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Covid-19 and Fungal Infections: A Scientometric Assessment of Global Publications during 2020-21

B.M.Gupta*
Madhu Bansal**
Jeevanjot Kaur***
Asha Rani****

People with severe Covid-19, such as those in an intensive care unit (ICU), are particularly vulnerable to fungal infections, which are reported with increasing frequency and can be associated with severe illness and death. The present study gives a bibliometric overview of global literature on 'Covid-19 and Fungal Infections'. Keywords related to "COVID-19" and "Fungal Infection" was used in a search query in the Scopus database covering time span from 2020-2021. Data pertaining to the growth of publications, the most active countries and institutions, the most cited articles, and mapping of keywords to analyze research trends were analyzed. A total of 258 journal articles were retrieved. The United States of America (n=48; 18.60%) ranked first in productivity followed by the France and Italy (n=256; 9.69% each), and China (n=22; 8.53%). Radboud University Nijmegen Medical Centre, Netherlands (n=10, 3.87%) ranked first in productivity, followed by INSERM, France (n=8, 3.10%), CNRS, France and Assistance Publique– Hôpitaux de Paris, France (n=7, 2.71% each) and The Pasteur Institute, France (6 papers, 2.32%). The journal *Mycoses* ranked first (n=13; 5.04%) in publishing articles on this topic, followed by *Medical Mycology Case Reports* (n=8; 3.10%), *Dermatologic Therapy* (n=7; 2.71%) and *American Journal of Respiratory & Critical Care Medicine* (n=6; 2.33). The study points out that awareness of the possibility of fungal co-infection are essential to reduce delays in diagnosis and treatment in order to help prevent severe illness and death from these infections.

Keywords: *Covid-19, Fungal Infection, Global Publications, Scientometrics, Bibliometrics*

* Formerly with CSIR-NISTADS, New Delhi, India.

** Punjab University, Department of Mathematics Library, Chandigarh, India.

*** Formerly with PGIMER Library, Chandigarh, India.

**** CSIR-CSIO Library, Chandigarh, India.

1 INTRODUCTION

In December 2019, the Coronavirus disease 2019 caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged as a new viral respiratory infection first reported in Wuhan (Hubei province), China. Since then, 195,886, 929 confirmed Covid-19 cases and including 4,189,148 deaths have been reported till 30.7.21[1].

Although the majority of cases have asymptomatic to mild infections, a significant proportion progress to severe pneumonia and acute respiratory distress syndrome requiring critical care and mechanical ventilation. SARS- CoV-2 infection leads to both innate and adaptive immune responses, which include a local immune response, recruiting macrophages and monocytes that respond to the infection, release cytokines, and prime adaptive T and B cell immune responses. In most cases, this process is capable of resolving the infection. However, in some cases, which present as severe Covid-19 infections, a dysfunctional immune response occurs, which can cause significant lung and even systemic pathology.

The diffuse alveolar lung damage and dysregulated immune response in severe Covid-19 pneumonia makes these patients vulnerable to secondary infections [2].

A significant gap in our knowledge is whether bacterial and fungal infections in Covid-19 are directly attributable to SARS-CoV-2 or a consequence of factors such as managing high numbers of critically unwell patients, overstretched healthcare systems, and prolonged duration of mechanical ventilation/critical care admission[3].

The most common fungal infections in patients with Covid-19 include aspergillosis or invasive candidiasis. Available information indicates that Covid-19-associated pulmonary aspergillosis (CAPA) usually occurs in patients with severe Covid-19 (e.g., patients on ventilators in ICUs). Covid-19–associated mucormycosis is less common than other Covid-19–associated fungal infections, but emerging reports from India highlight the importance of considering this infection. Some medications used to treat severe Covid-19, including high-dose corticosteroids and tocilizumab, might predispose patients with Covid-19 to mucormycosis. Mucormycosis has been reported in patients with severe Covid-19 infection who lacked other classical mucormycosis risk factors, such as diabetes, conditions or medications that weaken the immune system, and cancer [4].

11 LITERATURE REVIEW

Although a number of bibliometric studies are conducted both on coronoviris in general and Covid-19 in particular. Also a few bibliometric studies are undertaken on assessment of fungal infections. Among such studies, Cen, Li, Huang and Wang [5] presented a bibliometric analysis 1906 global papers of fungal keratitis during 1959-2019 with the objectives to characterize the overall status, general trends and current foci of keratomycoiss research field, using Web of Science database. Howard, López-Agudelo and Gómez-Ríos [6] presented a bibliometric analysis of global scientific research (227 records) on Candida auris, an emerging multidrug resistant fungus considered as the cause of several nosocomial infections, using Scopus databases during 2009- 2018. Sweileh, Sawalha, Al-Jabi and Zyoud[7] presented an

overview of bibliometric analysis of global literature (1648 records) on triazole antifungal drug resistance during 1980- 2015. Data pertaining to growth of publications, the most active countries and institutions, the most cited articles, and mapping of molecular mechanisms of resistance were presented. Sivankalai and Sivasekaran [8] examined 4451 global publications (3798 institutions and 8562 authors contributed and 1151 journals) on Mucormycosis research during 1923 to May 2021, with focus on publications profile of top countries, organisations, authors and journals, based on indexed papers covered in Web of Science database.

