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Trend of Research Visualization of COVID-19 Complications in PubMed Database Using Scientometric Analysis from 2020 to March 20, 2021

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Declaration

Authors declare no potential conflict of interest for this study.

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Abstract

This study focused to evaluate the published articles on PubMed whose focus was to study the different relations between COVID 19, and different complications caused due to it. The main complications that were used to formulate this study are Deep Venous Thrombosis (DVT), Stroke, Pulmonary Embolism, Disseminated Intravascular Coagulation (DIC), Myocardial Infarction (MI), anosmia, and pneumonia. The data was extracted from the PubMed database on March 20, 2021at 03:20 PM, PST with the period of 2020 to March 20, 2021. We used Biblioshiny, VOSviewer, and MS Excel software to analyze data and found 2375 published documents. The results revealed that Pneumonia and COVID-19 was the top topic out of 2375 published documents, journal articles as the top type, and the top year was 2020. Similarly, study findings also asserted that Guaraldi, Giovanni was the top author, China was a top country, COVID-19 top keyword, and Stroke was the top source of published documents. Further, the results were illustrated in tables and figures to show the trend of the published document.

Keywords: Scientometric Analysis, COVID-19, Stroke, Pulmonary Embolism, Disseminated Intravascular Coagulation (DIC), Myocardial Infarction (MI), Pneumonia

1. Introduction

In late 2019 a cluster of cases of pneumonia was detected in Wuhan, China (WHO, 2020a, 2020c, 2020d). Initially, the cause of the pneumonia was unknown, and these cases were reported to World Health Organization (WHO) in late December 2019 (Shoaib & Abdullah, 2020). With further research and analysis, the cause of this new pneumonia was ascertained, and a new virus was identified to be the cause of this disease (Swerdlow, Finelli, & Lipsitch, 2020; Wang & Lund, 2020). This virus was named as 2019 novel coronavirus and the disease that was caused due to this virus was named COVID-19 by WHO in February 2020. The virus is also called SARS-CoV 19. The virus had significant infectivity potential and within months it involved almost all countries of the world and was declared as a pandemic by WHO (Sönmez, Apostolopoulos, Lemke, & Hsieh, 2020; Sood, 2020; WHO, 2020b). Coronaviruses are a group of viruses that are implicated in several human and animal diseases (Romano et al., 2020; Sadhu et al., 2020). These viruses are also known for their potential to infect different organisms and undergo mutations as well (Plohl & Musil, 2020). These viruses have the potential to diseases that range from a spectrum

of being mild to very severe for example, they are implicated as a cause of common cold and mild gastroenteritis while in the end, they can cause pneumonia and death.

It is important to mention here that a new coronavirus that was previously unknown to human beings is given a suffix of novel e.g., SARS-COV 19 is called "novel" coronavirus 19. Coronaviruses are zoonotic and are transmitted from animals to humans. Previously Middle East Respiratory Syndrome (MERS- COV) causing coronavirus was found to be transmitted to humans from camels. While the search of the source of SARS-COV 19 is underway it is presumed that a possible bat source is the cause of the beginning of this disease. COVID 19 is transmitted through aerosol particles and has very high infectivity rates. The infected patient can have a range of symptoms (Shoaib & Abdullah, 2020, 2021). It can present as simple cough, flu, fever, headache, anosmia, pneumonia, etc. The severity of symptoms depends upon different variables and the most important one being patient characteristics (Bridwell, Long, & Gottlieb, 2020; Filatov, Sharma, Hindi, & Espinosa, 2020). If the patient is old, having different comorbid conditions, and immunocompromised, he is at higher risk of developing complications from the infection. In contrast, healthy and young people are less likely to develop these complications. Hence, this scientometric study focuses to study the published articles on PubMed whose focus was to study the different relations between COVID 19, and different complications caused due to it. The main complications that were used to formulate this study are Deep Venous Thrombosis (DVT), Stroke, Pulmonary Embolism, Disseminated Intravascular Coagulation (DIC), Myocardial Infarction (MI), anosmia, and pneumonia.

