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Article

A Bibliometric Analysis of COVID-19 across Science and Social Science Research Landscape

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Abstract: The COVID-19 pandemic caused by the novel coronavirus emerged in Wuhan City, Hubei province of China at the end of 2019, has radically transformed the lives of people around the world. Due to its fast spreading, it is currently considered as a worldwide health, social and economic concern. The lack of knowledge on this area has encouraged academic sphere for extensive research, which is reflected in exponentially growing scientific literature in this area. However, current state of COVID-19 research reveals only early development of knowledge, while a comprehensive and in-depth overview remains neglected. Accordingly, the main aim of this paper is to fill the aforementioned gap in the literature and provide an extensive bibliometric analysis of COVID-19 research across science and social science research landscape. The bibliometric analysis is based on the Scopus database including all relevant and latest information on COVID-19 related publications (n=10,344) in the January-May 2020 period. The findings emphasize an importance of a comprehensive and in-depth approach considering different scientific disciplines in COVID-19 research. The understanding of the evolution of emerging scientific knowledge on COVID-19 is beneficial not only for scientific community but also for evidence-based policymaking in order to prevent and address the COVID-19 pandemic.

Keywords: COVID-19; coronavirus; pandemic; science; social science; bibliometric analysis

1. Introduction

Since 2000s, the world has witnessed two large-scale disease outbreaks. These are Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), which emerged in 2003 and 2012, respectively, and caused a worldwide pandemic that claimed thousands of human lives [1]. In December 2019, a new strain of coronavirus (COVID-19), not previously identified in humans, has emerged in Wuhan City, Hubei province of China. The virus has begun to spread exponentially across all inhabited continents and the number of cases and deaths related to COVID-19 has soon exceeded the numbers of other two coronaviruses (SARS and MERS). The outbreak of COVID-19 is a typical public health emergency. Its high infection rate makes it a huge threat to global public health [2-4]. However, its rapid spread has not only affected the lives of many people around the world, but also disrupted the pattern of social and economic development, leading to incalculable social and economic losses [5]. In last 6 months, more than 10 million cases and more than 500,000 deaths have been seen at the global level [6]. International institutions have therefore announced the global economy is now in a recession – as bad or worse than in the global financial crisis of 2009, arguing this recession will affect both developed and developing countries [7,8]. Therefore, it is not surprising, why the COVID-19 pandemic has attracted the attention of the academic sphere and spurred a new wave of research in this area.

The recent bibliometric studies considering broader aspect of coronavirus research over time emphasize that pandemics represent a major medical issue and provide some interesting findings. Taking into account previous coronavirus pandemics Hu et al. [9] establish that the highest research

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interest occurs in the first year after outburst. This is further confirmed by the study addressing coronavirus research trends during the last 20-years [10,11] and last 50-years period [12, 13]. However, although the growth pattern was not uniform, China and the United States have played a major role in the contribution of coronavirus research [14]. Therefore, it is not surprising why recently COVID-19 has become the central topic in the recent scientific literature, since the research addressing various aspects of COVID-19 may be the key to mitigating the current COVID-19 pandemic as well as their consequences [15,16]. The current high-growing interest in COVID-19 and related coronaviruses has even led to the creation of so called COVID-19 Open Research Dataset (CORD-19) covering over 158,000 scholarly articles, including over 75,000 with full text in order to provide a solid basis for generating new insights in support of the ongoing fight against COVID-19 [17]. The overview of CORD-19 publications reveals that publications are mostly focused on a few and well-defined areas, including coronaviruses (primarily SARS, MERS and COVID-19), public health and viral epidemics, the molecular biology of viruses, influenza and other families of viruses, immunology and antivirals as well as methodology (testing, diagnosing and clinical trials). However, the review of latest CORD-19 publications from 2020 indicates a shift from health to other relevant scientific disciplines [18].

In the literature, there exist also several recent bibliographic studies, which are focusing only on COVID-19 research. They reveal that China and the United States have the largest COVID-19 scientific production [19-23]. The most relevant institutions involved in COVID-19 research are Huazhong University of Science and Technology, Wuhan University and University of Hong Kong. Moreover, the majority of published documents on COVID-19 are published in prestigious journals with high impact factors, including the Lancet, BMJ – Clinical Research Ed. and Journal of Medical Virology [19,23]. Furthermore, according to the number of publications, the most influential authors in COVID-19 research are Huang, C., Zhu, N. and Chan, J.F. [21]. Finally, it is also established that virology, epidemiology, clinical features, laboratory examination, radiography, diagnosis and treatment are the current research hotspots of COVID-19 [21,22].

