

## Brief Communication

# The impact of COVID-19-related chronic disease is gradually emerging: discovery and trends from a bibliometric analysis

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**Abstract:** Objective: To conduct a literature survey of COVID-19-related chronic diseases to inform future research. Methods: Publications on COVID-19 and chronic disease were retrieved from PubMed using MeSH Major Topic, including the terms COVID-19, SARS-CoV-2, Chronic Disease and Noncommunicable Diseases. Bibliometric features, journals, research areas, countries, funding agencies and citation reports, were extracted from Web of Science and highly cited papers identified and summarized. Fisher's exact probability test was used to associate highly cited papers with countries. Results: A total of 1034 English-language publications were included. Urology/nephrology was the most active research area (n=230), PLOS ONE the most frequently involved journal (n=29) and the United States of America (USA) had the greatest research output (n=223). A medium number of publications were in the areas of hematology and immunology and these papers had a high citation rate. No statistically significant difference was found in the ratio of highly cited papers: total papers across high-output countries (P=0.668). The USA, Europe and China were the sources of the most highly cited articles and productive funding agencies. Conclusions: The influence of COVID-19 on chronic disease has received considerable attention. Hematology and immunology may continue to be productive research fields. Much research remains to be done to characterize the emerging chronic effects of COVID-19 on human health.

**Keywords:** COVID-19, chronic disease, bibliometrics, PubMed, Web of Science

## Introduction

Coronavirus Disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has shown rapid global spread since December 2019. The source and viral transmission route, epidemiological characteristics, diagnosis and treatment strategies, prevention and control measures and vaccines have all received much research attention [1]. Pre-dominant topics have been public health response, clinical care practices, clinical characteristics and risk factors with the creation of

epidemic models to monitor spread [2]. The COVID-19 pandemic posed new challenges for chronic disease prevention and management [3], illustrated by the fact that excess mortality during the pandemic was much higher than was accounted for by deaths from COVID-19 [4-6]. Many studies have addressed the detrimental effects of COVID-19 on patients with chronic disease and the complexities introduced by post-COVID-19 syndromes [7, 8].

Pre-existing chronic disease and chronic consequences of COVID-19 lasting more than three

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**Table 1.** The top ten most productive WoS research areas

Research areas	Frequency (n, %)	Average citation per item (n)
Urology Nephrology	230 (22.24%)	10.34
General Internal Medicine	137 (13.25%)	8.77
Respiratory System	136 (13.15%)	6.06
Public Environmental Occupational Health	117 (11.32%)	5.09
Infectious Diseases <sup>1</sup>	97 (9.38%)	3.10
Hematology	91 (8.80%)	9.62
Immunology	83 (8.03%)	9.41
Health Care Sciences Services	53 (5.13%)	1.72
Pharmacology Pharmacy	53 (5.13%)	5.21
Cardiovascular System Cardiology	46 (4.45%)	4.96

<sup>1</sup>COVID-19 and other infectious diseases, such as AIDS, hepatitis B.

months, including asthma, diabetes, cancer, chronic obstructive pulmonary disease, chronic kidney disease, hepatitis C and AIDS, are the subject of the current study. The COVID-19 pandemic has had huge implications for patients with chronic disease, illustrating the need to identify research hotspots and gaps. The bibliometric analysis uses literature metrology to gauge the contribution made by a particular research area and to predict trends. The present study analyzed categories and metrology of scientific publications on COVID-19 and chronic disease to inform future research into global public health.

## Materials and methods

PubMed and Web of Science (WoS) were utilized. Medical Subject Headings (MeSH) is a controlled and hierarchically-organized vocabulary used for indexing, cataloging, searching and MeSH Major Topic (Majr) identifies the primary focus of retrieved literature. Narrower MeSH terms are automatically indented under the main heading in the MeSH Tree Structure, ensuring that the search includes relevant sub-groups within PubMed. Retrieval of original research, reviews, letters, editorials, case reports and news in the English language was performed on 20th September 2022 in PubMed with search strategy: (“COVID-19”[Majr]) OR “SARS-CoV-2”[Majr]) AND (“Chronic Disease”[Majr]) OR “Noncommunicable Diseases”[Majr]). A total of 1034 publications were identified and document type, research area, publication/source title, countries/regions, funding agencies and citation reports analyzed within WoS.