1.1 The objective of the Study

The main objective of the study was to evaluate published documents on COVID-19 complications in PubMed Database using scientometric analysis from 2020 to March 20, 2021. Further, this study focused to examine the published articles on PubMed whose focus was to study the different relations between COVID 19, and different complications caused due to it. The main complications that were used to formulate this study are Deep Venous Thrombosis (DVT), Stroke, Pulmonary Embolism, Disseminated Intravascular Coagulation (DIC), Myocardial Infarction (MI), anosmia, and pneumonia.

2. Literature Review

Several studies have been conducted on the causes, consequences, complications, safety measures, social distancing, and use of personal protective equipment during pandemic situations i.e.,

COVID-19 (Bridwell et al., 2020; Shoaib & Abdullah, 2021). Since the start of the pandemic, this disease had affected all aspects of human life (Shoaib & Abdullah, 2020). Preventive measures including handwashing, using facemasks, disinfection, etc. were being advocated by WHO around the world, and vaccination had also been started to get rid of the said outbreak (Shoaib & Abdullah, 2020, 2021; WHO, 2020a, 2020c, 2020d). This had been made possible due to extensive research done on the current pandemic (Bohlouli et al., 2021; Bury et al., 2021; Cabañas, Williams, Gallagher, & Brice, 2021; Gray et al., 2021). The mortality and morbidity due to COVID 19 were based on different complications that were caused because of infection from the SARS-CoV 19 virus (Shchendrygina, Nagel, Puntmann, & Valbuena-Lopez, 2021; Soheili et al., 2021; Taherifard & Taherifard, 2020; Vrints et al., 2020). The medical research community had dedicated a lot of effort and resources to find about the causes of these complications, treatment options that were available to treat these complications, and methods to prevent these complications (Hus, Salomon-Perzyński, Tomasiewicz, & Robak, 2020; Kaseda & Levine, 2020; Mosaddeghi, Shahabinezhad, Dorvash, Goodarzi, & Negahdaripour, 2020; Saleh et al., 2020; Taherifard & Taherifard, 2020; Wagner et al., 2021). Similarly, several studies had been conducted to analyze the complications of the COVID-19 pandemic worldwide including (Ai et al., 2020; Akacha et al., 2020; Anwar, 2020; Bartel, Sherry, & Stewart, 2020; Collins & Levenson, 2020; Shoaib & Abdullah, 2020, 2021). Further, it is important to mention here that several studies has been conducted employing different methods including qualitative/quantitative survey (Anwar, Shoaib, & Javed, 2013; Shoaib, Khan, & Shaukat, 2012; Shoaib, Latif, & Usmani, 2013; Shoaib, Saeed, & Cheema, 2012; Shoaib & Ullah, 2019, 2021a, 2021b) and the bibliometric or scientometric analysis techniques to show the trend of data and data visualization (Ali, Shoaib, & Asad, 2021; Shoaib, Abdullah, & Ali, 2020; Shoaib, Rasool, & Anwar, 2021; Ullah & Shoaib, 2021).

The Data and Methods

We used scientometric analysis and extracted data from the PubMed database. The rationale to select the database was based on the availability of extensive medical literature and the authenticity of research published on this site. Further, we used the searched query in PubMed *as*; ((((((DVT Deep Venous Thrombosis[Title] AND COVID 19[Title]) OR (Stroke[Title] AND COVID 19[Title])) OR (Pulmonary Embolism[Title] AND COVID 19[Title])) OR (Disseminated Intravascular Coagulation[Title] AND COVID 19[Title])) OR (MI Myocardial Infarction[Title] AND COVID 19[Title])) OR (Anosmia[Title] AND COVID 19[Title])) OR (Pneumonia[Title]

AND COVID 19[Title]). Furthermore, the data was extracted on March 20, 2021at 03:20 PM, PST with the timespan of 2020 to March 20, 2021. We used Biblioshiny, VOSviewer, and MS Excel software to analyze data and found 2375 published documents. Further, the results and trends of data were presented in tables and figures to conclude.

3. Results and Discussion

This section provides the results and discussion on the subject under consideration. Further, it is divided into sub-sections including topics of published documents, document types and publication years, authors' information by published documents, top organizations and countries of the published documents, and top keywords and sources of publications.

