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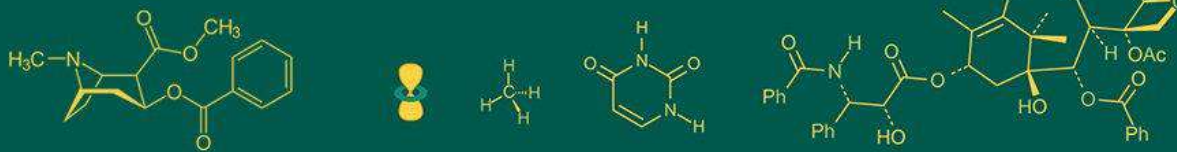
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Status and trends of Indian coronavirus research and highly (100) cited papers: Bibliometric and visualization analyses

Prema

Abstract
COVID-19 has affected almost everyone on this world directly or indirectly. The virus has changed people's way of life, the economy has collapsed, and because of the effects of the virus, people have maintained social distance. Researchers and scientists around the world are trying their best to find a medication/solution for this disease, and as a result, more than 20,000 research papers have been published during mid-2020. It is a record in itself that in a short period of time. This study was conducted to quantify the Indian researcher's contribution to the COVID-19. Indian authors published a total of 2826 papers, of them 241 were published in single authorship. All these papers were counted 11491 total citations with 4.07 CPP. This study also analysed the research papers using various indicators like country collaborations, author collaborations, authorship patterns, keyword occurrences, etc.

Keywords: COVID-19, Corona virus, bibliometrics, authorship pattern, highly cited papers, India

Introduction

Present connected global, infectious and formerly mysterious virus have become a global pandemic. In early January 2020, the sanatorium/ sanitarium of Wuhan city in china stated receiving patients with chest infection of an unknown purpose. The medical reports of those sufferers resembled viral chest infections and included fever, cough, and dyspnea. Preliminary laboratory investigations connected it with the coronavirus family; but no positive links were established. The World Health Organization (WHO) was alarmed about this outbreak. Within a month (January 30, 2020), the WHO had declared this outbreak as global health emergency. On March 11, 2020, they pronounced it a pandemic [1]. In the absence of a specific treatment or vaccine, minimizing human contact was the only way to slow its spread [2]. The virus has been named a novel coronavirus and coded as COVID-19 and 2019-nCoV. Phylogenetic analyses have revealed its close similarity with the severe acute respiratory syndrome (SARS)-related coronavirus clade. It is a single-stranded positive-sense ribonucleic acid (RNA) type virus, which bears 82% similarity to SARS-CoV. Predominantly, patients on presentation have respiratory symptoms, but may also involve intestines, liver, and brain.

The current pandemic status has put an extremely large pressure on medical practitioners, virologists, and research workers to devise a productive cure, vaccines to treat the changes in artificial way patients. The researchers working energetically in contact with dispassionate trial research and testing arrangement. As a result of this, India starts COVID-19 immunization amid a trial by Bharat Biotech, which exists developing a cure as one accompanying the Indian Council of Medical Research, the Indian Government's agency for discovery through experimentation research. The cure exists called COVAXIN. In January 2021, India's drug something that regulates circulated a restricted crisis authorization for COVAXIN, alongside COVISHIELD. On January 16, 2021, India started the world's best vaccination program for COVID-19, point or direct at a goal of a primary group of 300 people [3-5].

However, studies on qualitative and quantitative characteristics of global as well as Indian research of coronavirus are restricted [6, 7]. Assessment of the current status and patterns of coronavirus research and anticipating promising current topics and directions in the field are

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more fundamental. Publication, as a central part of scientific research, is an important indicator for research contribution. Bibliometrics combined with visualized mapping has been perceived as an effective means of measuring scientific growth [8]. Information from online databases and metrology characteristics were examined through bibliometric examination, which can be utilized to qualitatively and quantitatively assess the patterns in the research community over time [9]. Assessment among the contributions of scholars, journals, institutions, and countries could be shown through the bibliometric analysis. Bibliometric study is also useful to policymaking and clinical guidelines. Likewise, proficient analysis has been applied effectively to make studies more intuitional, including Middle East respiratory syndrome coronavirus, exosomes, retina regeneration, stem cells for osteoarthritis, and spinal ultrasound [5, 10–14]. The aim of the study is to measure the Indian coronavirus research status, trends and discover the current topics for researchers interested in coronavirus and assess the highly cited articles in 'Coronavirus' research published till 2020.