Excel 2019 (Microsoft Corporation, Redmond, USA) was used for data processing and differences between highly cited and other publications analyzed by country using Fisher’s exact probability test with SPSS 26.0 software (SPSS v26.0, SPSS Inc., Chicago, Illinois, USA, 2012). Highly cited papers were in the top 1% compared with other papers published in the same field in the same year. All statistical inference testing was two-sided and a value of  $P < 0.05$  was considered statistically significant.

## Results

A total of 669 original publications were identified, accounting for 64.7% of the total literature. Remaining publications were letters (n=144, 13.73%); review articles (n=144, 13.73%); editorial material (n=92, 8.90%) and case reports (n=7, 0.68%). The research area of urology and nephrology had the greatest number of publications (n=230, 22.24%) with a mean of 10.34 citations per item. General internal medicine had the second largest share (n=137, 8.75 mean citations per item), followed by the respiratory system (n=136, 13.15%), public environmental occupational health (n=117, 11.32%), infectious diseases (n=97, 9.38%) and hematology (n=91, 8.80%, see **Table 1** for the top 10 research areas).

Increases in publication output for the top six chronic disease research fields related to COVID-19 between June 2020 and October 2022 are shown in **Figure 1**. Publications in urology/nephrology, general internal medicine, respiratory system and public environmental occupational health began to increase from mid to late 2020, peaking in the first half of 2021 before declining and remaining stable in 2022. Publications in infectious diseases and hematology started to appear in late 2020, and peaked in early 2022 before declining to a stable rate of output. PLOS ONE had the greatest number of COVID-19 and chronic disease publications (n=29, 2.81%, **Table 2**). The average citation per article of all journals exceeded the 2021 journal impact factor, except for BMJ OPEN and BRITISH JOURNAL OF HAEMATOLOGY.