4.1 Topics of Published Documents

Table 1
Topics of Published Documents Retrieved from PubMed Database

The topic of the documents	Total Publications	Percentage
Pneumonia AND COVID-19	1562	65.77
Stroke AND COVID-19	451	18.99
Pulmonary Embolism AND COVID-19	203	8.55
Anosmia AND COVID-19	108	4.55
Myocardial Infarction AND COVID-19	29	1.22
Disseminated Intravascular Coagulation AND COVID-19	15	0.63
Deep Venous Thrombosis AND COVID-19	07	0.29
Total	2375	100

The data in Table 1 asserted that was retrieved from the PubMed database showed that pneumonia and COVID-19 were searched the most among the used keywords (65.77%). It was an expected response as the most common complication due to COVID-19 is pneumonia and keeping this in view there was a lot of research dedicated to this complication by the medical research community. One of the complications that are developed due to COVID-19 infection is extensive and erratic blood clotting that might lead to ischemic complications like stroke. Association of COVID-19 and stroke was found to be the second most used keywords in the database (18.99%) that was closely followed by pulmonary embolism (8.55%) which is also a clotting complication. Although anosmia is a presenting symptom of COVID-19 infection, this symptom persisted even after that patient completely recovered. This symptom by itself does not cause any mortality but it is

associated with decreased quality of life even after recovering from the infection, almost (4.55%) of the articles studied the association of COVID-19 with anosmia and its different aspects. One of the grave complications that can occur due to COVID-19 is Disseminated Intravascular Coagulation (DIC), a condition in which the clotting system is overwhelmed and there are unnecessary small blood clots in different parts of the body. This leads to the consumption of clotting factors that leads to bleeding tendency. 0.63% of the articles studied this in association with COVID-19 which was followed by myocardial infarction (MI), having a percentage of 0.29.

4.2 Document Types and Publication Years

Data in Table 2 revealed that there were a total of 2375 publications, out of which journal articles were the most published items (1296 and 54.54%). Next to the journal articles were case reports which were almost half of journal articles (565 and 23.79%). Comment Cum Editorial, Letter, and Comparative Study Cum Journal Article were at third, fourth, and fifth place respectively depending upon the number of publications. Review Cum Books were the least published items during the studied time. The largest number of articles were published in the year 2020 (1712 and 72%) while 663 or 28% articles were published in 2021. As the cutoff date was March 2021 so the number of articles at the end of 2021 is expected to be much higher. Out of 2375 publications, 93 were written by a single author while there were 5.81 authors per document. Moreover, 7.89 co-authors were per publication and on average 0.172 documents were published per author.

Table 2
Document Types and Publication Years

Document Types	Total Publication	Percentage
Journal Article	1296	54.57
Case Reports	565	23.79
Comment Cum Editorial	207	8.72
Letter	186	7.83
Comparative Study Cum Journal Article	43	1.81
Editorial	35	1.47
Clinical Trial Cum Articles	28	1.18
Published Erratum	10	0.42
Systematic Review	03	0.13
Review Cum Book	02	0.08
Total	2375	100.0
Publication Years	Total Publication	Percentage
2020	1712	72
2021	663	28
Total	2375	100.0

4.3 Authors' Information by Published Documents

Data based on bibliometric analysis in Table 3 indicated that the name of Guaraldi, Giovanni was the most productive author based on the highest total link strength of 48. Besides, De Riu, Giacomo had the highest number of total publications (10). There was a total of 13797 authors who published their articles on COVID-19 and its complications and these authors had a total appearance of 18748 in different articles. 70 persons authored a single-authored document, while 13727 people were authors in multi-authored documents. Further, in terms of collaboration, we had a collaboration index of 6.02 during the study period. Similarly, 93 documents had a single author, there were 5.81 authors per document and 0.172 documents per author. There were 7.89 co-authors per document. Further, there are 13797 authors, author appearances 18748, authors of single-authored documents 70, and authors of multi-authored documents 13727. The results also assert that single-authored documents are 93, documents per author 0.172, authors per document 5.81, co-authors per documents 7.89, collaboration index 6.02 *(See Figure 1)*.