Research Questions

This study is organized with the key research questions to provide a revealing picture of peer-reviewed literature published on the Coronavirus that has already been published during the outbreak of disease. The main research questions of the study are:

1. Overall publication trends
2. Analysis of the most cited articles on the COVID-19 field
3. Authorship Pattern
4. The top 20 most productive Authors
5. The top 20 highly productive and influential institutions in research on COVID-19 and collaborations among highly productive institutions
6. Keywords analysis
7. Countries Collaboration

Materials and Methods

Web of science database has been used to retrieve bibliographic data using the below search query. "TS= (COVID-19 OR 2019-nCoV OR coronavirus 2019 OR Coronavirus disease 2019 OR SARS-CoV-2) AND CU=India Timespan: 2020-2021. Indexes: SCI-EXPANDED, SSCI, A&HCI." However, the titles, years of publication, names of authors, nationalities, affiliations, keywords, names of publishing journal, abstracts of each record, and citations within the publications downloaded from WOS, were saved as TXT files and imported into Microsoft Excel 2019 and later to analysed the data with VOSviewer and R software's. In R software, the biblioshiny app, which is a completely web-based application, was used to do science mapping and bibliometric analysis (Aria et al., 2020).

Results and Discussion

As I am involved in historical nature of research and publications, I have considered the keywords like 'COVID-19' '2019-nCoV' 'coronavirus 2019' 'Coronavirus disease 2019' 'SARS-CoV-2' to get a me extensive coverage and to find out potential areas for future studies on COVID- 19. Also, we have included the keywords like 'SARS,' 'MERS,' 'severe acute respiratory syndrome' and 'Middle East Respiratory Syndrome' meanwhile it denotes the historical alliance with COVID-19. Table 1 summarizes the search results:

Table 1: Summarizes the Search Results

Description	Results
Period	2020-2021
Sources (Journals, Books, etc)	928
Documents	2826
Average citations per documents	4.066
Document Types	
article	1322
letter	718
review	472
editorial material	293
meeting abstract	12
correction	8
news item	1
Document Contents	
Keywords Plus (ID)	2856
Author's Keywords (DE)	4759
Authors	
Authors	10126
Authors of single-authored documents	186
Authors of multi-authored documents	9940
Authors Collaboration	
Single-authored documents	241
Co-Authors per Documents	5.74
Collaboration Index	3.85

Overall Publication Trends

From 2019 to 2020 (until 5th January 2021) 2826 publications were found in the web of science database, published by Indian authors. Table 1 shows that the most common category was an article (46.78% of 2826) followed by letters (25.41%, 718) early accesses (19.36%). 293 (10.37%) editorial materials were published in various journals. In total, 1615 research output were published in 262 journals mostly in Journal of Biomolecular Structure & Dynamics (5.02%; 142 articles), Indian Journal of Ophthalmology (3.60%; 102 articles), Indian Pediatrics (1.87%; 53 articles), and Dermatologic Therapy (1.84%; 52 articles).

Analysis of the most cited articles on the COVID-19 field

As on date (until 5th January 2021), 2826 papers were published. Of these 1504 (53.22 %) were not cited yet, 407 (14.14%) had one citation, 214(7.57 %) had two citations, 155(5.48 %) had three citations; 93(3.29 %) had four citations, 72(2.55 %) had five citations, 158(5.59 %) had 6 – 10 citations; 208(7.36 %) had 11 – 100 citations, 13(0.46 %) had 101 – 263 citations and 2(0.07 %) had 402 and 404 citations. The top 20 most cited articles in 2020 are given in Table 6. Of these two articles were published in Asian Journal of Psychiatry and Science of the Total Environment. One each in Aging and Disease, British Medical Journal, Brain Behavior and Immunity, Diabetes Research and Clinical Practice, GUT, Head and Neck-Journal for The Sciences and Specialties of The Head and Neck, Human Vaccines & Immunotherapeutics, Indian Journal of Pediatrics, Jama-Journal of The American Medical Association, Journal of Biomolecular Structure & Dynamics, Journal Of The American Academy of Dermatology, Kidney International, Lancet Neurology, Lancet Respiratory Medicine, Travel Medicine and Infectious Disease and Veterinary Quarterly. The most cited article was SINGHAL T, 2020 with TC2020 of 404.

