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Research Article

SARS-CoV-2 in the Field of Radiology: A Bibliometric Study of the Novel Coronavirus Disease

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Abstract

To the best of our knowledge, there are few publications regarding bibliometric analyses of SARSCoV-2 in English and this is one of the most comprehensive studies in the field of clinical imaging set in database coverage. The initial, underestimated, severe acute respiratory syndrome coronavirus 2 of the genus Betacoronavirus (SARS-CoV-2) pandemic remains an ongoing major health crisis and a challenge to public healthcare systems worldwide. Subsequently, there have been rapidly increasing numbers of scientific publications about this emerging area of research. The aim of this study was to analyze research trends and explore the influence of scientific publications on coronavirus disease 2019 (COVID-19) in terms of publication type, language, country of origin, publication citation, and journal medical field. A bibliometric study

with high emphasis on publications retrieved from the Web of Science database from January to July 2020 was conducted. Data were extracted using the following keywords: 2019-nCoV, SARS-CoV-2, Radiology, COVID-19, Radiology, COVID-19 and X-Ray, COVID-19 and Ultrasound, COVID-19 and CT, COVID-19, and MRI.

The majority of extracted scientific publications were free full-text articles in English. Interestingly, no published books and only a few randomized controlled trials were found. China and the United States of America contributed the most highly cited scientific papers in the academic literature. Institutional ethical approval to conduct our study was not necessary, as all data were available in electronic versions online and in libraries. Statistical evaluation of publications on COVID-19 is crucial to measure the impact of research outputs in the scientific community and is important for future quality planning of management and protective strategies.

1. Introduction

Novel coronavirus, COVID-19, also known as SARS-CoV-2, was first identified in Wuhan, Hubei Province, in the Republic of China in December 2019 [1, 2]. Since the novel virus could remain viable and highly infectious in the form of aerosols or droplets, the disease has a significant potential to escalate rapidly across continents [3]. The symptoms of disease vary from asymptomatic presentations or mild respiratory symptoms to severe pneumonia with neurological, cardiovascular complications, or even multiple organ failure. Both symptomatic and asymptomatic community transmission contributed to an alarming increase in new cases [4-7]. The World Health Organization announced a worldwide pandemic in March 2020 and subsequently encouraged the public to strengthen and implement protective measures to minimize the spread of COVID-19 [8]. Careful calculation and analysis of the published resources extracted from Web of Science is helpful to recognize research gaps in publication types and scientific fields. Such investigations can shed light on our ability to cope with unexpected challenges. Since the radiological imaging spectrum plays a pivotal role in establishing correct diagnoses along with reverse transcription polymerase chain reaction (RTPCR) testing, a statistical quantitative evaluation of the increasing number of associated publications parallel to the surge of the disease in radiological sciences was conducted.

To the best of our knowledge, there have been few publications of bibliometric analyses of SARS-CoV-2 in English literature, despite this being one of the most comprehensive studies in the field of clinical imaging set in database coverage. Shortly after the virus outbreak, there were numerous significant scholarly publications in the medical literature. Thus, the purpose of our bibliometric study is to investigate the impact of academic literature on emerging infectious diseases. Moreover, the main aim is to analyze the progression of research trends and potential scenarios of future pandemics. Thus, this study explored the influence of scientific publications on COVID-19 in terms of publication type, language, country of origin, publication citation, and journal medical field.

2. Materials and Methods

An extensive Web of Science database search was conducted on July 12, 2020, and radiology publications associated with COVID-19 were retrieved. The timeframe related to our search included published scientific papers from January 2020 until July 12, 2020. A few keywords were searched, namely, 2019-nCoV, SARS-CoV-2,

Radiology, COVID-19 and Radiology, COVID-19 and X-Ray, COVID-19 and Ultrasound, COVID-19 and CT, COVID-19, and MRI (Figure 1). A comprehensive data search in the Web of Science (WOS) included 668 manuscripts from 60 countries. MS Excel and R Studio with Bibliometrix R package software were used for the study. A thorough analysis of predominant variables was performed: "WOS Category," "Publication Year," "Document Type," "Organization," "Funding," "Author," "Source Title," "Country," "Language," and "Research Area."

