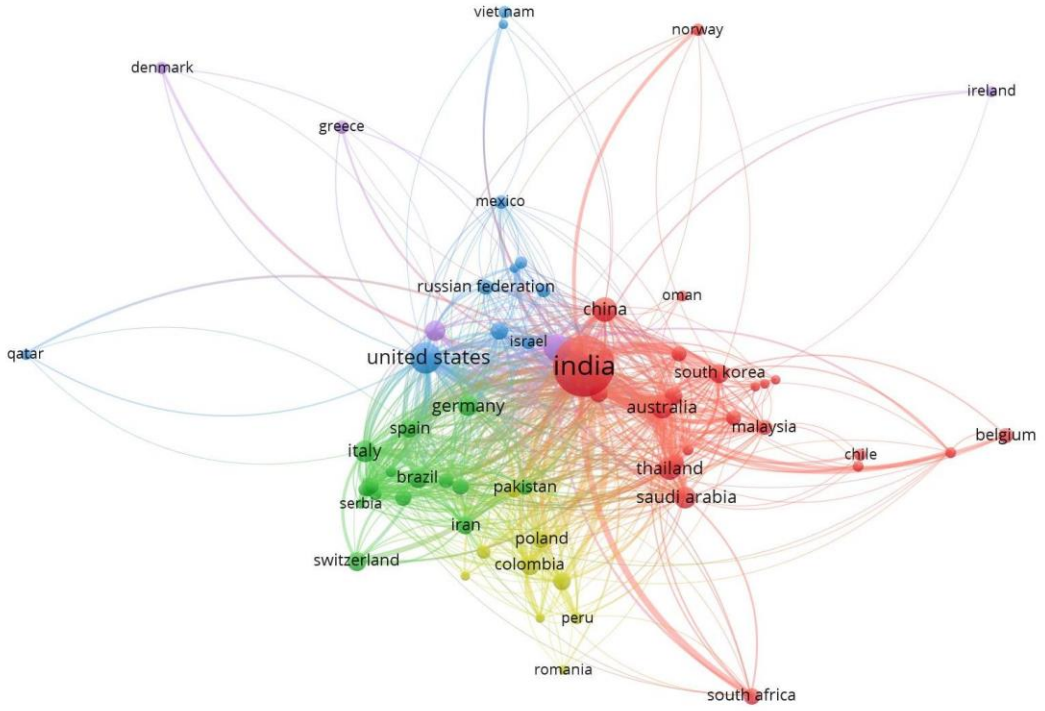

Figure 1. Represents the cross-country collaboration of Indian researchers. Collaboration network of countries with threshold of (≥5) publications was considered for generating the map

Leading Institutional Contribution Analysis

From the data analysis, It has been found that All India Institute of Medical Sciences, New Delhi has produced the highest number of research papers 266(7.68%) followed by The Postgraduate Institute of Medical Education & Research, Chandigarh 186(5.37%) and D.Y. Patil University, Pune 110(3.17%) of total publications. The other leading institutions along with their research output are National Institute of Mental Health and Neuro Sciences 65(1.88%), Sanjay Gandhi Postgraduate Institute of Medical Sciences Lucknow 63(1.82%), Indian Council of Medical Research 58(1.67%), Tata Memorial Hospital 58(1.67%), Indian Council of Agricultural Research 50(1.44%) and Indian Veterinary Research Institute 48(1.39).

Prominent Journals for communicating Covid-19 Research

It has been found that 3465 Covid-19 publications by Indian researchers are communicated in both national and international sources. Top 15 core journals in terms of maximum publication are shown in **Table I**. It has been found that 'Diabetes and Metabolic Syndrome Clinical Research and Reviews' publish maximum research documents 102(2.94%) followed by 'International Journal of Research in Pharmaceutical Sciences' of 96 (2.77%) and 'Asian Journal

of Psychiatry' of 95 (2.74%) research papers. Significant portion of research finding also communicated in Journal of Biomolecular Structure and Dynamics (82), Indian Journal of Ophthalmology (81), Dermatologic Therapy (66) and Indian Journal of Medical Research (51). The study also reveals that the top 15 journals have produced 24.96% (865) share of total research articles.