Table 3
Top Twenty Productive Authors

Author	TP*	TLS*	Author	TP*	TLS*
De Riu, Giacomo	10	29	Mussini, Cristina	7	40
Mocco, J	9	20	Qureshi, Adnan I	7	33
Zhang, Wei	9	16	Salzano, Giovanni	7	19
Guaraldi, Giovanni	8	48	Banerjee, Soma	6	37
Xia, Liming	8	29	Chen, Wei	6	3
Danzi, Gian Battista	7	17	Ciceri, Fabio	6	33
Hopkins, Claire	7	12	Colombi, Davide	6	32
Loffi, Marco	7	17	Cossarizza, Andrea	6	42
Marchiori, Edson	7	5	Duclos, Gary	6	39
Meschiari, Marianna	7	45	Fan, Bing	6	6
TP* = Total Publications, TLS* = Total Link Strength					
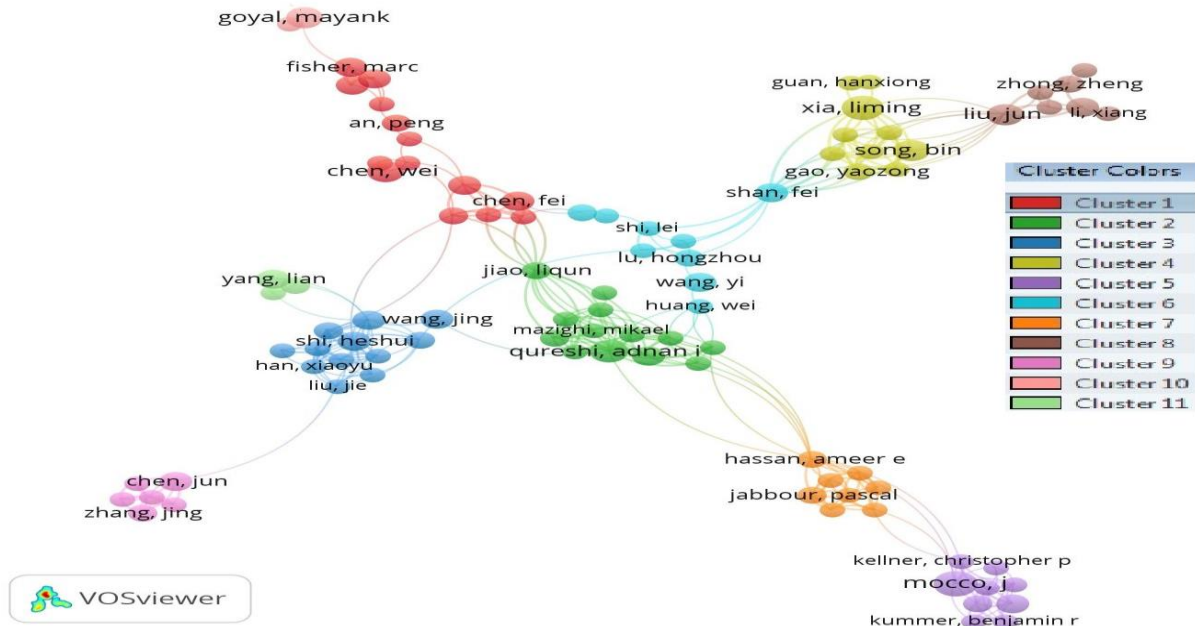
Figure 1. Published documents by top productive authors

4.4 Top Organizations and Countries of the Published Documents

Out of 7527 total contributing organizations, Clinical Neurology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran was the most productive organization based on a total link strength score of 37 *(See Appendix A).* While Maxillofacial Surgery Unit, University Hospital of Sassari, Sassari, Italy was the top institute based on a total publication score of seven *(See Figure 2).*