Although, the absence of knowledge on the novel COVID-19 has grabbed the attention of the academic sphere, spurring a new wave of research into the virus [24], yet, the vast majority of recent studies chiefly consider health-related issues, leaving other aspects neglected, as indicated by the latest literature [19-23]. Moreover, COVID-19 research's current status is only of the early development of knowledge. Therefore, the literature stresses that greater research should be conducted in less-explored areas, including life, physical and social sciences [21]. Accordingly, the main aim of this paper is to provide an extensive bibliometric analysis on COVID-19 research in first five months of 2020. Although there already exist several papers addressing bibliometric analysis of COVID-19 research, several research gaps are identified, which are carefully tackled by this paper. First, the existing bibliometric studies are predominantly focused on general analysis of COVID-19 research, showing the importance of health sciences in this area, while detailed insight considering different research landscapes remain neglected. Therefore, this paper provides in-depth bibliometric analysis by considering various science and social science research landscapes. Second, the predominant part of the research are mostly addressing databases containing document information only. Accordingly, this paper extends the analysis on a comprehensive database including document and source information, allowing the bibliometric analysis in different research landscapes. Finally, recent research is neglecting the fact that scientific disciplines intertwine strongly with each other. Therefore, this paper provides an innovative approach, allowing showing all possible logical relations between different research landscapes.

Thus, the main aim of this paper is to provide an unprecedented, comprehensive and in-depth examination of COVID-19 research across different research landscapes, which can suggest important guidelines for researchers about the avenues for future research. The remaining sections of this paper are structured as follows. The second section presents materials and methods. In the third section, the results are discussed. The paper ends with conclusion, where main findings are summarized.

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2. Materials and Methods

A comprehensive bibliometric data on COVID-19 related research is obtained throughout two consecutive phases. The first phase involves identification of all relevant documents or publications on June 1, 2020 in the Scopus database on document information, which is widely recognised database also by the previous research [9,13,19,23]. The applied search query extends previously narrowly defined queries [21,22] by including a wide range of COVID-19 related keywords: "novel coronavirus 2019", "coronavirus 2019", "COVID 2019", "COVID19", "COVID 19", "COVID-19", "SARS-CoV-2", "HCoV-19", "2019-nCoV" and "severe acute respiratory syndrome coronavirus 2". Additionally, the search query is restricted to the current year 2020 and English language. The second phase involves supplementing the presented Scopus database on document information with Scopus CiteScore metrics containing source related information (e.g. citations, rankings, SNIP, etc.). The process of obtaining and merging the relevant data is facilitated by Python programming language.

Then, an in-depth bibliometric analysis followed, allowing for an innovative approach to literature review. Namely, the structured literature review represents a traditional approach to analyse and review scientific literature, providing an in-depth overview of the content. However, this approach suffers from several limitations related to subjective factors, time-consumption and efficiency. The application of modern bibliometric approaches reduces the aforementioned limitations and provide an effective way to handle extensive collections of scientific literature [25]. So far, the existing bibliometric studies have been hardly neglecting the fact that scientific disciplines are strongly intertwined, resulting in similar findings and conclusions in these studies and lack of knowledge in less-explored areas [21]. Therefore, an innovative quantitative bibliometric analysis is conducted to supplement the existing research and assess the state of current COVID-19 research across different research landscapes (health sciences, life sciences, physical sciences and social sciences & humanities) by innovative statistical approaches using Python programming language and software bibliometric tools such as Biblioshiny and VOSviewer.

3. Results

An overview of scientific documents utilised in this study is presented in Table 1. A total of 10,344 documents written by 44,439 different authors and published in 1,978 journals were utilised in this study, whereby 3,790 (37%) of them have at least one citation in the Scopus database providing a total of 48,044 citations. For these documents, the average citations per document were 12.68 and the average authors per document were 4.30. A major proportion of the documents were articles (39%) and letters (27%). Much smaller proportion of the documents were editorials (11%) notes (10%) and reviews (10%). Finally, there was a negligible proportion of other documents (3%) such as short surveys, conference papers, erratums and data papers. The presented characteristics of scientific documents on COVID-19 research are predominantly in line with previous research [20,21].

Table 1. Overview of scientific documents on COVID-19 research (January-May 2020).

Database summary	Findings
Bibliometric items	**Number**
Total documents	10,344
Total authors	44,439
Total journals	1,978
Total citations	48,044
Cited documents	3,790
Average citations	12.68
Average authors	4.30
Document type	**Number (share)**
Article	4,001 (39%)
Letter	2,827 (27%)
Editorial	1,158 (11%)
Note	1,024 (10%)
Review	1,017 (10%)

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Other	317 (3%)

Source: Authors' elaboration based on Scopus database, June 2020.

Table 2 presents most relevant (top 20) journals in COVID-19 research by number of documents. They contain about one-fifth (19%) of total documents and cover more than half (53%) of total citations. Most of them are ranked into the first quartile (Q1) and have a relatively high source normalized impact per paper (SNIP), which is in line with the existing research [19,23]. Moreover, the majority of these journals are subject to health sciences and they are classified predominantly in the following subsubject areas: infectious diseases, general medicine and microbiology (medical). Finally, most of these journals are from Anglo-Saxon countries such as the United States, the United Kingdom and the Netherlands. Similar findings are provided also by previous COVID-19 bibliometric studies [21,22]. However, all of the existing bibliometric studies are neglecting the fact that sciences are strongly intertwined, leading to a lack of understanding of the COVID-19 research in other scientific disciplines [21].