Table I. Distribution of Indian research on Covid-19 in Top 15 journals

Rank	Source Title	Count	%TP	CiteScore	SJR	SNIP
1	Diabetes and Metabolic Syndrome Clinical Research and Reviews	102	2.94	2.08	0.76	0.848
3	International Journal of Research In Pharmaceutical Sciences	96	2.77	0.21	0.122	0.363
2	Asian Journal of Psychiatry	95	2.74	1.29	0.619	0.816
4	Journal of Biomolecular Structure and Dynamics	82	2.37	4.5	0.504	0.98
5	Indian Journal of Ophthalmology	81	2.34	0.81	0.421	0.74
6	Dermatologic Therapy	66	1.90	1.24	0.674	0.779
7	Indian Journal of Medical Research	51	1.47	1.09	0.616	0.956
8	Indian Pediatrics	42	1.21	0.51	0.336	0.654
9	Indian Journal of Public Health	41	1.18	1	0.305	-1
10	Medical Hypotheses	40	1.15	2.2	0.427	0.509
11	Chaos Solitons and Fractals	39	1.13	5.9	1.036	1.38
12	Journal of Pure and Applied Microbiology	34	0.98	0.3	0.13	0.179
13	Science of the Total Environment	33	0.95	5.92	1.536	1.809
14	Journal of the Association Of Physicians Of India	32	0.92	0.7	0.183	0.36
15	Indian Journal of Community Health	31	0.89	0.17	0.148	0.177

TP: Total Publication, SJR: SCImago Journal Rank, SNIP: Source Normalized Impact per Paper

Table I. Scattering of Indian research **on** Covid-19 has featured in both national and international journals. Top 15 journals that have published 24.96% of total research articles are listed here.

Active Indian Researcher/Contributor

Resultant data reveals that Wiwanitkit, V. contributed the highest number of publications (109) and ranked as the most prolific author. The other prominent authors publishing a significant number of research documents are K. Dhama, R. Vaishya, S. Bhatnagar, R. Tiwari and A. Mishra. The scientific productivity in terms of publications of the top 20 contributors varied from 14 to 109. The **Table II** presents the top 20 leading Indian contributors in the domain of Covid-19 research.

Table II. Top 20 leading Indian contributors in the domain of Covid-19 research

Contributor Name	Count	Institution
Wiwanitkit, V.	109	D.Y. Patil University, Pune
Dhama, K.	46	Indian Veterinary Research Institute, Bareilly
Vaishya, R.	30	Indraprastha Apollo Hospitals, New Delhi
Bhatnagar, S.	25	All India Institute of Medical Sciences, New Delhi
Tiwari, R.	25	College of Veterinary Science India, Tirupati
Misra, A.	22	Fortis CDOC Hospital for Diabetes and Allied Sciences, New Delhi
Singh, A.K.	20	G.D Hospital & Diabetes Institute, Kolkata
Grover, S.	19	Postgraduate Institute of Medical Education & Research, Chandigarh
Malik, Y.S.	19	Indian Veterinary Research Institute, Bareilly
Pal, R.	18	Postgraduate Institute of Medical Education & Research, Chandigarh
Mehra, A.	17	Indian Veterinary Research Institute, Bareilly
Sahoo, S.	17	Postgraduate Institute of Medical Education & Research, Chandigarh
Gupta, N.	16	VMMC & Safdarjang Hospital, New Delhi
Ish, P.	16	VMMC & Safdarjang Hospital, New Delhi
Javaid, M.	15	Jamia Millia Islamia, New Delhi
Vaish, A.	15	Indraprastha Apollo Hospitals, New Delhi
Haleem, A.	14	Jamia Millia Islamia, New Delhi
Gupta, N.	14	Indian Council of Medical Research, New Delhi
Kar, S.K.	14	King George's Medical University, Lucknow
Prasad, N.	14	Sanjay Gandhi Postgraduate Institute of Medical Sciences Lucknow

Table II. Shows the top 20 active researchers with their institutional affiliation. These authors produce higher number of articles in the domain knowledge of Covid-19 research

Keyword Cluster Analysis

Top keywords having a frequency of occurrence (≥15) are considered for creating a cluster map from the author's keywords. Top 67 key terms are grouped into eight clusters based on their link strength and influence. Cluster wise distributions of keywords are shown in **Figure 2**. As indicated in Figure 2, the higher occurrence of these keywords and link strength indicates the information about current research trends. Each cluster is distinguished from each other by different color. Top five most frequent keywords with total link strength are covid-19 (Occurrence-1419, TLS-1925), sars-cov-2 (Occurrence-451, TLS-865), coronavirus (Occurrence-364, TLS-721), pandemic (Occurrence-286, TLS-573) and India (Occurrence-117, TLS-209).