Since no bibliometric study exists which focuses on fungal infections complicating Covid-19 both at national and internal level, so we decided to undertake the present bibliometric study at global level on the topic "Covid- 19 and Fungal Infections" with the objective to analyze the literature characteristics, subject scatter and identification of significant keywords identify the major players (countries, organizations, authors and journals) and also study their collaborative linkages.

2 METHODOLOGY

Using a well-conceived search strategy, we performed a bibliometric search on the theme "Covid-19 and Fungal Infection" and identified, retrieved and downloaded all relevant publications records from the Scopus database (https://www.scopus.com), using two set of keywords related to "Covid-19" and "Fungal Infection" and all of its synonyms and homonyms field tags, "Keyword" or "Title" (Article Title) and limiting the search to 2020-3.7. 21 period. The search yielded 258 records, which were further analyzed using additional analytical provisions in the Scopus database.

TITLE ("Covid 19" or "2019 novel coronavirus" or "coronavirus 2019" or "coronavirus disease 2019" or "2019-novel CoV" or "2019 ncov" or covid 2019 or covid19 or "corona virus 2019" or ncov-2019 or ncov2019 or "nCoV 2019" or 2019-ncov or covid-19 or "Severe acute respiratory syndrome coronavirus 2" or "SARS-CoV-2") or KEY ("Covid 19" or "2019 novel coronavirus" or "coronavirus 2019" or "coronavirus disease 2019" or "2019-novel CoV" or "2019 ncov" orR covid 2019 or covid19 or "corona virus 2019" or ncov-2019 or ncov2019 or "nCoV 2019" or 2019-ncov or covid-19 or "Severe acute respiratory syndrome coronavirus 2" or "SARS-CoV-2") and KEY (mucormycosos or aspergillosis or candidiasis or fungal and infection or fungus* or fungal*)

3 ANALYSIS AND RESULTS

31 OVERALL OUTPUT

The global literature on "Covid-19 and Fungal Infections" consisted of 258 publications (2020=132 an 2021=126), as indexed in Scopus database on 3.7.2021. These 258 global publications received 4155 citations, averaging 16.1 citations per publication. Of the 258 global publications on this theme, 74 (28.68%) received external funding support and they together registered 2387 citations, averaging 32.26 citations per paper. The leading global agencies providing funding support

(along with their output) to research in this area are Gilead Sciences and Pfizer (10 publications each), U.S.Department of Health & Human Sciences (9 papers), National Institute of Health, USA and Roche (6 publications each), Brazilian Agency for Scientific Agency, Merck, Mesoscale Diagnostics and National Natural Science Foundations of China (5 papers each), etc. Of the 258 total publications, articles constituted the largest global share (57.36%), followed by reviews and letters (16.67% and 15.89%), editorials and notes (5.04% and 3.88%), short surveys and conference papers (0.78% and 0.19%).

32 TOP 10 COUNTRIES

46 countries unevenly participated in global research on "Covid-19 and Fungal Infections": 31 countries contributed 1-5 papers each, 5 countries 6-10 papers each, 6 countries 11-20 papers each and 4 countries 22 to 48 papers each. The top 10 countries individually contributed 12 to 48 paper each and together contributed 82.56% and more than 100% share in global publications and citations. Among top 10 countries, the largest contribution is made by USA (with 18.60% global share), followed by France, Italy, China, Spain,

U.K. and Netherlands (from 6.20% to 9.69%) and Brazil, India and Germany (from 4.65% to 5.81%). Four out of top 10 countries registered citations per paper and relative citation index higher than their group average (19.74 and 1.23):U.K.(75.59 and 4.69), France (32.12 and 2.0), China (29.59 and 1.84) and Germany (21.75 and 1.35) The share of international collaborative papers of top 10 countries varied from 13.33% to 62.50%, with an average of 23.94% (Table 1).