Figure 2. Top productive organizations

Table 4 depicted that authors from China published the greatest number of articles (343) among all the countries (65) whose authors published their articles on COVID-19 and its complications. Chinese authors had the highest number of single country publications (288) and multiple country publications (55). Chinese authors were closely followed by Italian autho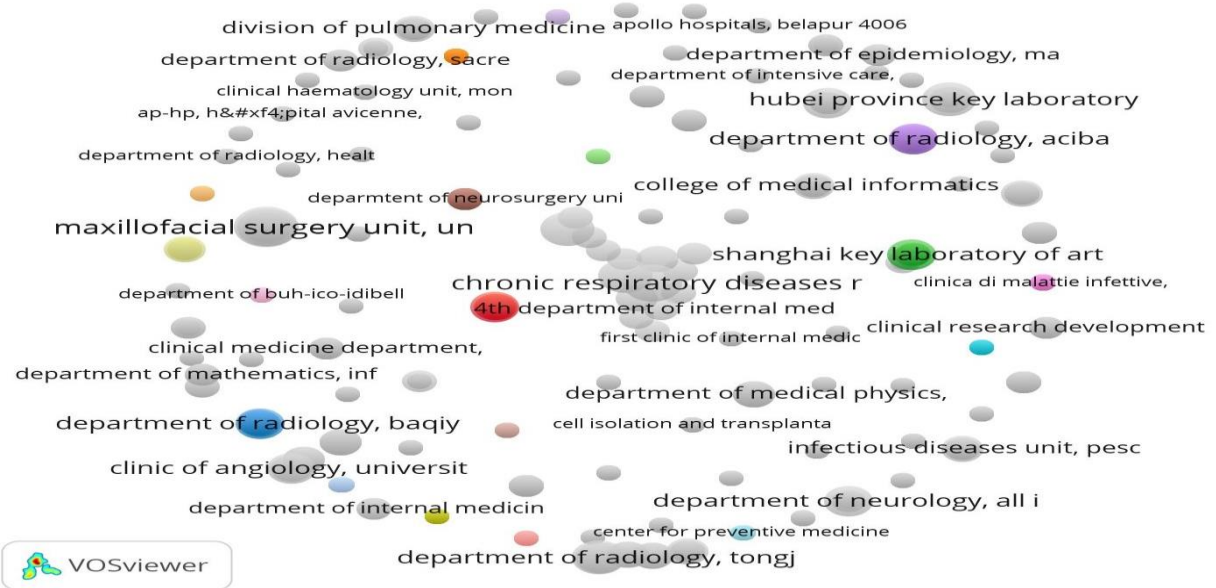rs having 312 total publications with 261 single country publications and 51 multiple country publications. Multiple Country Publication ratio was highest among Pakistani Authors (0.4545). It is pertinent to mention here that the documents were published from 65 countries worldwide *(See Figure 3)*.

Table 4
Top Twenty Countries

Country	TP*	Freq.	SCP*	MCP*	MCP*_Ratio
China	343	0.2	288	55	0.1603
Italy	312	0.18192	261	51	0.1635
USA	213	0.1242	177	36	0.169
France	103	0.06006	81	22	0.2136
Spain	82	0.04781	71	11	0.1341
Turkey	75	0.04373	64	11	0.1467
Japan	67	0.03907	62	5	0.0746
Iran	64	0.03732	40	24	0.375
Germany	48	0.02799	39	9	0.1875
India	38	0.02216	35	3	0.0789
Brazil	36	0.02099	28	8	0.2222
Switzerland	26	0.01516	20	6	0.2308
Canada	22	0.01283	16	6	0.2727
Netherlands	21	0.01225	20	1	0.0476
Korea	19	0.01108	16	3	0.1579
Greece	18	0.0105	14	4	0.2222
Singapore	16	0.00933	16	0	0
United Kingdom	16	0.00933	13	3	0.1875
Saudi Arabia	14	0.00816	8	6	0.4286
Pakistan	11	0.00641	6	5	0.4545