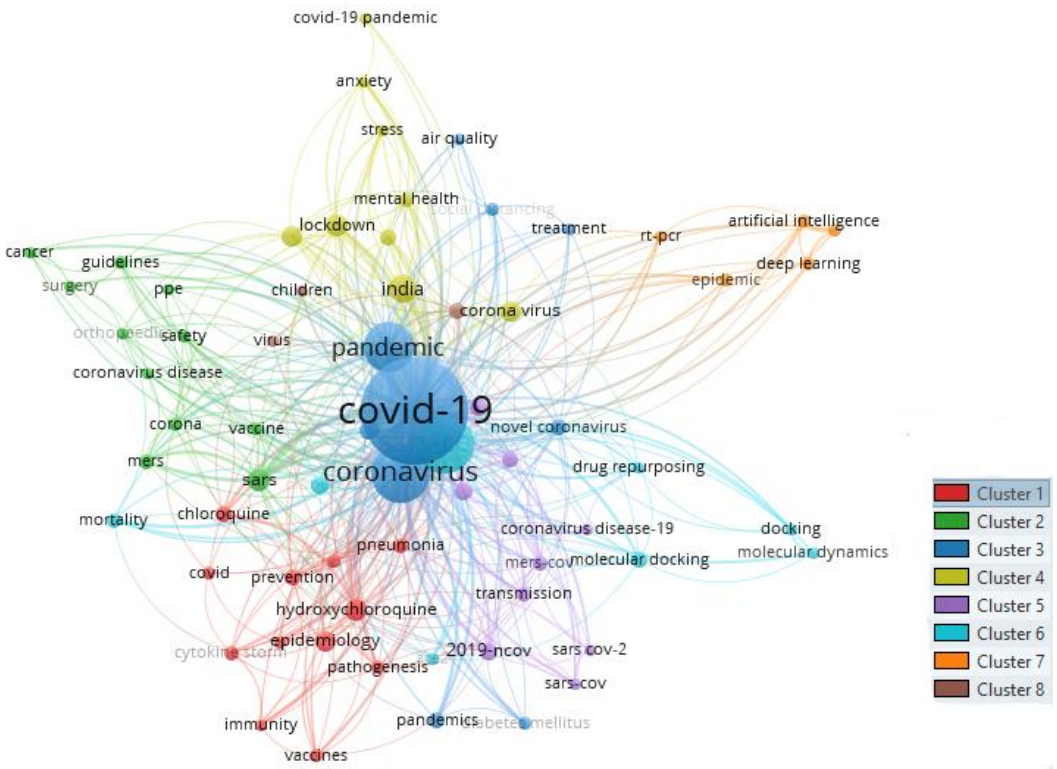

Figure 2. Visualization of keywords having a frequency of occurrence (≥15) are considered for creating a cluster map. Top key terms are grouped into eight clusters based on their link strength and influence

Documents Co-Citation Analysis

The analysis of co-cited articles explores the links between co-cited references. A co-citation cluster is created using CiteSpace. Top clusters are represented in different colors with co-citations of the publications. The top-ranked publication by citation counts is (Huang C) in Cluster #0, with citation counts of 211. The second one is (Chen N) in Cluster #0, with citation counts of 150. The third is (Wang D) in Cluster #0, with citation counts of 136. The 4th is (Wu Z) in Cluster #0, with citation counts of 123. The 5th is (Wang M) in Cluster #0, with citation counts of 110.

The top ranked publications by centrality is (Kumar D) with centrality of 30. The second one is (Umesh KD) with centrality of 30. The third is (Joshi RS) in with centrality of 29. The 4th is (Sarma P) with centrality of 28. The 5th is (Al-Khafaji K) with centrality of 28. The 6th is (Sinha SK) with centrality of 27. The 7th is (Islam R) with centrality of 27. The 8th is (Muralidharan N) in with centrality of 25. The 9th is (Khan SA) in with centrality of 25. The 10th is (Elfiky AA) in with centrality of 25.