Table 2. Most relevant journals in COVID-19 research (January-May 2020).

Source title	Number of documents	Number of citations	Sub-subject area (ranking) 2019	SNIP 2019	Country
Journal of Medical Virology	221	1,781	Infectious Diseases (108/283, Q2) Virology (37/66, Q3)	0.780	US
The Lancet	196	7,493	General Medicine (1/529, Q1)	21.313	UK
BMJ Case Reports	187	573	General Medicine (289/529, Q3)	0.364	UK
JAMA - Journal of the American Medical Association	121	4,077	General Medicine (4/529, Q1)	11.131	US
Journal of Infection	121	429	Infectious Diseases (21/283, Q1) Microbiology (medical) (13/115, Q1)	1.587	UK
Infection Control and Hospital Epidemiology	108	68	Infectious Diseases (91/283, Q2) Microbiology (medical) (39/115, Q2) Epidemiology (40/93, Q2)	1.358	UK
Travel Medicine and Infectious Disease	97	300	Public Health, Environmental and Occupational Health (73/516, Q1) Infectious Diseases(82/283, Q2)	1.184	NL
International Journal of Infectious Diseases	97	766	Infectious Diseases (59/283, Q1) Microbiology (medical) (26/115, Q1)	1.426	NL
The Lancet Infectious Diseases	91	1,103	Infectious Diseases (4/283, Q1)	7.234	UK
International Journal of Environmental Research and Public Health	90	169	Public Health, Environmental and Occupational Health (174/516, Q2) Health, Toxicology and Mutagenesis (68/128, Q3) Pollution (58/120; Q2)	1.248	CH
Science of the Total Environment	88	164	Environmental Engineering (10/132, Q1) Pollution (13/120, Q1) Waste Management and Disposal (10/100, Q1) Environmental Chemistry (17/115, Q1)	1.977	NL
Head and Neck	78	73	Otorhinolaryngology (5/106, Q1)	1.356	US
Medical Hypotheses	75	16	General Medicine (99/529, Q1)	0.509	US
Journal of Clinical Virology	70	44	Infectious Diseases (44/283, Q2) Virology (19/66, Q2)	1.238	NL

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Psychiatry Research	66	109	Psychiatry and Mental health (154/506, Q2) Biological Psychiatry (25/38, Q3)	0.968	IE
Brain, Behavior, and Immunity	64	248	Behavioral Neuroscience (2/73, Q1) Immunology (27/200, Q1) Endocrine and Autonomic Systems (3/24, Q1)	1.416	US
New England Journal of Medicine	62	6,049	General Medicine (2/529, Q1)	13.212	US
Science	62	625	Multidisciplinary (2/111, Q1)	7.521	US
Otolaryngology - Head and Neck Surgery	62	95	Surgery (66/420, Q1) Otorhinolaryngology (14/106, Q1)	1.505	US
The Lancet Respiratory Medicine	60	1,215	Pulmonary and Respiratory Medicine (1/131, Q1)	6.666	UK

Source: Authors' elaboration based on Scopus database, June 2020.

According to the Scopus classification, documents can be classified into four different subject areas, namely: health sciences, life sciences, physical sciences and social sciences & humanities. However, these subject areas are strongly intertwined meaning that individual document can be classified in several subject areas at the same time. Accordingly, for the purposes of addressing the comprehensiveness of COVID-19 research, Figure 1 shows the Venn diagram of the presented subject areas and all the possible sets that can be made from them. This also makes it possible to determine the so-called pure sciences, covering only those documents belonging exclusively to just one subject area (without intersecting with other subject areas). According to the number of documents, health sciences contain a total of 8,896 documents of which 6,575 documents are identified as pure health sciences. Further, life sciences encompass a total of 2,549 documents of which 599 documents are considered as pure life sciences. Moreover, physical sciences include a total of 878 documents of which 314 documents belongs to pure physical science. Finally, social sciences & humanities cover 977 documents of which 323 are determined as pure social sciences & humanities. A comparison between different subject areas reveals that health sciences are the most relevant in COVID-19 research, while the second most relevant subject area is represented by life sciences. Moreover, physical sciences and social sciences & humanities seem to be the least popular so far. This is in line with the expectations. Namely, the first immediate response to COVID-19 pandemic is the protection of public health, while the real socio-economic consequences occur later. This path is also revealed by the recent scientific literature on COVID-19. Finally, some of the documents (n=173) are considered as multidisciplinary, making impossible to include them in the further bibliometric analysis.