Table 1. Profile of Top 10 Countries in Global Output in "Covid-19 and Fungal Infection"

S. No.	Country	TP	TC	CPP	H-Index	ICP	%ICP	% TP	RCI
1	United States	48	276	5.75	10	7	14.58	18.60	0.36
2	France	25	803	32.12	9	4	16.00	9.69	2.00
3	Italy	25	360	14.40	8	4	16.00	9.69	0.89
4	China	22	651	29.59	10	5	22.73	8.53	1.84
5	Spain	18	137	7.61	6	6	33.33	6.98	0.47
6	U.K.	17	1285	75.59	7	5	29.41	6.59	4.69
7	Netherlands	16	266	16.63	7	10	62.50	6.20	1.03
8	Brazil	15	110	7.33	5	4	26.67	5.81	0.46
9	India	15	55	3.67	4	2	13.33	5.81	0.23
10	Germany	12	261	21.75	6	4	33.33	4.65	1.35
	Total	213	4204	19.74	7.2	51	23.94	82.56	1.23
	Global Total	258	4155	16.10					

TP=Total papers; TC=Total citations; CPP=Citations per paper; ICP=International collaborative papers

321 COLLABORATIVE LINKAGES AMONG TOP 10 COUNTRIES

The total collaborative linkages among top 10 countries on "Covid-19 and Fungal Infection" varied each from 1 to 11 and individual country-to- country linkages varied from 1 to 3. The top 3 countries depicting the largest collaborative linkages (11, 10 and 9) comes from USA, Netherlands and Italy. The largest country-

to-country collaborative linkages (3) are made by USA- Germany, followed by USA-France, USA-Italy, France-Italy, Italy-Spain, Brazil-Spain and Italy - Germany (2 linkages each), etc. (Table 2).

Table 2. Size of Collaborative Linkages among Top 10 Countries

S. No.	Country	TP	TC	CPP	H-Index	ICP	%ICP	% TP	RCI
1	United States	48	276	5.75	10	7	14.58	18.60	0.36
2	France	25	803	32.12	9	4	16.00	9.69	2.00
3	Italy	25	360	14.40	8	4	16.00	9.69	0.89
4	China	22	651	29.59	10	5	22.73	8.53	1.84
5	Spain	18	137	7.61	6	6	33.33	6.98	0.47
6	U.K.	17	1285	75.59	7	5	29.41	6.59	4.69
7	Netherlands	16	266	16.63	7	10	62.50	6.20	1.03
8	Brazil	15	110	7.33	5	4	26.67	5.81	0.46
9	India	15	55	3.67	4	2	13.33	5.81	0.23
10	Germany	12	261	21.75	6	4	33.33	4.65	1.35
	Total	213	4204	19.74	7.2	51	23.94	82.56	1.23
	Global Total	258	4155	16.10					

TP=Total papers; TC=Total citations; CPP=Citations per paper; ICP=International collaborative papers

Figure 1 shows the collaborative network map of productive countries, generated using the VOSviewer. The map presents 46 countries in 11 clusters with 210 links and total link strength of 235. Each node represents a country and its size represents its productivity. The lines connecting the nodes show their collaboration. Higher the thickness of links, higher the collaboration. Red cluster contains 11 countries including China Denmark, NewZealand etc. Light green cluster has 5 countries including United States, Peru, Nepal, etc.

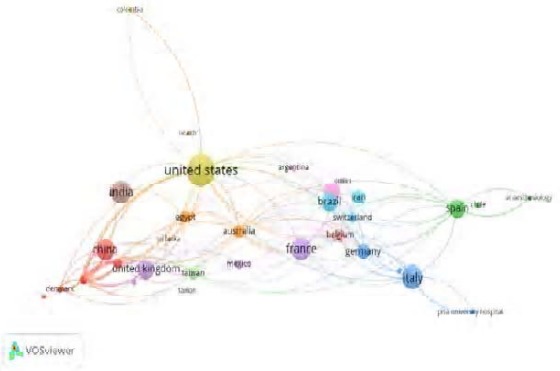


Fig.1 Coauthor ship collaborative network of countries

33 SUBJECT-WISE DISTRIBUTION OF PUBLICATIONS

On classifying 258 publications on "Covid-19 and Fungal Infection" according to Scopus database classification, it was observed that Medicine account for the largest share (88.37%) in total output, followed byImmunology & Microbiology (14.73%), Biochemistry, Genetics & Molecular Biology (7.36%), Pharmacology, Toxicology & Pharmaceutics complications (6.98%), Agricultural & Biological Sciences (2.71%) and Environment Science (1.55%). In terms of impact, publications on Immunology & Microbiology registered the highest citation impact per paper (35.61) and Environment Science the least (0.75).

331 SIGNIFICANT KEYWORDS

The 51 significant keywords (with frequency of appearance varying from 20 to 237) have been identified from the literature, which throw light on the trends of research on his theme. The largest frequency of occurrence (237) was reported by keyword Covid-19, followed by pandemic (114), virus pneumonia (87), clinical study (119), etc (Table 3)

Visualization map of keywords presents them in 7 clusters with 69439 links and total link strength of 215539. Out of 4870 keywords, 543 meet the threshold with minimum occurrences of 5. Seven clusters are: Cluster1 (Red, 175) includes human, mycosis, coronavirus infections etc. Cluster 2 (Green, 152)includes azithromycin, cytokines, immunoglobulin, tocilizumab etc. Cluster 3 (Blue, 100) includes Amphoterecin b, candidiasis, fungal infection etc. Cluster4 (Light Green, 94) includes lung mycosis, cotrimoxazole etc. Cluster5 (Violet, 15) includes mucormycosis, eye infections, fungal etc. Cluster 6(6) includes lymphocytopenia, immune competence etc. Cluster7 (1) includes 1 keyword i.e. virus pneumonia.