The top ranked item by sigma is (Coutard B) with sigma of 0.09. The second one is (Huang C) with sigma of 0.09. The third is (Wu A) with sigma of 0.09. The 4th is (Gautret P) with sigma of 0.08. The 5th is (Lu R) with sigma of 0.08. The 6th is (Wang M) in with sigma of 0.07. The 7th is (Liu X) with sigma of 0.06. The 8th is (CaiQ) with sigma of 0.06. The 9th is (Shi H) with sigma of 0.06. The 10th is (Grein J) with sigma of 0.05.

A timeline view of a co-citation network represented in **Figure 3** derived from 480 nodes and 1440 links of 3465 publications. Each timeline runs from the left to the right. Clusters are shown from the top downwards in the descending order of their size. The earliest co-citation cluster is Cluster #0 clinical studies and starting from 2015. Around 2013, the major attention was shifted to Cluster #1 diabetes mellitus, which in turn shifted to Cluster #2 antiviral activities. Cluster #8 zoonotic lesson and started getting attention during 2019-2020. Cluster #0 (82 publications) &Cluser #1 contain a series of highly cited articles with 68 publications.

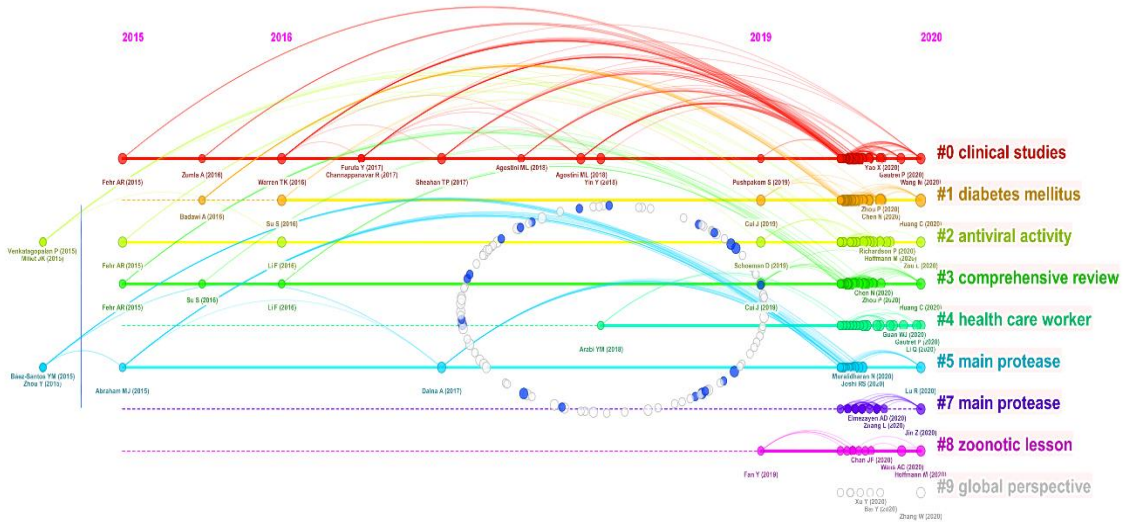

Figure 3. A timeline visualization map of cited references in Covid-19 research indicating the hotspot in the current research field

The **Table III** represents the numbers of the publications in the cluster according to the size. The largest cluster (#0) contains 82 members' references, followed by cluster (#1), which has 68 members' references. Silhouette scores calculated by CiteSpace measure the homogeneity of a cluster. Higher score of silhouette represents better of the homogeneity among nodes. Silhouette

score 0.7 represents that clustering is considered to be highly reliable where as silhouette score >0.5 denotes that clustering result is reasonable. The silhouette score of the largest 4 clusters as calculated by CiteSpace listed in Table V. Silhouette value of all clusters (#0-3) are above 0.7 signifies that these clusters are efficient and convincing. Mean represents the average year of the published documents of the regarding cluster. It can be used to judge whether the cluster is new or old (Yu & Xu, 2017). These Clusters (#0 -3) are larger and significant clusters which indicates that 'clinical studies' and 'diabetes mellitus' 'antiviral activity', and 'comprehensive review' on Coid-19 are is a research hotspot in the current research field.