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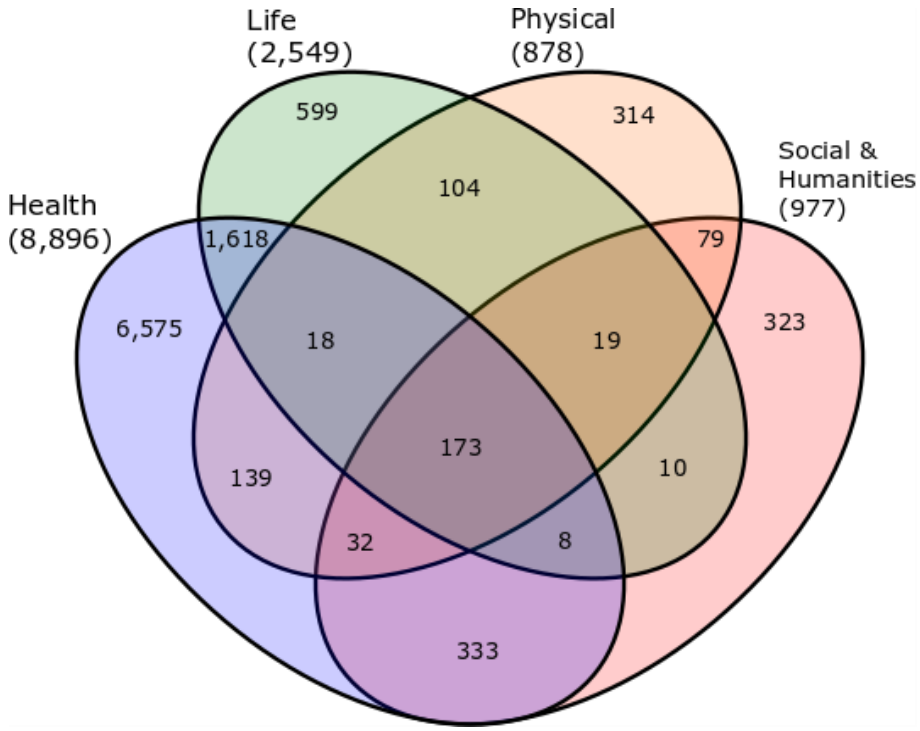

Figure 1. Venn diagram on COVID-19 research across different subject areas (January-May 2020). Source: Authors' elaboration based on Scopus database (all documents included), June 2020.

Figure 2 presents most relevant countries of COVID-19 research by subject area. It shows the top 5 countries, providing the largest number of documents of corresponding author. It is evident, that regardless of scientific discipline (except for physical sciences with Italy on the first place) the United States and China have leading position in COVID-19 research, confirming findings of the existing bibliometric studies, which do not consider scientific disciplines separately [19-23].

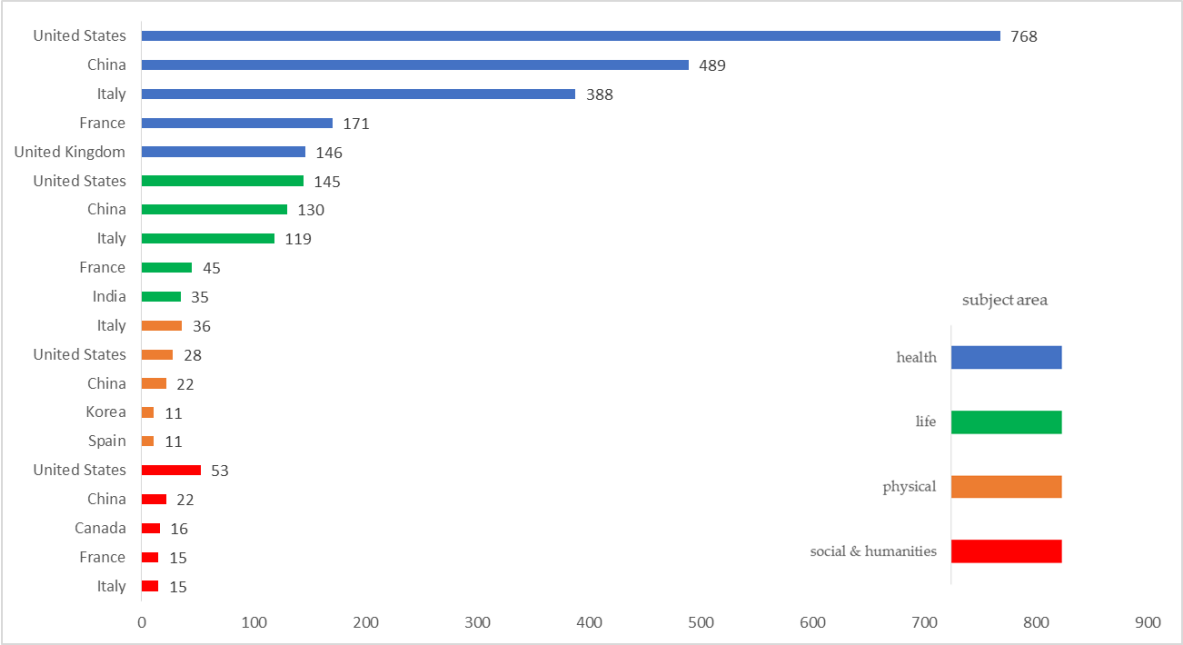

Figure 2. Most relevant countries of COVID-19 research by subject area (January-May 2020). Source: Authors' elaboration based on Scopus database (only documents with at least one citation included), June 2020.