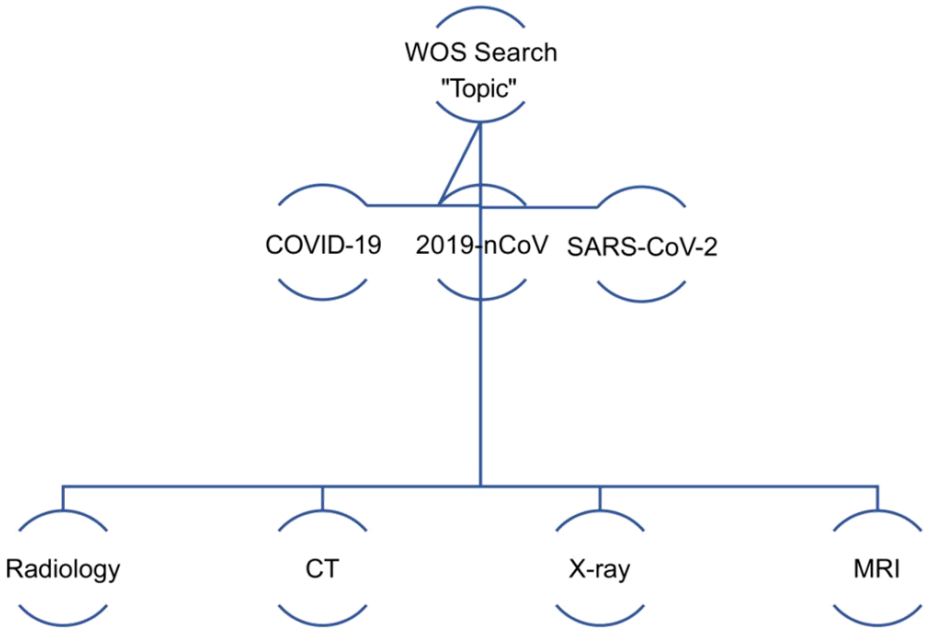

Figure 1: Collation of search keywords used for the dataset and research output about the novel coronavirus.

Note. COVID-19: coronavirus disease of 2019, CT: Computerized tomography scan, MRI: Magnetic resonance imaging, SARS-CoV-2: severe acute respiratory syndrome coronavirus 2 of the genus Betacoronavirus, WOS: Web of Science.

3. Results

Unsurprisingly, the overwhelming majority of the 688 research papers from 60 countries were in English and represented approximately 97.7% of our records (Table 1). Most retrieved scientific items were original articles, approximately 60.47% (Table 2). Moreover, retrieved data show that China and the USA collaborated most actively and were the main contributing countries with respect to the number of citations (Figures 2 and 3). Not surprisingly, Chinese institutions such as Huazhong University of Science and Technology in Wuhan, Wuhan University, and Sun Yat-sen University in Guangzhou, China, produced the highest numbers of COVID-19 publications (Table 3).

Languages	**Records**	**% of 668**
ENGLISH	654	97,904
GERMAN	4	0,599
FRENCH	3	0,449
HUNGARIAN	2	0,299
CZECH	1	0,15
ITALIAN	1	0,15
NORWEGIAN	1	0,15
PORTUGUESE	1	0,15
TURKISH	1	0,15

Table 1: Languages analysis of scientific manuscripts reveal that the majority were published in English.

Document Types	**Records**	**% of 668**
Article	404	60,479
Early Access	146	21,856
Letter	112	16,766
Review	79	11,826
Editorial Material	71	10,629
Correction	1	0,15
News Item	1	0,15

Table 2: Records for majority type of publications.

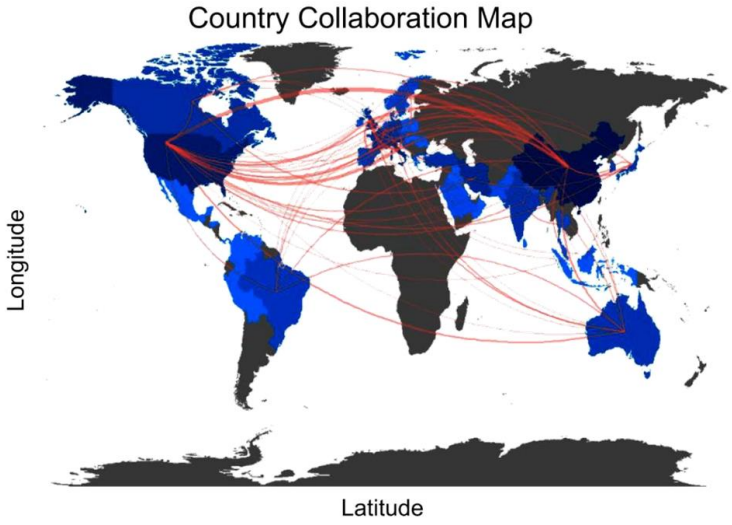

Figure 2: Country collaboration map.