Table III. Top 5 clusters based on size in Covid-19 research

Cluster ID	Size	Silhouette	mean(Year)	Label (LLR)
0	32	0.64	2019	evidence-based recommendation
1	32	0.763	2019	novel coronavirus disease sars-like coronavirus
2	31	0.875	2019	practical consideration
3	31	0.721	2019	special reference
4	22	0.749	2020	pediatric intensive care unit

Table III. Presents the numbers of the publications in the cluster according to its size. Silhouette scores calculated by CiteSpace measure the homogeneity of a cluster. Higher score of silhouette represents better of the homogeneity among nodes.

Discussion

This bibliometrics analysis brings to light some interesting facts about covid-19 research trends, and collaborative pattern and the influential institutions & authors of India.

Although USA, England and China are found as leading research partner, but countries like the Thailand, Italy, Australia, Germany, Brazil and Canada are other prominent collaborators with India for producing significant research in the area of Covid-19. In total contributors from 192 countries collaborated with India for producing 6.55 percentage of the global research output (52,916).

India ranked 5th position in the number of covid-19 scientific publications published in the world. India's premier medical institution All India Institute of Medical Sciences, New Delhi has played key role in Covid-19 and produces maximum research on this domain. It has been observed that Government aided medical research institutions such as AIIMS, ICMR, PGIMER, NIMHANS, IVRI are mainly producing maximum research whereas there is lack of active participations of Indian universities and private institutions. This gap need to be filled and universities & private

institutions should actively involve in different aspect of the epidemic research. The pharmaceutical industries which are particularly engaged in developing potential vaccine should collaborate with these leading medical research institutions for better research sharing.

The journal analysis revealed that although Indian publications are featured on high quality global journal still significant share of research work were communicated in Indian based journals. Publishing research findings in an interdisciplinary journal such as Nature and Science will provide a better platform for Indian scientists to reach out to wider global community. The study also reveals that one fourth share of the total research articles are communicated in top 15 core journals listed in Table II.

Significant portion of Indian research is concentrated in the area of Covid-19 and its impact on diabetes, cardiovascular patients, social and environmental impact of the pandemic. Result also revealed that few studies are carried out on the clinical prognosis of the disease, drugs target and laboratory based studies.

Co-citation cluster analysis indicate that clusters (#0 -3) are larger and significant clusters which shows that ‘clinical studies’ and 'diabetes mellitus’ ‘antiviral activity’, and ‘comprehensive review’ on Coid-19 are is a research hotspot in the current research field

Conclusions

India is one of among 10 worst Coronavirus-Hit Nations. The world faces a severe and urgent public health emergency due to the ongoing COVID-19 pandemic. Indian researchers have contributed significantly in Covid-19 research and ranked 5th position in the number of covid-19 scientific publications published in the world. However lack of more international collaboration and high quality papers are being observed in this study. The All India Institute of Medical Sciences, New Delhi has produced the highest number of research papers 102(7.13%) followed by the Postgraduate Institute of Medical Education & Research, Chandigarh 86(6.25%). The ‘Diabetes and Metabolic Syndrome Clinical Research and Reviews’ publish maximum research documents 102(2.94%) followed by ‘International Journal of Research in Pharmaceutical Sciences’ of 96 (2.77%) and ‘Asian Journal of Psychiatry’ of 95 (2.74%) research papers. Study also reveals that there is continuous growth of Indian research publications on COVID-19 since

the outbreak of the epidemic and many researchers across the world are working together to containment the spread of Covid-19 infectious diseases. Result of our study found some significant insights and can be used further research in identifying potential collaborator and a better understanding of COVID-19 research arena and improve research covid-19 dimensions to a new height. Analysis of the data indicates that for focus on national and international levels collaboration among researchers is needed. Considering the global impact and social distressed occurred due to the outbreak of Covid-19 pandemic, this study is useful in the present scenario for understanding research pattern emerging from Indian. This clearly depicts the perspective areas of research which required urgent attention of the scientific communities and discovery of vaccine will potentially limit the spread of the epidemic.

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