Figure 3 shows most relevant institutions in COVID-19 research by subject area. Due to the strong intertwining between individual scientific disciplines, they to some extent can share the same most relevant institutions. In health sciences, the most involved institutions are Huazhong University of Science and Technology (n=981), Zhongnan Hospital of Wuhan University (n=374), Renmin Hospital of Wuhan University (n=283), Zhejiang University (n=257) and Harvard Medical School (n=239). These findings are to some extend with previous COVID-19 bibliometric research not distinguishing between individual scientific disciplines [19,23]. As far as other scientific disciplines are concerned, the results show the following. In physical sciences, the most relevant institutions are Huazhong University of Science and Technology (n=230), Fudan University (n=131), Zhejiang University (n=114), Icahn School of Medicine at Mount Sinai (n=109) and Centers for Disease Control and Prevention (n=97). Moreover, for physical sciences, the most important institutions are Public Health – Seattle and King County (n=45), National Center for Immunization and Respiratory Diseases (n=36), Fudan University (n=31), Lanzhou University (n=31) and University of Electronic Science and Technology of China (n=26). Finally, in social sciences & humanities, the most involved institutions are Public Health – Seattle and King County (n=45), National Center for Immunization and Respiratory Diseases (n=36), Capital Medical University (n=17), Peking Union Medical College Hospital (n=13) and Chicago Department of Public Health (n=12).

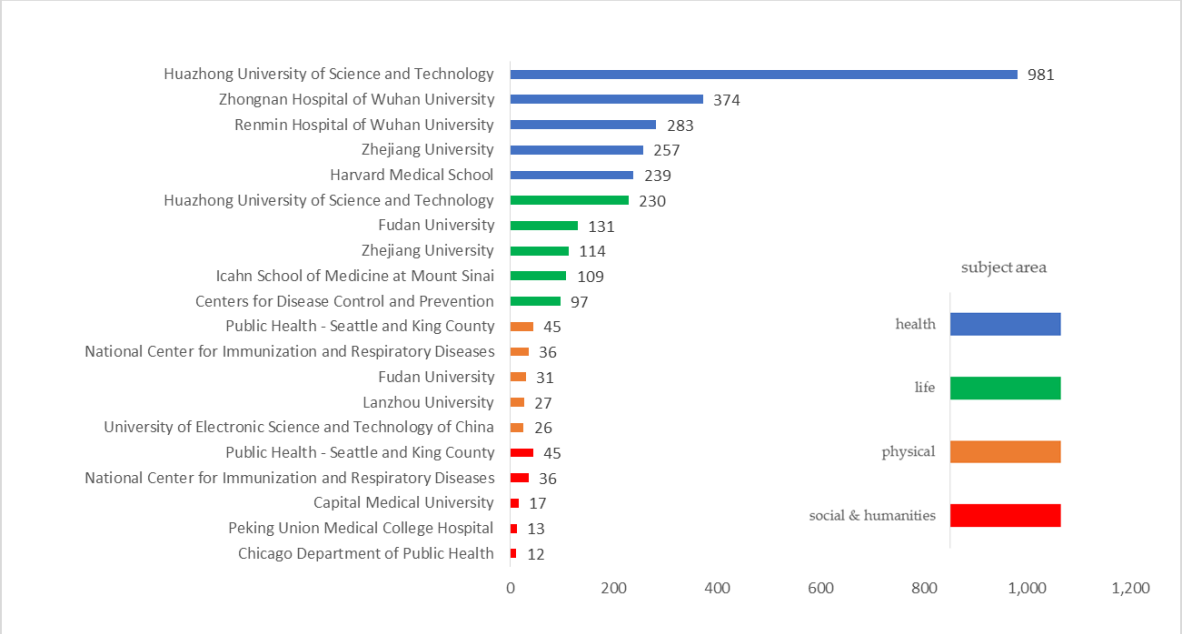

Figure 3. Most relevant institutions in COVID-19 research by subject area (January-May 2020). Source: Authors' elaboration based on Scopus database (only documents with at least one citation included), June 2020.

Figure 4 presents the most relevant journals in COVID-19 research by subject area. In health sciences, Journal of Medical Virology has the most documents (n=221), which is followed by The Lancet (n=196), the BMJ (n=187), JAMA – Journal of the American Medical Association (n=121) and Journal of Infection (n=121). These findings are to some extend with previous COVID-19 bibliometric research not distinguishing between individual scientific disciplines [19,23]. As far as other scientific disciplines are concerned, the results reveal the following. For life sciences, due to strong intertweaving with health sciences, the most relevant journal is also Journal of Medical Virology, having the most documents (n=221), which is followed by Journal of Clinical Virology (n=70), Psychiatry Research (n=66), Brain, Behaviour and Immunity (n=64) and Eurosurveillance (n=50). In physical sciences, the most relevant journals are International Journal of Environmental Research (n=90), followed by Science of the Total Environment (n=88), International Journal of Advanced Science and Technology (n=52), Morbidity and Mortality Weekly Report (n=19) and Chaos, Solitons and Fractals (n=19). Finally, for social sciences & humanities the most relevant journals are Asian

Journal of Psychiatry (n=60), followed by AIDS and Behavior (n=40), Economic and Political Weekly (n=36), Irish Journal of Psychological Medicine (n=27) and Social Anthropology (n=24).