Table 3. List of Significant Keywords appearing in Literature on "Covid-19 and Fungal Infection"

S.No.	Keywords	TP	S.No	Keywords	TP			
1	Covid-19	237	18	Azithromycin	41	35	Comorbidity	24
2	Pandemic	114	19	Aspergillus Fumigatus	40	36	Mucormycosis	24
3	Virus Pneumonia	87	20	Galactomannan	40	37	Remdesivir	24
4	Clinical Study	119	21	Risk Factors	39	38	X-Ray Computed Tomography	24
5	Case Reports	80	22	AntifungalTherapy	38	39	Influenza	23
6	Complications	75	23	Mycosis	38	40	Fluconazole	22
7	Invasive Aspergillosis	73	24	Invasive Pulmonary Aspergillosis	37	41	Candida Albicans	21
8	Aspergillosis	55	25	Adult Respiratory Distress Syndrome	36	42	Immunosupportive Agents	21
9	Microbiology	51	26	Antibiotic Therapy	33	43	Lopinavir Plus Ritnovir	21
10	Virology	51	27	Hypertension	33	44	Lymphocy	
11	Voriconazole	51	28	Bacterial Infections	32	45		
12	Computer Assisted Tomography	50	29	Aspergillus	31	46	Lymphocytopenia	21
13	Throx Radiography	48	30	Mortality	30	47	Respiratory Failure	21
14	Candidiasis	47	31	Tocilizumab	30	48	Vancomycin	21
15	Hydrooxychloroquine	47	32	Corticosteroid	28	49	Amphotericin B	20
16	Antifungal Agents	47	33	Lung Lavage	28	50	Opportunistic Infection	20
17	Lung Aspergillosis	42	34	Ceftriaxone	26	51	Pulmonary Aspergillois	20

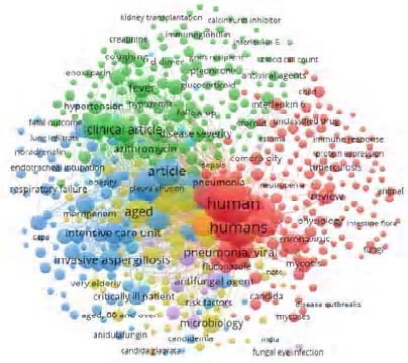


Fig.2. Network visualization map of co-occurrence of keywords

34 PROFILEOF TOP 15 ORGANIZATIONS

In all 211 organizations participated unevenly in global research on "Covid-19 and Fungal Infection": 82 organizations contributed 1 paper each, 79

organizations 2 papers each, 33 organizations 3 papers each, 7 organizations 4 papers each, 5 organizations 5 papers each and 5 organizations 6-10 papers each The top 15 organization individually contributed 4 to 10 papers and together contributed 31.78% (82 papers) and 96.13% (3994 citations) respectively share in global publications and citations. On further analysis, it was observed that: (i) Five organizations contributed papers higher than their group average (5.47) and (ii) Four organizations registered citation per paper and relative citation index above their group average (48.71 and 3.03). Table 3 lists the top 5 most productive and 5 most impactful organizations (Table 4).

Table 4. Profile of Top 5 Most Productive and Most Impactful Organizations on "Covid-19 and Fungal Infection"

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	% ICP	RCI
Top 5 Most Productive Organizations								
1	Radboud University Medical Center, Nijmegen, Netherland	10	214	21.40	5	8	80.00	1.33
2	French National Institute of Health and Medical Research. (INSERM), France	8	645	80.63	6	1	12.50	5.01
3	The French National Centre for Scientific Research (CNRS) , France	7	635	90.71	5	2	28.57	5.63
4	Assistance Publique–Hôpitaux de Paris (AP-HP), France	7	688	98.29	6	1	14.29	6.10
5	The Pasteur Institute, France	6	678	113.00	5	2	33.33	7.02
Top 5 Most Impactful Organizations								
1	The Pasteur Institute, France	6	678	113.00	5	2	33.33	7.02
2	Assistance Publique–Hôpitaux de Paris (AP-HP), France	7	688	98.29	6	1	14.29	6.10
3	The French National Centre for Scientific Research (CNRS) , France	7	635	90.71	5	2	28.57	5.63
4	French National Institute of Health and Medical Research. (INSERM), France	8	645	80.63	6	1	12.50	5.01
5	University of Cologne, Germany	5	228	45.60	4	2	40.00	2.83
TP=Total papers; TC=Total citations; CPP=Citations per paper; ICP=International collaborative papers; RCI=Relative citation index								