Table 2: Highly cited Papers on Coronavirus

| Paper	DOI	TC
Singhal T, 2020, Indian J Pediatr	10.1007/s12098-020-03263-6	404
Rodriguez-Morales AJ, 2020, Travel Med Infect DI	10.1016/j.tmaid.2020.101623	402
Rajkumar RP, 2020, Asian J Psychiatr	10.1016/j.ajp.2020.102066	263
Leng ZK, 2020, Aging DIS	10.14336/AD.2020.0228	244
Phua J, 2020, Lancet Resp Med	10.1016/S2213-2600(20)30161-2	236
Sethuraman N, 2020, JAMA-J AM Med Assoc	10.1001/jama.2020.8259	185
Naicker S, 2020, Kidney INT	10.1016/j.kint.2020.03.001	138
Joob B, 2020, J AM Acad Dermatol	10.1016/j.jaad.2020.03.036	135
Roy D, 2020, Asian J Psychiatr	10.1016/j.ajp.2020.102083	132
Dhama K, 2020, Hum Vacc Immunother	10.1080/21645515.2020.1735227	128
Muralidharan N, NA, J Biomol Struct DYN	10.1080/07391102.2020.1752802	125
Chew NWS, 2020, BRAIN Behav Immun	10.1016/j.bbi.2020.04.049	121
Sharma S, 2020, Sci Total Environ	10.1016/j.scitotenv.2020.138878	119
Hussain A, 2020, Diabetes Res Clin PR	10.1016/j.diabres.2020.108142	108
Chiu PWY, 2020, GUT	10.1136/gutjnl-2020-321185	103
Khunti K, 2020, BMJ-Brit Med J	10.1136/bmj.m1548	97
Malik YS, 2020, Vet Quart	10.1080/01652176.2020.1727993	91
Ellul MA, 2020, Lancet Neurol	10.1016/S1474-4422(20)30221-0	90
Mahato S, 2020, Sci Total Environ	10.1016/j.scitotenv.2020.139086	89
Kowalski LP, 2020, Head Neck-J SCI SPEC	10.1002/hed.26164	88
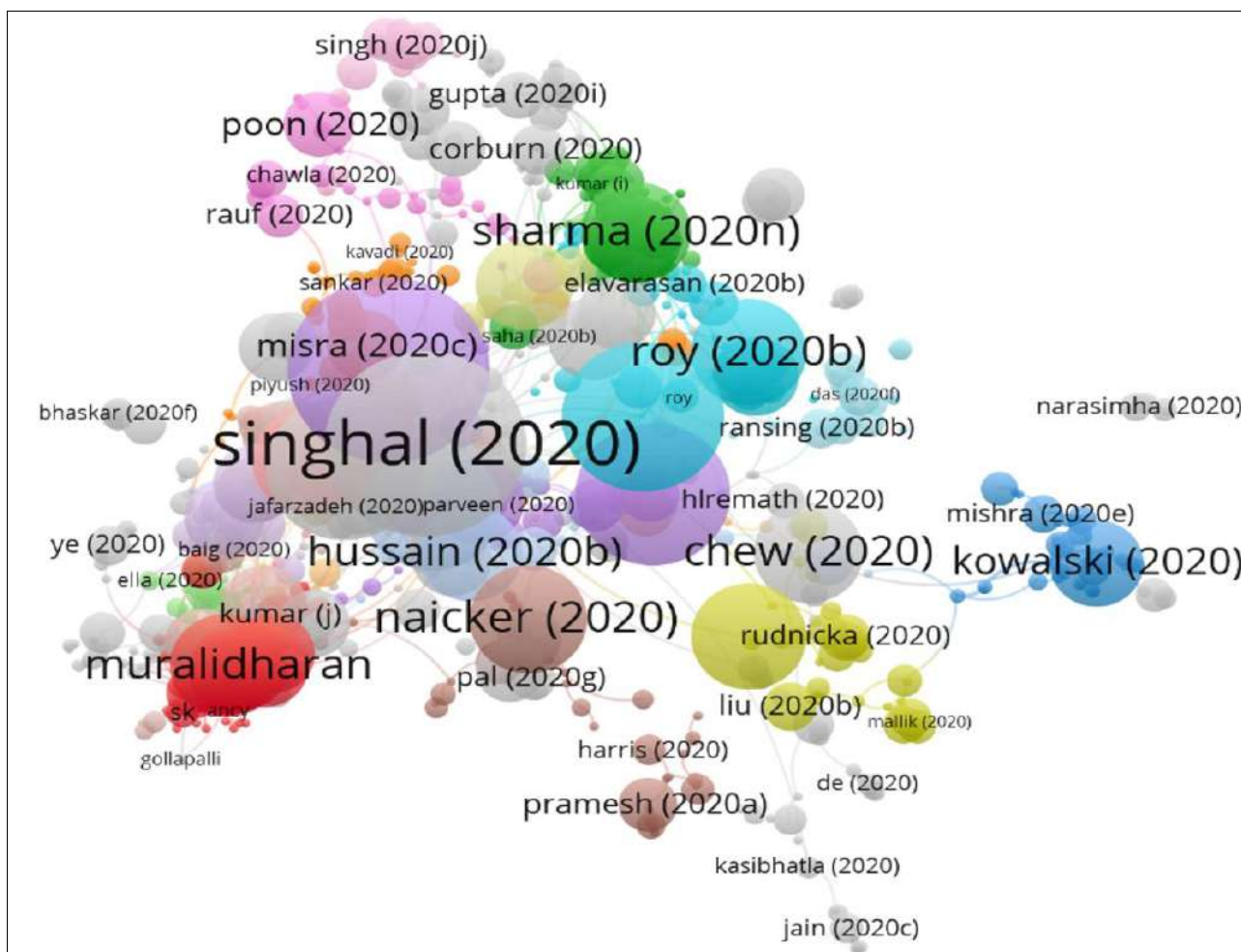
Fig 1: Highly Cited Articles Network