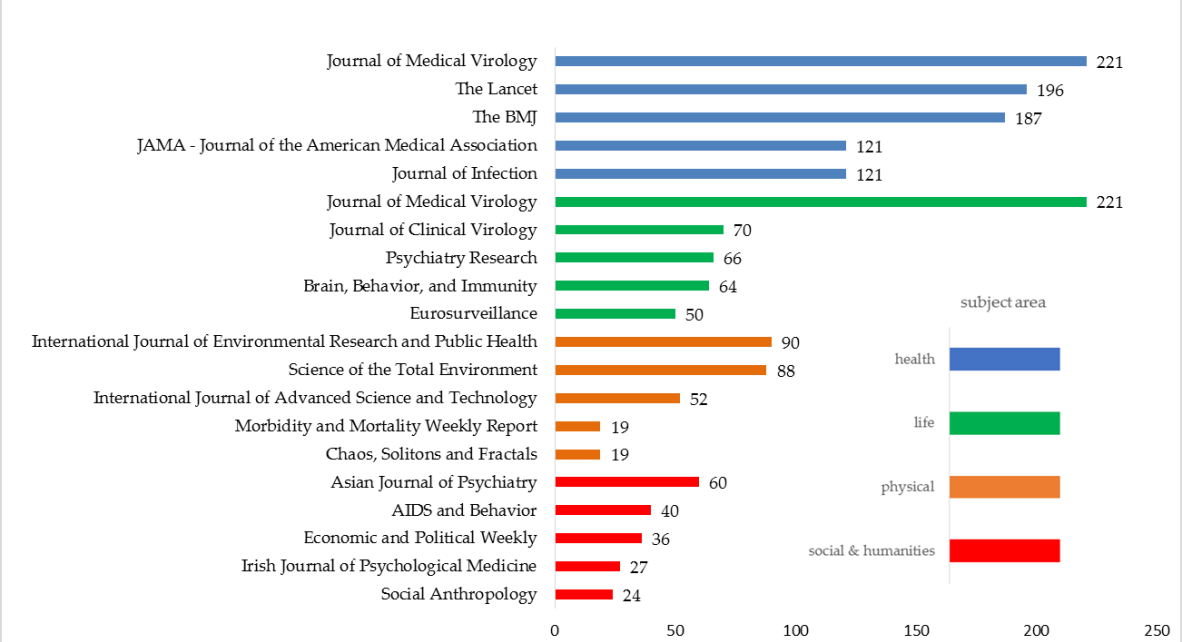

Figure 4. Most relevant journals in COVID-19 research by subject area (January-May 2020).
Source: Authors' elaboration based on Scopus database (all documents included), June 2020.

Figure 5 shows most relevant authors in COVID-19 research by subject area. According to the number of total citations it is evident that Wang, Y. and Li, X. are the most important authors involved in COVID-19 research as they are among top 5 cited authors in all four scientific disciplines. The most prominent author in health sciences and social sciences & humanities is Wang, Y. while in life sciences and physical sciences is Li, X. This finding is different according to the existing bibliometric studies, presumably due to different criteria applied [21].