341 COLLABORATION AMONG TOP 15 ORGANIZATIONS

Except two, all other top 13 organizations have one-to-one collaborative linkages with other organizations. The total collaborative linkages of top 13 organizations varied from 2 to 24 and organization-to-organization collaborative linkages varied from 1-5. The top three organizations with largest collaborative linkages (24, 21 and 20) were The Pasteur Institute, France, CNRS-France and Hopital Saint-Louis, Paris, France. In terms of organization-to-organization linkages, the largest linkages (5 each) are depicted CNRS-France and The Pasteur Institute, France, University of Cologne, Germany and CECAD Excellent in Aging Research, University of Cologne, Germany and Assistance Publique–Hôpitaux de Paris (AP-HP), France and The Pasteur Institute, France, followed by INSERM – France and Assistance Publique–Hôpitaux de Paris (AP-HP), France and CNRS-France and Hopital Saint-Louis, Paris, France (4 each), etc. (Table 5)

Bibliographic coupling of organizations is visualized in Figure 3. Bibliographic coupling shows the relation when two organizations refer to common work. 21 organizations met the threshold and are depicted with 5 clusters, 101 links and total link strength of 1206.

Table 5. Number of Collaborative Linkages among Top 15 Organizations

S.No	Name of the Organization	Collaborative linkages wIth other top organizations	TCL (NOO)
1	Radboud University Medical Center, Nijmegen, Netherland	3(2), 4(1), 5(2), 7(1), 8(1), 9(1), 10(2), 13(1)	11(8)
2	French National Institute of Health and Medical Research. (INSERM), France	3(3), 4(4), 5(3), 9(1), 10(1), 12(1)	13(6)
3	The French National Centre for Scientific Research (CNRS) , France	1(2), 2(3), 5(5), 7(1), 8(1), 9(3), 10(4), 12(1), 13(1)	21(9)
4	Assistance Publique–Hôpitaux de Paris (AP-HP), France	1(1), 2(4), 5(5), 8(1), 9(2), 10(3), 13(1)	17(7)
5	The Pasteur Institute, France	1(2), 2(3), 3(5), 4(5), 7(1), 9(3), 10(4), 13(1)	24(8)
6	The Federal University of Rio de Janeiro, Brazil	Nil	Nil
7	University of Cologne, Germany	1(1), 3(1), 5(1), 8(5), 10(1), 11(4), 13(2), 15(1)	16(8)
8	CECAD Excellent in Aging Research, University of Cologne, Germany	1(1), , 3(1), 4(1), 7(5), 10(1), 11(4), 13(2)	15(7)
9	University of Paris, France	1(1), 2(1), 3(3), 4(2), 5(3), 10(3)	13(6)
10	Hopital Saint-Louis, Paris, France	1(2), 2(1), 3(4), 4(3), 5(4), 7(1), 8(1), 9(3), 13(1)	20(9)
11	University Hospital Cologne, Germany	7(4), 8(4), 13(1), 15(1)	10(4)
12	Pitié-Salpêtrière University Hospital, France	2(1), 3(1)	2(2)
13	University of Texas Health Center at San Antonio, USA	1(1), 3(1), 4(1), 5(1), 7(2), 8(2), 11(1),15(1)	10(8)
14	Hospital Universitario La Paz, Madrid, Spain	Nil	Nil
15	University of California at San Diego, USA	7(1), 11(1),13(1)	3(3)

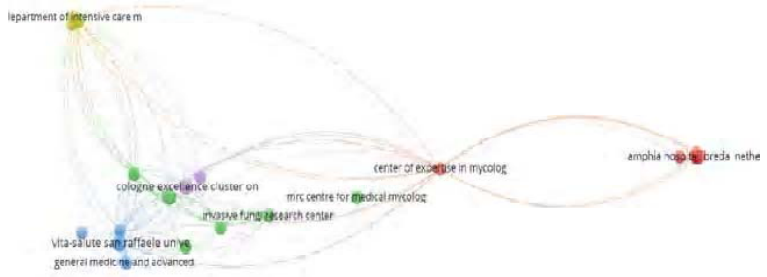


Figure 3. Bibliographic Coupling of organizations

35 PROFILE OF TOP 15 AUTHORS

252 authors participated unevenly in global research on "Covid-19 and Fungal Infection": 252 authors contributed 1-5 papers each and 1 author 7paper each. The top 15 authors individually contributed 2 to 4 papers each and together contributed 19.38% (50) and 31.29% (1300) shares in global publications and citations. On further analysis, it was observed that: (i) Five authors contributed papers higher than their group average (3.33) and (ii) Six authors registered citation per paper and relative citation index above their group average (26.0 and 1.61). Table 3 lists the top 5 most productive and 5 most impactful organisations (Table 6).