Authorship Pattern

Table 3 shows the 500 highly cited articles were authored by 3624 authors both single or in collaboration. The author's contribution pattern was found as: 23 (0.63 %) articles contributed by single author, 103 (5.68 %) articles contributed by two authors, 67 (5.55 %) articles contributed by three authors, 57 (6.29 %) articles contributed by four authors, and 87 (51.08 %) articles contributed by 10 or more authors.

Table 3: Authorship Pattern

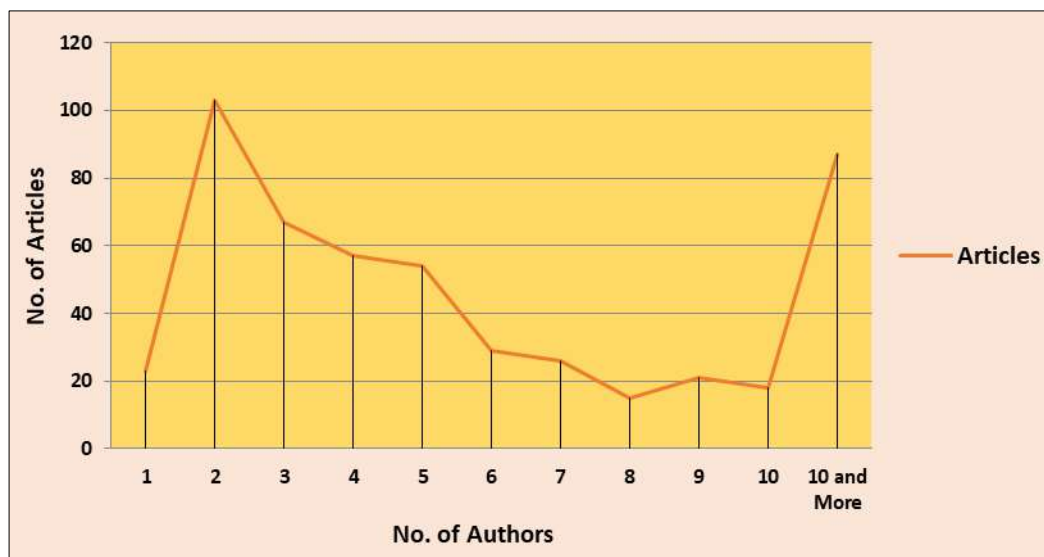| Authors	Articles	Total Authors	%
1	23	23	0.63
2	103	206	5.68
3	67	201	5.55
4	57	228	6.29
5	54	270	7.45
6	29	174	4.80
7	26	182	5.02
8	15	120	3.31
9	21	189	5.22
10	18	180	4.97
10 and more	87	1851	51.08
	500	3624	100.00

Fig 2: 500 Highly Cited Articles Authorship pattern

Authors of Highly Cited articles

Table 4 shows the list of the top 20 most productive author with 20 or more highly cited articles. Wiwanitkit V was the most productive author, who published 89 highly cited articles in Coronavirus. Dhama K. from Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh have published the most frequently cited papers and the 36 papers with 802 citations and 9 h-index; have an average citation of 22.28 per paper. It is observed that these highly cited authors have better-contributed research in coronavirus as shown within the co-citation network (Fig. 3).