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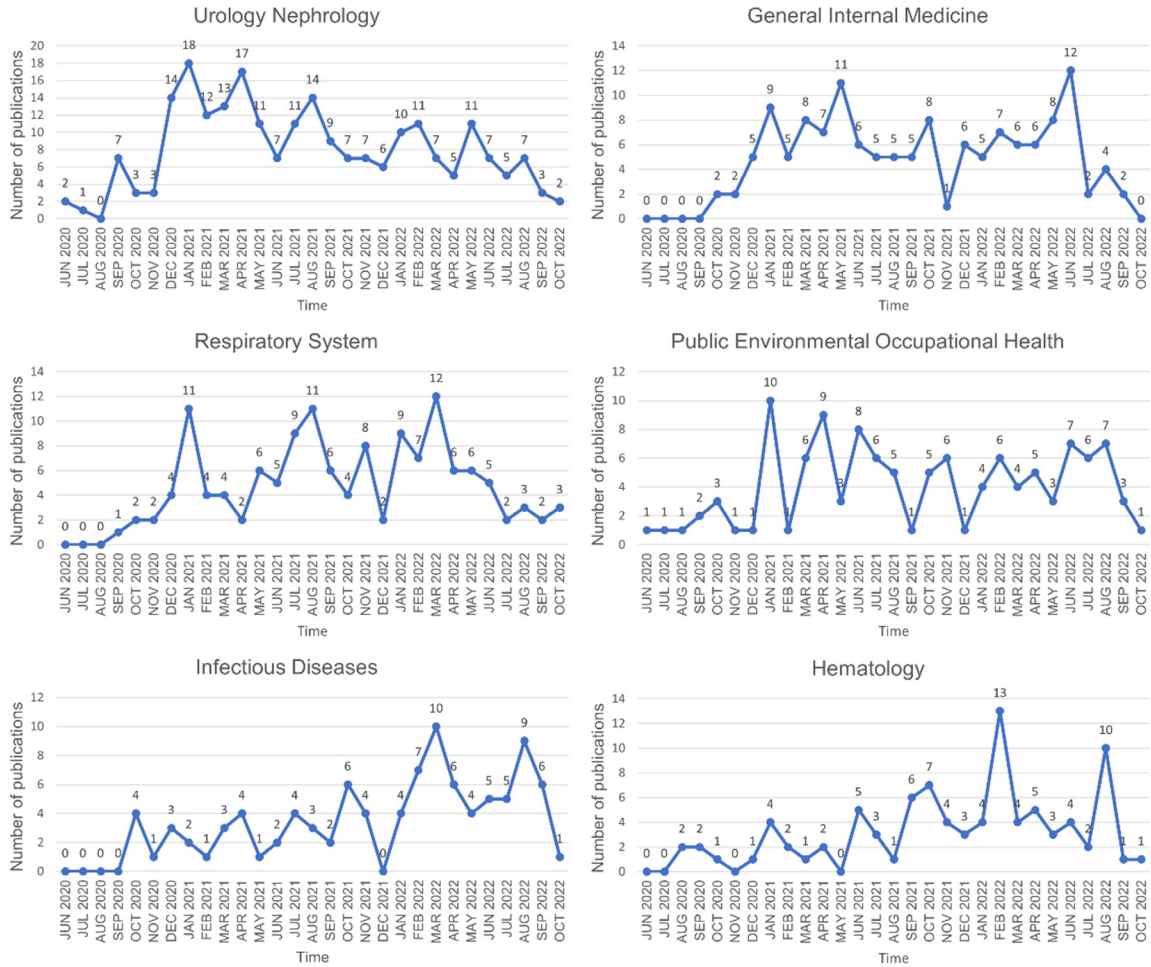


Figure 1. Time distribution of publications in different research areas.

Table 2. The top ten most active journals

Journal	Impact factors, 2021	JIF Quartile, 2021	Frequency (n, %)	Average citation per item (n)
PLOS ONE	3.752	Q2	29 (2.81%)	5.34
INTERNATIONAL UROLOGY AND NEPHROLOGY	2.266	Q3	19 (1.84%)	5.32
JOURNAL OF NEPHROLOGY	4.439	Q2	17 (1.64%)	12.35
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	4.614	Q2	16 (1.55%)	5.31
BMJ OPEN	3.017	Q2	15 (1.45%)	1.00
BMC NEPHROLOGY	2.585	Q3	13 (1.26%)	4.77
BRITISH JOURNAL OF HAEMATOLOGY	8.615	Q1	13 (1.26%)	6.85
INTERNATIONAL JOURNAL OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE	2.893	Q3	13 (1.26%)	4.38
KIDNEY INTERNATIONAL	18.998	Q1	11 (1.06%)	44.27
CLINICAL JOURNAL OF THE AMERICAN SOCIETY OF NEPHROLOGY	10.671	Q1	10 (0.97%)	11.00

Analysis of high-quality research publications from the six countries with the greatest output showed the USA to have the greatest number of highly cited papers, followed by England and Italy (Table 3). Ratios of highly cited work: other

publications showed no significant differences among the countries analyzed (Fisher's Exact Test value: 3.196; P>0.05). Mean citation rates were highest for Spain (20.03), followed by Germany (18.93) and Italy (15.89). Five funding

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**Table 3.** Highly cited papers from the top six countries in total publications

Country	Highly Cited Papers <sup>1</sup> (n)	Total Publications (n, %)	Citation Per Article <sup>2</sup>	Fisher's Exact Test/P
USA	18	223 (21.57%)	13.98	Fisher's Exact Test value =3.196; P=0.668>0.05
England	8	126 (12.19%)	14.62	
Italy	6	88 (8.51%)	15.89	
China	4	87 (8.41%)	15	
Spain	5	62 (6.00%)	20.03	
Germany	7	58 (5.61%)	18.93	
Total <sup>3</sup>	45	1034	8.85	

<sup>1</sup>Meeting a highly cited threshold of WoS; <sup>2</sup>For all publications in one country; <sup>3</sup>For the whole 1034 publications.