Note. Mapping visualization of continental activity and collaboration related to COVID-19. Developing countries are the minority in terms of research collaboration on the novel disease. China, USA, and Western Europe are the main global scientific collaborators.

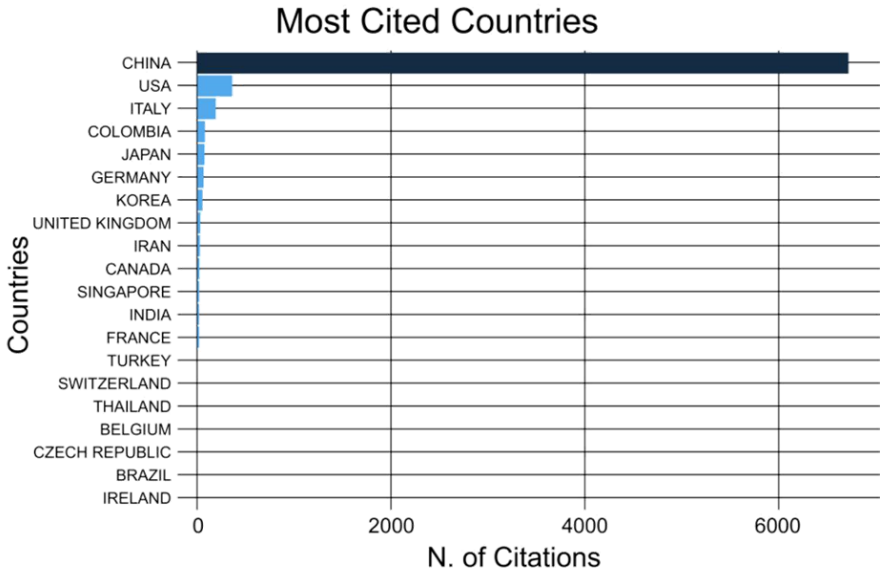

Figure 3: Most cited countries.

Note. N: Number

Organizations-Enhanced	**records**	**% of 668**
HUAZHONG UNIVERSITY OF SCIENCE TECHNOLOGY	43	6.437
SUN YAT SEN UNIVERSITY	37	5.539
WUHAN UNIVERSITY	27	4.042
SHAHID BEHESHTI UNIVERSITY MEDICAL SCIENCES	19	2.844
ASSISTANCE PUBLIQUE HOPITAUX PARIS APHP	18	2.695
SICHUAN UNIVERSITY	17	2.545
CATHOLIC UNIVERSITY OF THE SACRED HEART	15	2.246
IRCCS POLICLINICO GEMELLI	15	2.246
UNIVERSITY OF LONDON	15	2.246
CAPITAL MEDICAL UNIVERSITY	14	2.096
ZHEJIANG UNIVERSITY	14	2.096
CHINESE ACADEMY OF MEDICAL SCIENCES PEKING UNION MEDICAL COLLEGE	13	1.946
CHINESE ACADEMY OF SCIENCES	11	1.647
CHINESE UNIVERSITY OF HONG KONG	11	1.647
FUDAN UNIVERSITY	11	1.647
TEHRAN UNIVERSITY OF MEDICAL SCIENCES	11	1.647
UNIVERSITY OF CALIFORNIA SYSTEM	11	1.647
GUANGZHOU MEDICAL UNIVERSITY	10	1.497
SHANGHAI JIAO TONG UNIVERSITY	10	1.497
GUIZHOU MEDICAL UNIVERSITY	9	1.347
UNIVERSITY OF MILAN	9	1.347
UNIVERSITY OF TEXAS SYSTEM	9	1.347
UNIVERSITY OF WASHINGTON	9	1.347
UNIVERSITY OF WASHINGTON SEATTLE	9	1.347
CHONGQING MEDICAL UNIVERSITY	8	1.198
HUBEI UNIVERSITY OF MEDICINE	8	1.198
JIANGXI PROV PEOPLES HOSP	8	1.198
LANZHOU UNIVERSITY	8	1.198
SINGAPORE GENERAL HOSPITAL	8	1.198
SORBONNE UNIVERSITE	8	1.198
SOUTHERN MEDICAL UNIVERSITY CHINA	8	1.198

UNIVERSITY COLLEGE LONDON	8	1.198
UNIVERSITY OF PENNSYLVANIA	8	1.198
UNIVERSITY OF SOUTHERN CALIFORNIA	8	1.198
WUHAN UNIVERSITY OF SCIENCE TECHNOLOGY	8	1.198
XI AN JIAOTONG UNIVERSITY	8	1.198

Table 3: Results of the highest number of citations among countries.