Table 4: Highly Cited authors

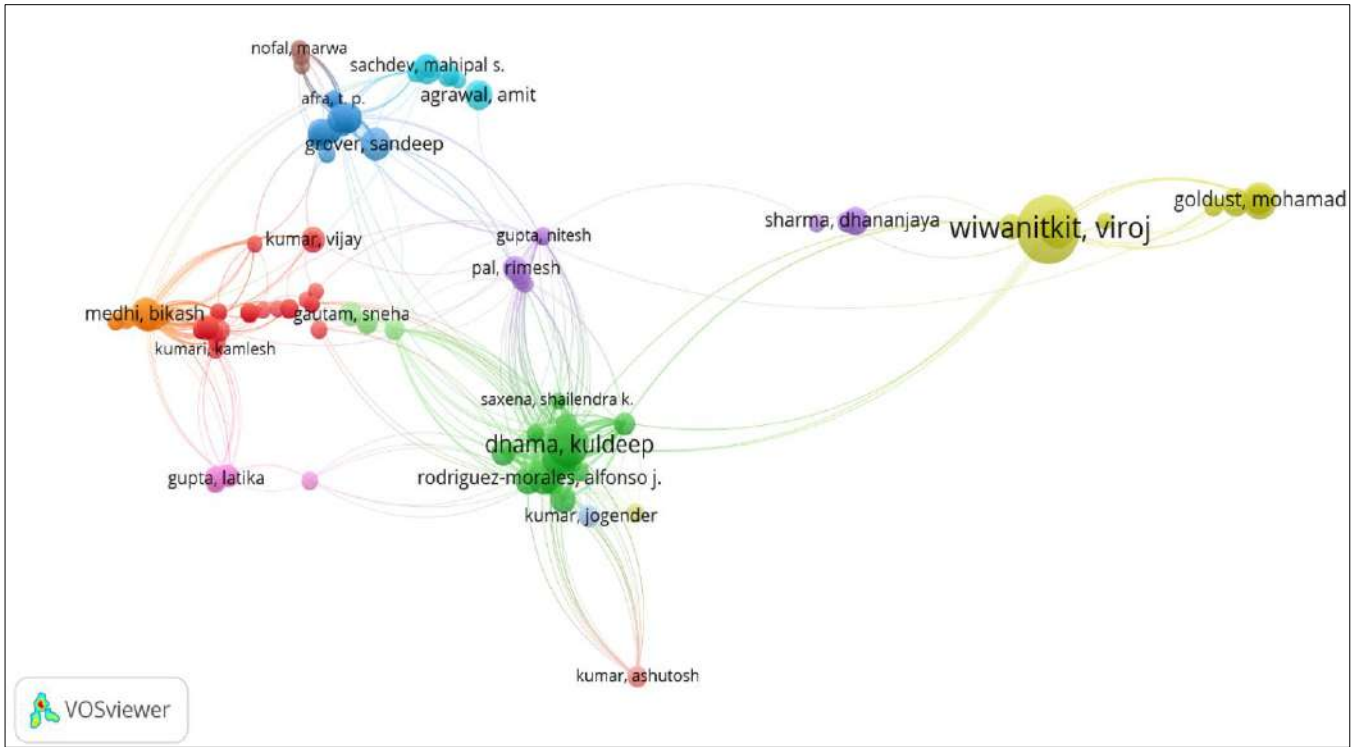| Author	NP	TC	h_index	g_index
Wiwanitkit V	89	353	8	17
Kumar A	74	167	7	11
Kumar S	63	362	8	18
Sharma S	43	192	6	13
Singh S	40	123	4	10
Sharma A	40	96	6	7
Kumar P	39	70	5	7
Gupta S	37	114	6	10
Dhama K	36	802	9	28
Kumar V	36	148	7	11
Sharma P	35	75	5	8
Joob B	33	258	8	15
Singh A	32	122	4	10
Kumar R	32	106	5	9
Das S	30	161	7	12
Gupta A	29	77	4	8
Gupta N	29	62	3	7
Sharma N	25	156	3	12
Tiwari R	24	366	8	19
Ghosh S	22	63	3	7