TP* = Total Publication, SCP* = Single Country Publications, MCP* = Multiple Country Publications
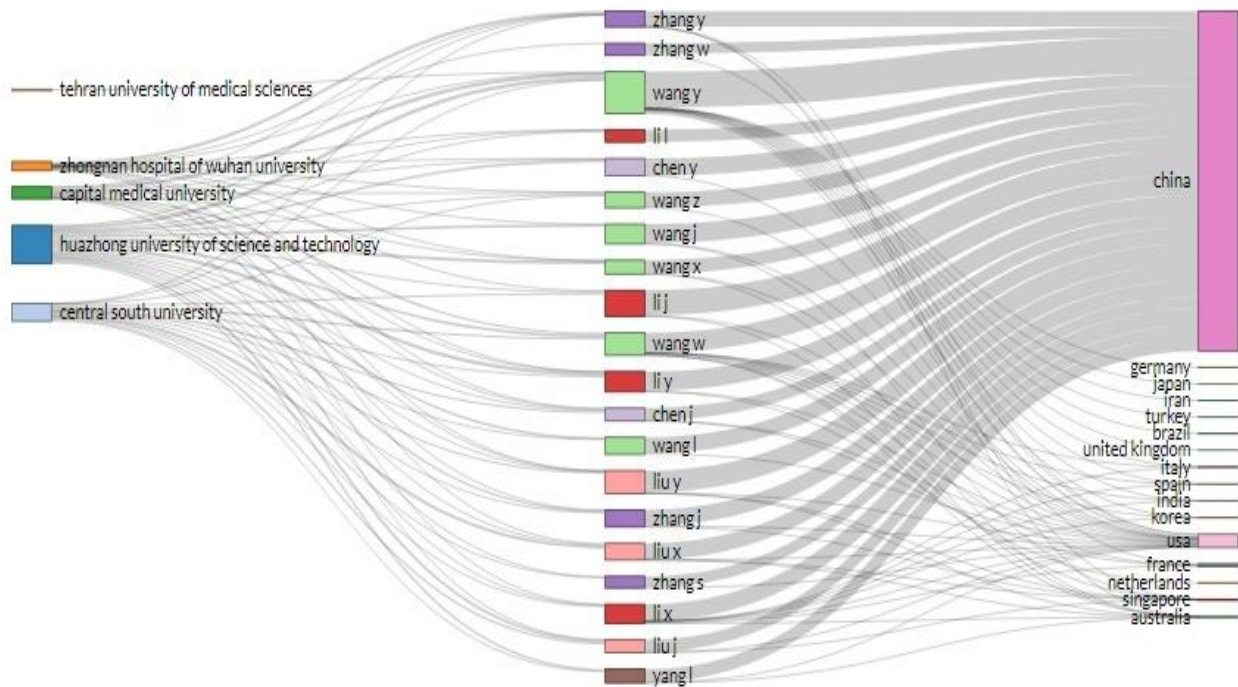
Figure 3. Top author affiliation with organization and countries.

4.5 Top Keywords and Sources of Publications

Table 5

Top Twenty Keywords

Keywords	f	TLS*	Keyword	f	TLS*
COVID-19	1853	19684	Aged	520	8509
Humans	1446	18771	Adult	387	6354
Sars-Cov-2	1256	15388	Tomography, X-Ray Computed	349	5141
Pandemics	1017	13935	Stroke	339	3733
Pneumonia, Viral	971	13484	Retrospective Studies	303	5264
Coronavirus Infections	923	12811	Pneumonia	287	2951
Male	797	12353	*COVID-19	265	3861
Betacoronavirus	780	11019	Lung	236	3424
Female	694	10977	Aged, 80 And Over	221	3860
Middle Aged	659	10462	Pulmonary Embolism	187	1968
		TLS* = Total Link Strength			

Data in the Table 5 illustrated that there were a total of 2375 publications of COVID-19 and its complications. A total of 4246 keywords were used in those publications. Out of these 4246 keywords, "COVID-19" was used most frequently (1853) with the highest link strength of 19684. This was followed by the keyword "human", which was used 1446 times with a link strength of 18771. "SARS-Cov-2" was the third most frequently used keyword with total use of 1256 times with a link strength of 15388 *(see Figure 4)*.

Figure 4. Top occurrences of keywords

There was a total of 800 sources where the articles on COVID-19 and its complications were published. Out of these highest number of articles were published in stroke (54, 2.27%). The second position was shared between Cureus and Journal of Stroke and Cerebrovascular Diseases having 40 publications each with a percentage of 1.68%. While Journal of Medical Virology had 29 articles on COVID-19 and its complications as keywords *(See Appendix B)*.