Enhanced bibliometric analysis revealed the most contributing universities producing the highest numbers of scientific publications. The analysis indicated that European Radiology and Journal of Infection were the main comprehensive bibliometric sources at the time of our search (Table 4). However, the most influential documents were from the New England Journal of Medicine and Lancet. The top cited publications were Huang CL, 2020, Lancet, and Guan W, 2020, New England Journal of Medicine (Figure 4). Interestingly, the book search resulted in "zero entries" and only limited randomized controlled trials were found. Therefore, bibliometric outcomes regarding publications of this type represent probable scientific gaps and potential near-future priority in this novel, rapidly emerging research field.

Source Titles	**Records**	**% of 668**
EUROPEAN RADIOLOGY	34	5.09
JOURNAL OF INFECTION	27	4.042
EUROPEAN JOURNAL OF NUCLEAR MEDICINE AND MOLECULAR IMAGING	21	3.144
AMERICAN JOURNAL OF ROENTGENOLOGY	20	2.994
ACADEMIC RADIOLOGY	17	2.545
CUREUS	16	2.395
QUANTITATIVE IMAGING IN MEDICINE AND SURGERY	16	2.395
KOREAN JOURNAL OF RADIOLOGY	15	2.246
JAPANESE JOURNAL OF RADIOLOGY	12	1.796
RADIOLOGY	12	1.796
ANNALS OF TRANSLATIONAL MEDICINE	11	1.647
JOURNAL OF MEDICAL VIROLOGY	11	1.647
JOURNAL OF THE AMERICAN COLLEGE OF RADIOLOGY	10	1.497
RADIOLOGIA MEDICA	10	1.497
EMERGENCY RADIOLOGY	9	1.347

INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES	9	1.347
EUROPEAN JOURNAL OF RADIOLOGY	8	1.198
FRONTIERS IN MEDICINE	8	1.198
ULTRASOUND IN OBSTETRICS GYNECOLOGY	8	1.198
CLINICAL RADIOLOGY	7	1.048
JOURNAL OF ULTRASOUND IN MEDICINE	7	1.048
DIAGNOSTIC AND INTERVENTIONAL IMAGING	6	0.898
INTENSIVE CARE MEDICINE	6	0.898
TRIALS	6	0.898

Table 4: Bibliometric analysis as per journal titles.

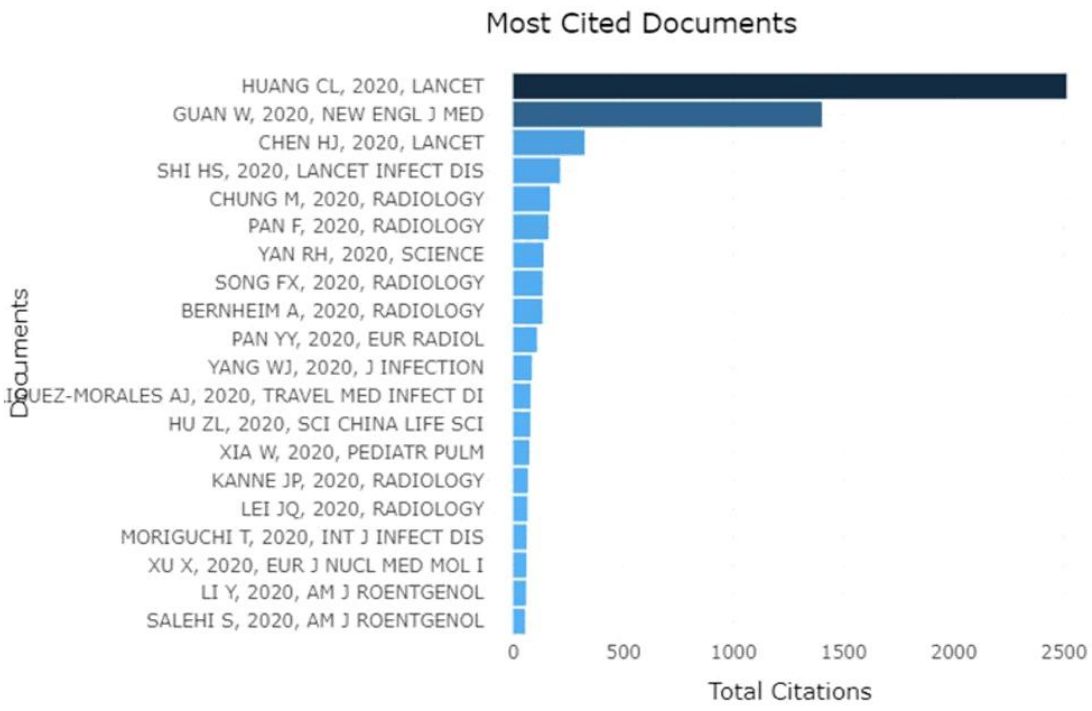

Figure 4: Statistical collation of most cited documents.