Table 6. Profile of Top 5 Most Productive and Most Impactful Authorson "COVID-19 and Fungal Infection"

S.No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
Top 5 Most Productive Authors									
1	P.E. Verwei	Radbound University Nijrnegen Medical Center, Netherland	7	188	26.86	4	4	57.14	1.67
2	M. Blaize	Hopital Universsitaire Pitie Salpetriere, France	4	73	18.25	3	0	0.00	1.13
3	O.A. Cornely	University of Colgne, Germany	4	228	57.00	4	2	50.00	3.54
4	A. Fakkar	Hopital Universsitaire Pitie Salpetriere, France	4	73	18.25	3	0	0.00	1.13
5	A. Lampros	Hopital Universsitaire Pitie Salpetriere, France	4	73	18.25	3	0	0.00	1.13
Top 5 Most Impactful Authors									
1	O.A. Cornely	University of Colgne, Germany	4	228	57.00	4	2	50.00	3.54
2	M. Kochanek	Uniklinik Koln, Germany	3	148	49.33	2	0	0.00	3.06
3	A. Alanio	Institut Pasteur, France	3	104	34.67	2	1	33.33	2.15
4	C.C.Lai	Veterans General Hospital – Kaohsiung, Taiwan	3	85	28.33	2	0	0.00	1.76
5	P.E. Verwei	Radbound University Nijrnegen Medical Center, Netherland	7	188	26.86	4	4	57.14	1.67
TP=Total papers; TC=Total citations; CPP=Citations per paper; ICP=International collaborative papers; RCI=Relative citation index									

351 COLLABORATION AMONG TOP 15 AUTHORS

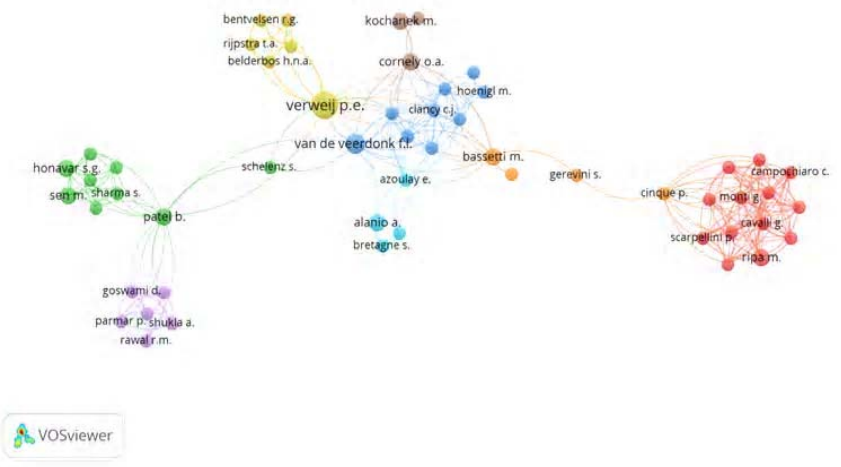
Except five, all other top 10 authors have one-to-one collaborative linkages with other authors. The total collaborative linkages of top 10 authors varied from 2 to 12 and author-to-author collaborative linkages varied from 1-7. The top three authors with largest collaborative linkages (12, 11 and 11) were P.E. Verwei, M. Blaize and A. Fakkar. In terms of individual author-to-author linkages, the largest linkages (7) is depicted by P.E. Verwei and M. Bassetti, etc. (Table 7)

Fig.4 represents collaborative network map of 54 productive authors. The map is visualized in 8 clusters, 235 links and total link strength of 327. Red cluster has authors like C Campochiaro ,L Dagna , M Ripa etc. Green cluster includes authors S.G. Honovar, TP Lahane etc Indigo cluster includes TR Rogers, M Hoenigl, TF Patterson etc. Light Green cluster includes RG Bentvelsen, TA Rijpstra etc. Purple Cluster includes D Goswami, P Parmar, RM Rawal etc. Blue cluster includes A Alcanio, S Bretagne etc. Orange cluster includes M Bassetti, P Cinque etc Brown Cluster includes OA Cornely, M Kochanek, P Koehler etc

Table 7. Number of Collaborative Linkages among Top 15 Authors

S.No	Name of the Author	Affiliation of the Author	Collaborative linkages with other top authors	TCL(NOA)
1	P.E. Verwei	Radbound University Nijrnegen Medical Center, Netherland	3(1), 6(1), 7(7), 11(1), 12(2)	12(5)
2	M. Blaize	Hopital Universsitaire Pitie Salpetriere, France	4(4), 5(4), 10(3)	11(3)
3	O.A. Cornely	University of Colgne, Germany	7(1), 8(2), 11(2), 12(1)	6(4)
4	A. Fakkar	Hopital Universsitaire Pitie Salpetriere, France	2(4), 5(4), 10(3)	11(3)
5	A. Lampros	Hopital Universsitaire Pitie Salpetriere, France	2(4), 4(4), 10(3)	11(3)
6	A. Alanio	Institut Pasteur, France	Nil	Nil
7	M. Bassetti	Universita degli Studi di Genova, Italy	1(7), 3(1), 11(1), 12(1)	4(4)
8	M. Kochanek	Uniklinik Koln, Germany	3(2)	2(1)
9	C.C.Lai	Veterans General Hospital – Kaohsiung, Taiwan	Nil	Nil
10	J.Mayaux	Hopital Universsitaire Pitie Salpetriere, France	2(3), 4(3), 5(3)	9(3)
11	T.R.Patterson	University of Texas Health Center at San Antonio, USA	3(2), 7(1), 12(1)	4(3)
12	F.L. Van de Veerdonk	Radbound University Nijrnegen Medical Center, Netherland	1(2), 3(1), 7(1), 11(1)	4(4)
13	T.T. Abdelaziz	Ainshams University, Egypt	Nil	Nil
14	K.Ahmadikia	Imam Khomeini Hospital, Iran	Nil	Nil
15	A. Alp	Hacettepe Universitesi, Turkey	Nil	Nil
TCL=Total collaborative linkages; NOA=Number of authors				