4. Conclusion

We reached the conclusion based on the scientometrics analysis that this method enabled scholars, researchers, and academicians to gain a more comprehensive understanding of the selected topic and support recognizing variables that are used during research on COVID-19 complications. The study was essentially centered on evaluating Deep Venous Thrombosis (DVT), Stroke, Pulmonary Embolism, Disseminated Intravascular Coagulation (DIC), Myocardial Infarction (MI), anosmia, and pneumonia employing bibliometric analysis from 2020 to March 20, 2021. The results concluded that Pneumonia and COVID-19 was the top topic out of 2375 published documents, journal articles as the top type, and the top year was 2020. Similarly, results also asserted that Guaraldi, Giovanni was the top author, China was a top country, COVID-19 top keyword, and Stroke was the top source of published documents.

5. Limitations of the Study

The present scientometric analysis was based on the published documents in the PubMed database only and we did not use other databases. Further, it only focussed to evaluate COVID-19 complications. The study was essentially centered on evaluating Deep Venous Thrombosis (DVT), Stroke, Pulmonary Embolism, Disseminated Intravascular Coagulation (DIC), Myocardial Infarction (MI), anosmia, and pneumonia employing scientometric analysis from 2020 to March 20, 2021. Therefore, we did not use other related topics concerning COVID-19 complications.

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Appendix A
Table 5
Top Twenty Organizations

Organization Name	TP*	TLS*
Maxillofacial Surgery Unit, University Hospital of Sassari, Sassari, Italy	7	18
Chronic Respiratory Diseases Research Center,(NRITLD), (SBUMS), Tehran, Iran	6	5
Maxillofacial Surgery Unit, University Hospital of Naples "Federico II", Naples, Italy	6	11
Clinical and Experimental Medicine PhD. Program, University of Modena and Reggio Emilia, Modena, Italy	5	0
Critical Care Department, King Saud Medical City, Riyadh, Saudi Arabia	5	2
Department of Radiology, Tongji Hospital, Tongji Medical College, HUST, Wuhan, China	5	2
Hubei Province Key Laboratory of Molecular Imaging, Wuhan, China	5	6
Clinic of Angiology, University Hospital Zurich, Zurich, Switzerland	4	6
Clinical Neurology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran	4	37
Department of Human Anatomy and Experimental Oncology, Faculty of Medicine, UMONS (IHST), (UMONS), Mons, Belgium	4	10
Department of Medical, Surgical and Experimental Sciences, University of Sassari, Sassari, Italy	4	4
Department of Neurology, All India Institute of Medical Sciences, New Delhi, India	4	2
Department of Radiology, Acibadem Kozyatagi Hospital, Istanbul, Turkey	4	7
Department of Radiology, Acibadem Taksim Hospital, Istanbul, Turkey	4	7
Department of Radiology, Baqiyatallah University of Medical Sciences, Tehran, Iran	4	13
Department Of Radiology, Union Hospital, Tongji Medical College, HUST, Wuhan, Hubei, China	4	9
Institute of Organ Transplantation, Tongji Hospital, Tongji Medical College, HUST, Wuhan, China	4	2
Shanghai Key Laboratory Of Artificial Intelligence For Medical Image And Knowledge Graph, Shanghai, China	4	13
College of Medical Informatics, China Medical University, Shenyang, 110122, Liaoning, China	3	18
Department of Cardiology, Democritus University of Thrace, Alexandroupolis, Greece	3	6
TP* = Total Publications, TLS* = Total Link Strength		

Appendix B
Table 6
Top Twenty Sources of Publications

Sources	Total Publications	% of 2375
Stroke	54	2.27
Cureus	40	1.68
Journal of Stroke and Cerebrovascular Diseases	40	1.68
Journal of Medical Virology	29	1.22
The American Journal of Case Reports	28	1.18
Thrombosis Research	28	1.18
International Journal of Infectious Diseases	27	1.14
European Radiology	26	1.09
Annals of The Rheumatic Diseases	23	0.97
Critical Care (London, England)	23	0.97
Frontiers in Neurology	23	0.97
AJR. American Journal of Roentgenology	21	0.88
Respiratory Medicine Case Reports	21	0.88
The European Respiratory Journal	21	0.88
PLOS One	20	0.84
Radiology	20	0.76
European Journal of Nuclear Medicine and Molecular Imaging	18	0.76
AJNR. American Journal of Neuroradiology	17	0.72
BMJ Case Reports	17	0.72
Neurological Sciences	17	0.72