Additionally, continental activity and collaboration among various countries appears limited to particular regions. More datasets or contributions from developing countries would be a valuable asset not only for bibliometric studies but also for the revision of and contributions to current global knowledge. Overall, a more supportive approach to

developing countries to enable more scientific opportunities and greater access to datasets could be considered another area of improvement (Figure 2). Impressively, we identified a sharp increase in publication numbers when allowing for our preliminary data search from July 6, 2020, at 9 am to repeat, as the number of items increased by seven on the same day shortly after, at 10:45 am. Thus, there are positive increasing research waves on short time scales that promote better access to timely and reliable information sources.

4. Discussion

Bibliometric studies emphasizing the quantitative and qualitative evaluation of publications represent a highly sensitive and valuable tool that can reveal and summarize global scientific trends [9-10]. Since a response to SARS-CoV-2 has strongly encouraged academic research, we observe the subsequent rapid growth of high-quality scientific publications. A significant volume of papers was published in journals with the highest impact factors. Not surprisingly, the New England Journal of Medicine and Lancet journals ranked first in top-cited publications worldwide.

China, the United States of America, and Western European countries represent the main scientific landscape and are highly connected in information flow and scientific progress on the novel disease (Figure 2). This could be attributed to more optimal research conditions, including satisfactory resources with appropriate levels of funding and a high number of cases in the regions. Nevertheless, according to the visualization map, there is a potential limitation of our analysis, and significant databases appearing to fall outside of our scope, as our mapping clearly highlights the need to encourage a number of countries, predominantly those with a lower research budget. It should be noted that empowering these potential future collaborators or building further scientific networks could contribute to further international developments and be helpful to transform current research advancements [10]. Overall, the research shows that insufficient collaboration among countries should be identified as a weakening research factor. Notably, since novel viruses have impacted many specializations in various fields, bibliometric results emphasize multidisciplinary collaborative efforts with great variability of aims and scope regarding extracted journals, including nuclear medicine, molecular imaging, virology, infectious diseases, surgery, and gynecology. Furthermore, journals with completely different aims and scope, such as European Radiology and the Journal of Infection, were identified among the main sources of retrieved scientific papers (Table 4).

Given that new knowledge of the disease is still dynamically evolving, our study represents a relatively early bibliometric analysis, revealing the need for more contributions to fill in the scientific gaps highlighted above. The limited number of randomized controlled trial reports draws attention to an urgent need for more therapeutic guidelines and optimal management options that could lead to improvements in affected patients [11-14]. Moreover, since the majority of important academic events and annual congresses have been cancelled or postponed indefinitely in order to limit physical presence and the spread of infectious diseases, it is crucial to highlight the increasing role of virtual collaboration in telemedicine or teleradiology to shape our future scientific perspectives [13].

5. Conclusions

Illustrated bibliometric analysis represents one of the most up-to-date comprehensive studies in extensive data search

coverage and international scientific literature. The study clearly demonstrates that influential publications related to the novel virus are dynamically evolving in a short period. The knowledge domain regarding SARS-CoV-2 still represents a new area of interest among researchers, and detailed bibliometric studies can provide substantial updates on valuable insights, highlight future trends, and address gaps in academic literature.

We emphasize that no hardcopy or eBooks on the coronavirus were found. Even allowing for considerable free online data, broad-ranging books with case review series related to COVID-19 imaging spectrum could be of great interest and represent effective learning tools for both clinicians and dedicated radiologists. Since infectious coronaviruses affect many people worldwide and remain a major global threat, reliable scientific publications of all types are in high demand and there is a subsequent sharp increase in the number of published items.

Even though China and the United States of America have most actively contributed advances to this field of science, it is imperative to highlight that many developing countries could add substantial value in terms of collaboration and research. Thus, an approach encouraging more scientific opportunities or greater funding within the regions with a lower human development index could be helpful in terms of research progress.

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