Fig.4. Network visualization map of productive authors in subject of "COVID-19 and Fungal Infection" research



36 PROFILE OF TOP 15 JOURNALS

Of the total 258 global publications on "Covid-19 and Fungal Infection", 257 (99.61%) publications are published in 160 journals and 1 (0.39%) in trade journal. Of the 160 journals participated unevenly in global research on "Covid-19 and Fungal Infection": 117 journals contributed 1 paper each, 25 journals 2 papers each, 10 journals 3 papers each, 4 journals 4-5 papers each and 4 journals 6-13 papers each. Top 15 journals that published the most papers are presented in Table 8, and these 10 journals contributed 28.79% of total publications in this research field.

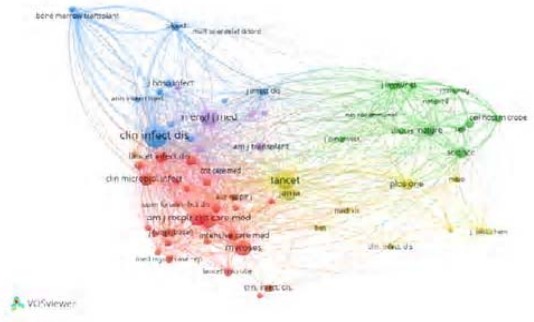
On further analysis it was found that (I) the top 5 most productive journals include *Mycoses* (13 papers), *Medical Mycology Case Reports* (8 papers), *Dermatologic Therapy* (7 papers), *American Journal of Respiratory & Critical Care Medicine* (6 papers) and *Clinical Microbiology & Infection* (5 papers); and (ii) the top five journals in terms of citation impact per paper are: *European Respiratory Journal* (39.33), *Clinical Microbiology & Infection* (28.2), *Intensive Care Medicine* (27.0), *Emerging Infectious Diseases* (26.67) and 23.0).

Co-citation analysis of cited sources on COVID-19 and Fungal infection is presented in Fig.5. It includes the sources with minimum 20 citations. Out of 3501 sources, 71 met the threshold. Cited sources are represented in 5 clusters, 1747 links and total link strength of 43373.

Table 8. Profile of 15 Top Journals on "Covid-19 and Fungal Infections"

S.No	Name of the Journal	TP	TC	CPP
1	Mycoses	13	249	19.15
2	Medical Mycology Case Reports	8	42	5.25
3	Dermatologic Therapy	7	53	7.57
4	American Journal of Respiratory & Critical Care Medicine	6	110	18.33
5	Clinical Microbiology & Infection	5	141	28.20
6	Critical Care	5	49	9.80
7	Indian Journal of Ophthalmology	5	13	2.60
8	Journal of Microbiology, Immunology & Infection	4	89	22.25
9	Emerging Infectious Diseases	3	80	26.67
10	European Respiratory Journal	3	118	39.33
11	Intensive Care Medicine	3	81	27.00
12	International Journal of Infectious Diseases	3	69	23.00
13	Journal De Mycologie	3	60	20.00
14	Journal of Medical Mycology	3	5	1.67
15	Journal of American Academy of Dermatology	3	15	5.00
	Total of top 15 journals	74	1174	15.86
	Global total	257		
	Share of top 15 journals in global total	28.79		
TP=Total papers; TC=Total citations; CPP=Citations per paper				

Fig.5. Co-citation network map of Cited Sources in "Covid-19 and Fungal Infection Research"



37 HIGH CITED PAPERS

Out of 258 publications on "Covid-19 and Fungal Infection", only 14 (5.42) publications (assumed as highly cited here) received 54 to 1118 citations since their publication and together received 2863 citations, averaging 204.5 citations per paper. Amongst 14 high-cited publications, 8 papers received 54 to 93 citations, 4 papers 141-190 citations and 2 papers 462-1118 citations.