Fig 3: Authors Citation Network

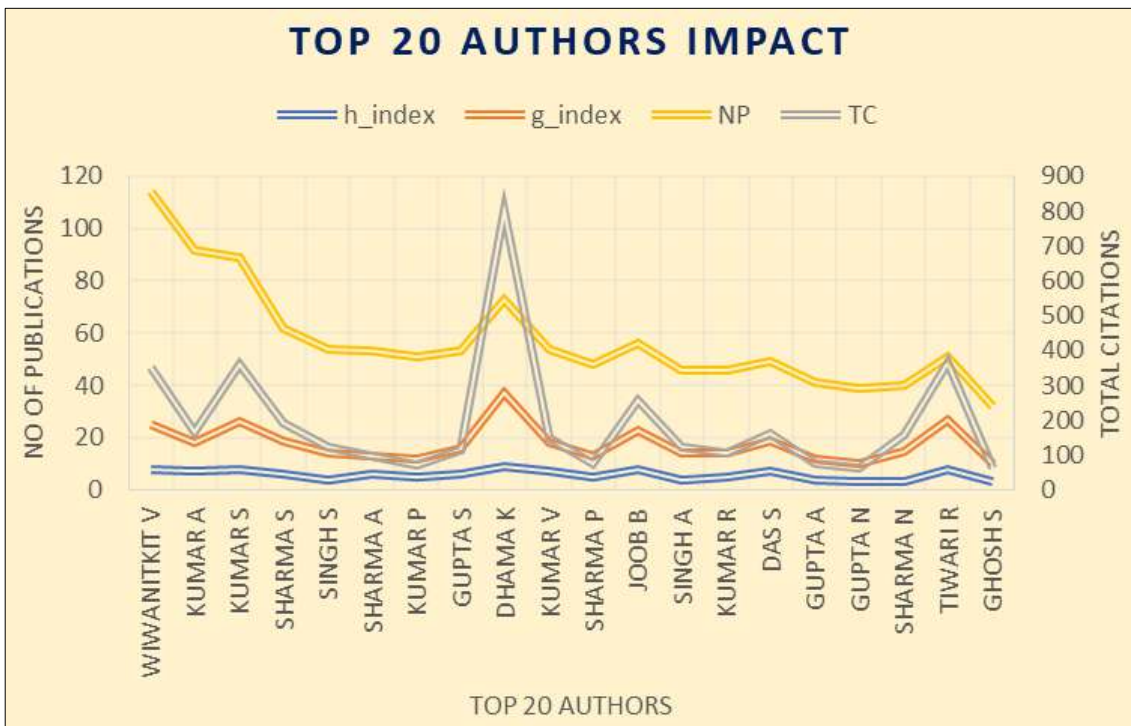**Fig 4:** Top 20 Author's Impact

Top 20 Highly Productive and Influential Institutions.
The most prolific institutions producing research on the Coronavirus are identified by checking scholars' institutional affiliations. 40 institutions had published 25 and more highly cited articles on Coronavirus. Table 4 presents the top 20 institutions with more than 25 highly cited articles. The All-India Institute of Medical Sciences, New Delhi was the most productive institution with 339 (11.996

%) highly cited articles on Coronavirus total citations of 402, followed by Post Graduate Institute of Medical Education Research, Chandigarh contributed 188 (6.653%) papers with 441 total citations. ICAR Indian Veterinary Research Institute had contributed 41 papers with the highest total citations of 800. The top 20 institutions had published 1585 (56.087 %) of the total publications (Table 5).

Table 5: Top 20 Highly Productive and Influential Institutions.

Organizations	TP	TC	% Of 2826
All India Institute of Medical Sciences AIIMS New Delhi	339	402	11.996
Post Graduate Institute of Medical Education Research (PGIMER) Chandigarh	188	441	6.653
Indian Institute of Technology System (IIT System)	171	144	6.051
Dr Dy Patil Vidyapeeth Pune	96	328	3.397
Council of Scientific Industrial Research (CSIR) India	77	211	2.725
Manipal Academy of Higher Education (MAHE)	66	301	2.335
University of London	66	549	2.335
Indian Council of Agricultural Research (ICAR)	60	800	2.123
National Institute of Mental Health Neurosciences India	53	68	1.875
Hainan Medical University	50	229	1.769
Banaras Hindu University	47	81	1.663
All India Institute of Medical Sciences (AIIMS) Rishikesh	46	101	1.628
All India Institute of Medical Sciences (AIIMS) Jodhpur	44	51	1.557
Department of Biotechnology (DBT) India	43	144	1.522
University of Delhi	42	94	1.486
ICAR Indian Veterinary Research Institute	41	800	1.451
King George S Medical University	41	237	1.451
Tata Memorial Hospital	41	393	1.451
Amity University	38	19	1.345
Homi Bhabha National Institute	36	11	1.274

Keywords analysis

The keywords analysis epitomizes the hotspot in the area of research. All the keywords were calculated by biblioshny and visualisation network was made by VOS viewer software. Table - 6 shows the output of biblioshny where it can be seen that the word "*COVID-19*" was occurred 1191 times, "*sars-cov-2*" was occurred 529 times and "*coronavirus*" was occurred 426 times. In the Figure – 5 (All keywords) and figure – 6 (Author keywords) which depict the visualisation of the co-occurrence of key words,

these three words are represented by large circles which discloses that the occurrence of the availability of these words in the datasets were more in evaluation to the other keywords. The network was formed by arranging the keywords by a least occurrence of 5 times. Out of the total 6574 keywords, 472 met the threshold. The network covers 9263 keywords, 54152 co-occurrence and 10 clusters. Keywords with the same colour suggest that these keywords have close connection and usually co-occur.