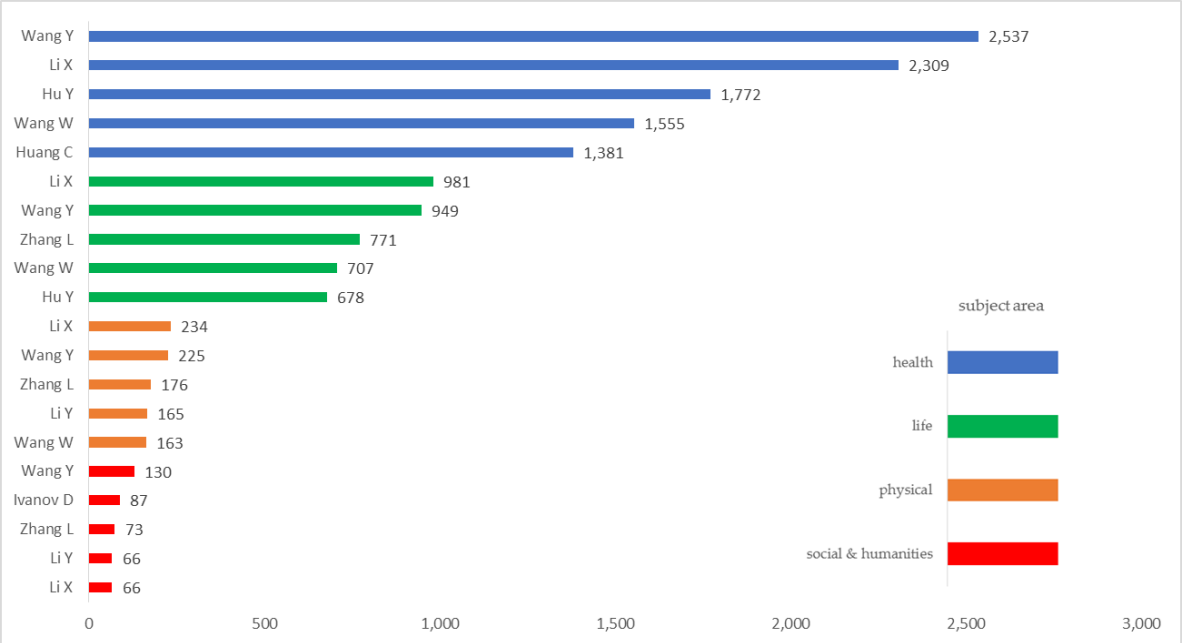

Figure 5. Most relevant authors in COVID-19 research by subject area (January-May 2020).
Source: Authors' elaboration based on Scopus database (total citations included), June 2020.

Figure 6 presents the keyword co-occurrence network for (a) health sciences, (b) life sciences, (c) physical sciences and (d) social sciences & humanities separately. In order to ensure greater

distinction between individual subject areas, only pure sciences (without intersecting with other sciences) are considered in the bibliometric analysis. Moreover, the bibliometric analysis is conducted on 100 most frequent (author and index) keywords by considering exclusion of the keywords used in the search query, elimination of stop words, and consolidation of the keywords describing the same phenomenon.

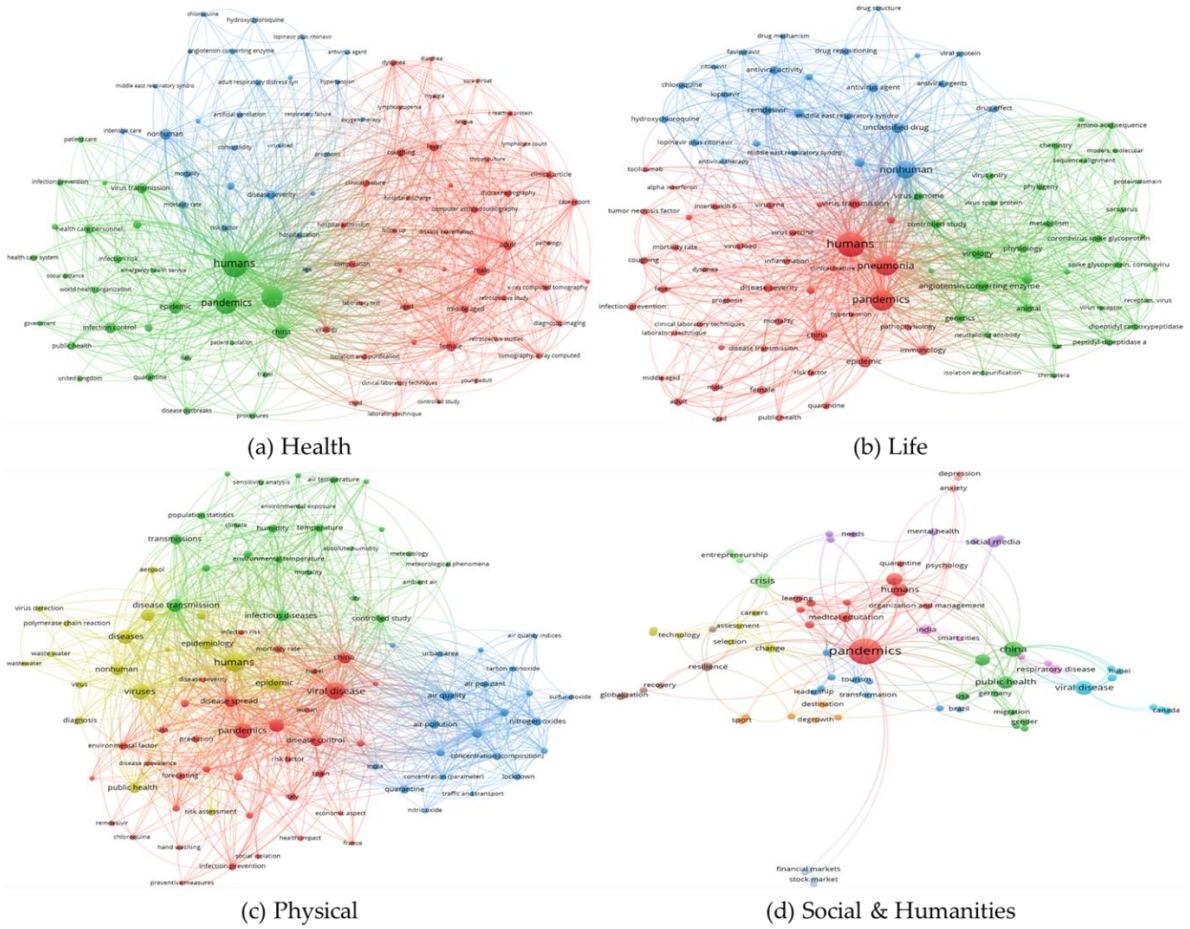

Figure 6. Keyword co-occurrence network in COVID-19 research by subject area (January-May 2020). Source: Authors' elaboration based on Scopus database, June 2020.