Among 14 high-cited papers, the largest number of contribution (5 papers) comes from France, followed by China (3 papers), Germany, Italy, Netherlands, Taiwan and U.K.(2 papers each), Australia, Belgium, Singapore, Spain and USA (1 paper each). These 14 high-cited papers (8 articles, 2 each as reviews and letters and 1 each as conference paper and editorial) witnessed the participation of 93 organizations and 165 authors and consist of 1 non- collaborative paper and 13

collaborative papers (10 national collaborative and 3 international collaborative)

Among 14 high-cited papers, the largest institutional contribution (4 papers each) comes from Assistance Publique–Hôpitaux de Paris, France and The Pasteur Institute, France, followed by INSERM, France and CNRS, France (3 papers each), Radboud University Medical Center, Nijmegen, Netherland, University of Cologne, Germany, CECAD Excellent in Aging Research, University of Cologne, Germany and Hopital Saint-Louis, Paris, France (2 papers each), etc..

The 14 high- cited publications on "Covid-19 and Fungal Infection" are published in 14 journals, with 1 paper each in *American Journal of Respiratory & Critical Care Medicine, Chest, Clinical Microbiology Infection, European Journal of Internal Medicine, Emerging Infectious Diseases, European Respiratory Journal, Infection, Intensive Care Medicine, Journal of Microbiology Immunology & Infection, Journal de Mycologie Medicale, Lancet Infectious Diseases, Lancet Respiratory Medicine, Mycoses and Nature Reviews Immunology*

4 SUMMARY AND CONCLUSION

The 258 global publications were published on "Covid-19 and Fungal Infections" as covered in Scopus database till 3.7.2021. These 258 global publications registered 4155 citations, averaging 16.1 citations per publication. Only 28.68% (74) of the total global publications received extramural funding support from 50+ research agencies and they these funded papers together received 2387 citations, averaging 32.26 citations per paper.

46 countries unevenly participated in 258 global publications "Covid-19 and Fungal Infections", of which the top 10 countries together contributed 82.56% and more than 100% share in global publications and citations. USA contributed the largest global share (18.6%), followed by France, Italy, China, Spain, U.K. and Netherlands (from 6.20% to 9.69%), etc. U.K.(75.59 and 4.69), France (32.12 and 2.0), China (29.59 and 1.84) and Germany (21.75 and 1.35) out of top 10 countries registered citations per paper and relative citation index higher than their group average (19.74 and 1.23).

In all 211 organizations and 252 authors participated unevenly in global research on "Covid-19 and Fungal Infection", of which the top 15 organizations and authors together contributed 31.78% and 19.48% and 96.13% and 31.29% respectively share in global publications and citations.

The top 5 most productive organizations were: Radboud University Medical Center, Nijmegen, Netherland, INSERM, France, CNRS, France French National Institute of Health and Medical Research. (INSERM), France, Assistance Publique–Hôpitaux de Paris (AP-HP), Franc and The Pasteur Institute, France (with 10, 8, 7, 7 and 6 papers). The top 5 most impactful organizations in terms of citations per paper and relative citation index were:The Pasteur Institute, France (113.0 and 7.02), Assistance Publique–Hôpitaux de Paris, France (98.29 and 6.1), CNRS, France (90.71 and 5.63), INSERM, France (80.63 and 5.01) and University of Cologne, Germany (45.6 and 2.83).The top 5 most productive authors were: P.E. Verwei (Netherlands), M. Blaize (France), O.A. Cornely (Germany), A. Fakkar

and A. Lampros (France)(with 7, 4, 4, 4 and 4 papers). The top 5 most impactful authors were: O.A. Cornely (57.0 and 3.54)(Germany), M. Kochanek (49.33 and 3.06)(Germany), A. Alanio (34.67 and 2.15)(France), C.C.Lai (28.33 and 1.76)(Taiwan) and P.E. Verwei (26.86 and 1.67)(Netherlands).

Mycoses (13 papers) was the most productive journal contributing on this theme, followed by *Medical Mycology Case Reports* (8 papers), *Dermatologic Therapy* (7 papers), *American Journal of Respiratory & Critical Care Medicine* (6 papers) and Clinical Microbiology & Infection (5 papers). *European Respiratory Journal* (39.33) was the most impactful journal in terms of citation per paper on this theme, followed by *Clinical Microbiology & Infection* (28.2), *Intensive Care Medicine* (27.0), *Emerging Infectious Diseases* (26.67) and 23.0).

Only 5.42% (14) publications received 54 to 1118 citations which together registered 2863 citations, averaging 204.5 citations per paper. Among 14 comparatively high-cited papers, France contributed the the largest number

(5) of papers, followed by China (3 papers), Germany, Italy, Netherlands, Taiwan and U.K.(2 papers each),etc. These 14 high-cited papers (8 articles, 2 each as reviews and letters and 1 each as conference paper and editorial) witnessed the participation of 93 organizations and 165 authors and consist of 1 non-collaborative paper and 13 collaborative papers (10 national collaborative and 3 international collaborative).

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