Table 6: Highly Prolific Keywords

Keyword	Frequency
COVID-19	1191
sars-cov-2	529
coronavirus	426
SARS	177
pandemic	173
pneumonia	124
virus	119
infection	110
India	107
lockdown	88
molecular docking	82
respiratory syndrome coronavirus	82
spike protein	70
docking	68
outbreak	68
protein	66
ace2	64
acute respiratory syndrome	62
china	62
chloroquine	61
hydroxychloroquine	59
receptor	58
transmission	58
cytokine storm	57
SARS-CoV-2	54

Fig 5: All keywords network

Fig 6: Author Keywords Network

Visualization of Countries Collaboration

The figure 7 shows the network visualization of the country's collaboration and 49 countries (with at least 5 documents from the same country) were found to have published highly cited papers on Coronavirus. All the 49 countries were taken for mapping. Each circle on the map represents a country. Collaboration can be seen in circles; big circles denote larger the research papers and more

collaborations among the countries. With the help of the map, it is found that India's circle is bigger, it means India is the host and shows its collaboration with the other country that has a larger number of scholarly publications. India is highest collaborated with the USA followed by the United Kingdom, China, Saudi Arabia, Thailand, Australia, etc.
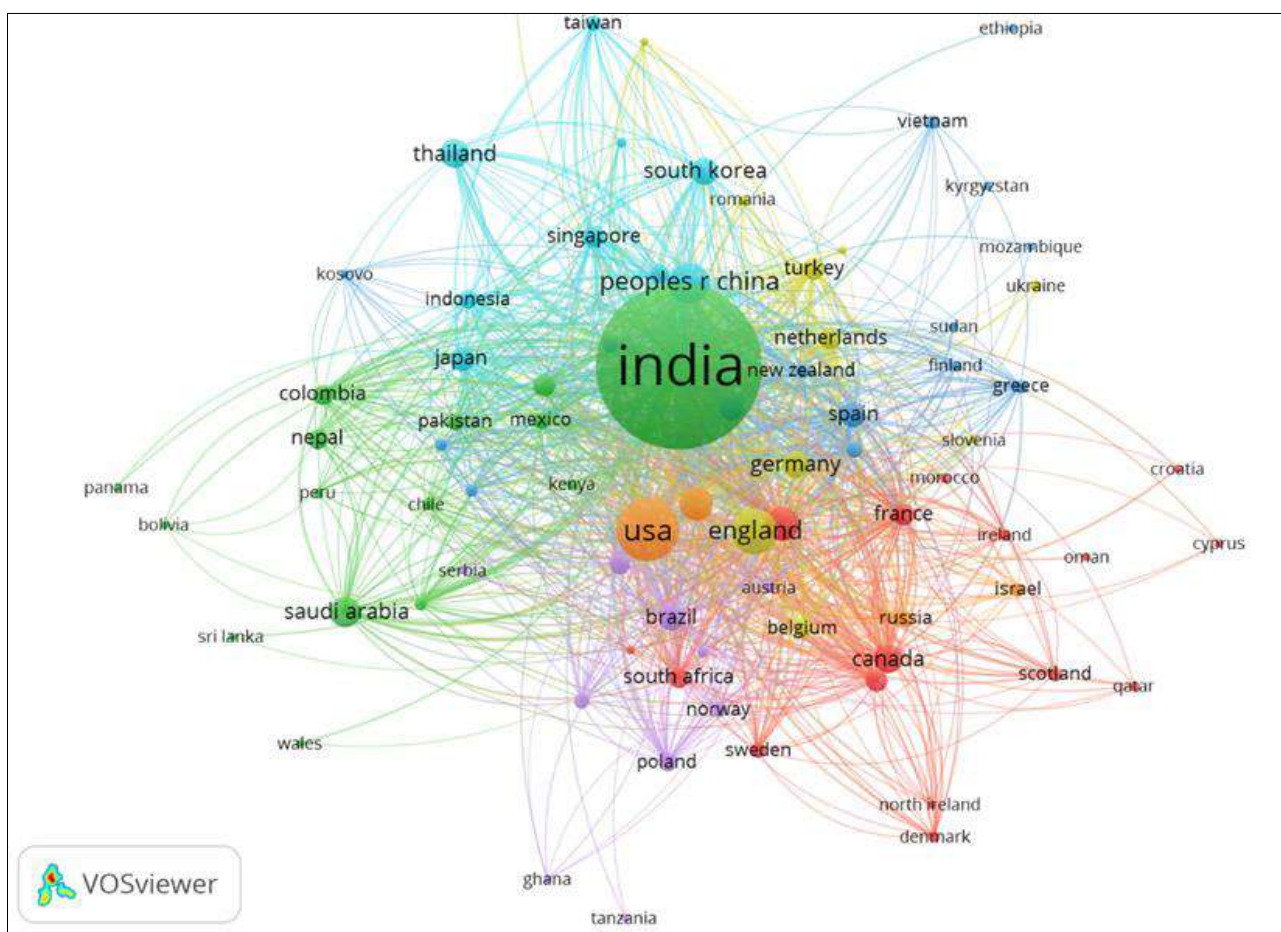