The bibliometric analysis reveals that research hotspots differ according to subject area. For health sciences, 3 clusters are identified, addressing the following topics: 1) pandemics; 2) risk factors and symptoms: and 3) mortality. Next, in the life sciences, 3 clusters are found, which are dealing with: 1) pandemics; 2) virology; and 3) drug efficiency. This corresponds to the findings from other recent bibliometric studies on COVID-19 research, emphasizing predominantly health related issues [21,22]. As regards other scientific disciplines, the results show the following. For physical sciences, 4 clusters are recognised, which are related to: 1) pandemics; 2) epidemics; 3) disease transmission and 4) air pollution. Finally, in social sciences & humanities, 13 clusters are identified, addressing the following topics: 1) pandemics; 2) viral disease; 3) humans and pneumonia; 4) China and public health; 5) India and respiratory disease; 6) medical education; 7) tourism and management; 8) technology change; 9) resilience; 10) sport and globalization; 11) financial and stock markets; 12) crisis and 13) mental health.

4. Discussion and Conclusion

The outbreak of COVID-19 is a typical public health emergency, which due to its high infection rate makes it a huge threat not only to global public health but also to economic and social development. In order to be able to solve such kind of emergencies, it is necessary to fully understand

the problem, its implications for different areas as well as the solutions that may be effective and efficient in addressing potential devastating consequences. Therefore, the scientific knowledge on COVID-19 is very important as it facilitates answering real-life questions. However, the extent of the current COVID-19 pandemic calls for in-depth knowledge allowing identification of numerous issues in different areas. Therefore, it is not surprising, why there is an unprecedented increase in the COVID-19 research since the pandemic started [24,26]. The COVID-19 pandemic resulted in generation of large amount of scientific publications, which can consequently present potential problems regarding the information velocity, availability, and scientific collaboration, especially in the early stages of the pandemic [27]. The current state of COVID-19 research, therefore, needs a comprehensive analysis to help guide an agenda for further research, especially from the perspective of cooperation between different scientific disciplines in different stages of pandemic prevention and control, by applying innovative scientific approaches [28,29].

Accordingly, this paper provides an extensive bibliometric analysis of COVID-19 research across science and social science research landscape by considering main subject areas and their relationships with one another. The results show that a total of 10,344 documents related to COVID-19 were published in Scopus database in the first 5 months in 2020. They were written by 44,439 different authors, published in 1,978 different journals and together provide a total of 48,044 citations. A major proportion of the documents are articles and letters, which is in line with previous bibliometric studies [20,21]. Moreover, the most relevant journals in COVID-19 research cover about one-fifth of total documents and cover more than half of total citations. Most of them are ranked into the first quartile (Q1) and have a relatively high source normalized impact per paper (SNIP), which is in line with the existing research [19,23]. Predominantly, they are subject to health sciences, as indicated by previous research [30], covering the subsubject areas of infectious diseases, general medicine and microbiology. Finally, most of these journals are from Anglo-Saxon countries such as the United States, the United Kingdom and the Netherlands, which confirm the findings of previous bibliometric studies [21,22].

A more detailed comparison between four scientific disciplines reveals that subject areas are strongly intertwined, which calls for an in-depth analysis of individual subject area separately. According to the number of documents health science is the most relevant subject area in COVID-19 research, the second most relevant subject area is life sciences, while physical sciences and social sciences & humanities seem to be the least popular. Moreover, the results suggest that regardless of scientific discipline the United States and China have leading position in COVID-19 research. As regards the most relevant institutions, Huazhong University of Science and Technology is the most involved institution in the research related to health and life sciences, while Public Health – Seattle and King County is the most involved institution in the research related to physical and social sciences & humanities. The results regarding journals reveal that Journal of Medical Virology is the most relevant journal for health sciences and life sciences, International Journal of Environmental Research for physical sciences and Asian Journal of Psychiatry for social sciences & humanities. As regards most important authors, Wang, Y. and Li, X. are the most important authors involved in COVID-19 research. Finally, the results of keyword co-occurrence analysis by main subject areas reveal different research hotspots for individual scientific disciplines, with a common point of pandemic. Health sciences are more focused on health consequences, while life sciences are more oriented towards drug efficiency. Moreover, physical sciences are more focused on environmental consequences, while social sciences are more oriented towards socio-economic consequences.

The paper highlights the importance of a comprehensive and in-depth approach considering different scientific disciplines in COVID-19 research. In order to address the health and socio-economic consequences of the current COVID-19 pandemic, COVID-19 must become the focus of the research in the near future. Namely, the understanding of the evolution of emerging scientific knowledge on COVID-19 is beneficial not only for scientific community but also for evidence-based policymaking in order to prevent and address the COVID-19 pandemic.

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