Fig 7: Countries Collaboration Network

Conclusion
Remarkably, there are 2826 publications published in this area of research, Thanks to the leading academic publishers who have committed to making today's research and information accessible through free access. Though the Journal of Biomolecular Structure & Dynamics tops the list having a total citation of 1021 and an h index value of 18, followed by the Science of the Total Environment (TC = 684; h index = 13). The trend indicates an augmented interest by the journals to publish relevant articles and authors can consider the opportunity to publish their latest scientific outputs, especially, on the recent coronavirus epidemic related topics. These findings indicate an instant need for collaborative research with datasets from other regions employing inclusive models. Analysing the keywords and co-words, we also identified the geographical concentrations of research recognizing the significant occurrences of keywords like 'India' (TO=107), 'China' (TO=62) and 'lockdown' (TO=88). The top keywords 'Coronavirus', 'COVID-19', 'SARS cov2', 'pandemic', 'respiratory syndrome coronavirus' and 'sars' along with 'Pneumonia' are mostly used in the recent publications. While several recent publications are concentrating on the nature of the virus and disease itself, a lack of preventive studies is observed. We noticed that some keywords like 'vaccine' or 'antiviral' were used in this area of research during the 2010s, although in a low frequency; but such studies seem helpful for future studies.

COVID-19 circulation and spread have a high prospective in locations where many people gather and have adjacent physical contact and it is hard to maintain social distance (e.g., airports, shopping malls, schools, colleges, universities, etc.) and in both closed and open environments including professional, university, amateur, or recreational members participating in numerous sporting places. Social isolation, staying at home (exclusively for the elderly and with illnesses) and leaving only when necessary is most careful, beginning of 2021, in the first semester, to witness the outcome of the epidemic scenario, even with the potential arrival of the vaccine and mass vaccination.

Since the health issues caused by COVID-19, one can assume that signs and symptoms could damage physical and sports performance and have medium, long term effects, cause immunosuppression, and growth to more severe health conditions if no diagnosis is made and adequate treatment is not completed. In most serious cases, COVID-19 can cause SARS requiring automated ventilation and care in an ICU and oxygen therapy. Incurable and serious cases were mainly found in the elderly (aged $\geq$ 60 years 15%). Nearly 50% of the serious cases are persons affected with comorbidities such as cardiovascular disease, diabetes, chronic respiratory disease, and oncological diseases. Thus, WHO and CDC issued an important note that "Older adults and people who have certain underlying conditions like heart or lung disease or diabetes are at increased risk of severe illness from COVID-19".

A few days ago, vaccines or specific antiviral drugs were available for treating the COVID-19. Still, the WHO and CDC has issued the following general recommendations: "Avoid close contact with subjects suffering from acute respiratory infections; Wash hands frequently, especially after contact with infected people or their environment; Avoid unprotected contact with farm or wild animals; People with symptoms of acute airway infection should keep their distance, cover coughs or sneezes with disposable tissues or clothes and wash their hands; Avoid close contact with subjects suffering from acute respiratory infections; People with symptoms of acute airway infection should keep their distance, cover coughs or sneezes with disposable tissues or clothes and wash their hands and must wear masks; Individuals that are immunocompromised should avoid public gatherings". However, gradually the world is resuming economic, social, and sportive activities after the first wave of the COVID-19 pandemic. Currently, the countries' scenarios around the world, for dealing with the pandemic, are different and continuously change over time with the arrival of each next wave.

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