**Table 4.** Publications from the five most productive funding agencies

Ranking	Funding Agencies	Frequency	Percentage	Country/Region
1	United States Department Of Health Human Services	58	5.61%	USA
2	National Institutes Of Health	56	5.42%	USA
3	National Natural Science Foundation Of China	28	2.71%	China
4	European Commission	23	2.22%	European
5	National Institute For Health Research	16	1.55%	England
Total		181	17.51%	

agencies were the most productive and accounted for 17.51% of total publications (Table 4). The top two funding agencies were USA-based, followed by two European and one Chinese.

### Discussion

Rapid publication and dissemination of scientific findings were central to the COVID-19 response and were evident as a surge of papers as the global health crisis developed [9]. The present study examined 1034 records on the topic of "COVID-19 and chronic disease" from the PubMed database, 2020-2022. Highly regarded papers and active journals were identified by bibliometric analysis with WoS. Trends in literature relating to COVID-19 and chronic disease in the areas of virology, epidemiology, clinical diagnosis and treatment, pathogenesis, drug development and health policy were analyzed [10]. The aim was to address the analytical gap in literature on COVID-19 and its association with chronic disease, given the many affected patients worldwide and complex mechanisms of disease interaction.

The majority of journals that published COVID-19-chronic disease articles were in Q1 or Q2 of

the JIF Quartile, suggesting the perceived value of such publications and citations typically exceeded journal impact factors. PLOS ONE, with its multidisciplinary scope, expedited review and publication times, had the greatest number of publications at 29. Highly cited publications were generally produced in Europe, the USA and China which are all geographical regions with superior medical resources and technology. China successfully prioritized pandemic prevention and control, leaving resources for the study of COVID-19 and chronic disease. Highly productive funding agencies were also located in Europe, the USA and China.

The area of urology and nephrology accounted for the greatest number of COVID-19-chronic disease publications. Angiotensin-converting enzyme 2 (ACE2) is a receptor for SARS-CoV-2 and is abundantly expressed in the kidney [11]. More than half of COVID-19 patients developed kidney damage [12, 13], with acute damage increasing morbidity and mortality due to multiple organ failure [14], and live SARS-CoV-2 virus was isolated from patients' urine samples [15]. General internal medicine and respiratory system also received considerable research attention due to the acute respiratory effects of SARS-COV-2. Many articles have analyzed the relationship between pre-existing dis-

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eases or risk factors and COVID-19 severity and mortality. However, work remains to be done to elucidate underlying mechanisms.

Mean citation rates per article generally decreased as the total output of publications in the field decreased, except in the cases of hematology and immunology. These research fields may have been later additions to the COVID-19 area, indicating the need for further future research and articles in other areas may have referred to effects of COVID-19 on hematologic and immune systems, increasing citation rates. Patients with hematologic neoplasms or immunodeficiency and those taking anti-rejection drugs following organ transplantation have the poorest immune function and require extra attention during the pandemic. Patients with chronic lymphocytic leukemia were found to respond poorly to COVID-19 vaccination with an antibody response produced in fewer than half [16]. Research has also been prompted by the observation that COVID-19 may trigger a cytokine storm that ultimately leads to acute respiratory distress syndrome, multi-organ failure and death. Indeed, convalescent blood products have been investigated for their potential to reduce COVID-19 mortality [17].

Infectious disease publications increased significantly in mid-to-late 2022, perhaps indicating that the relationship between COVID-19 and chronic infectious diseases was not a research priority in the early stages of the pandemic. Decreased immunity of COVID-19 patients or treatment with corticosteroids may lead to reactivation of latent viruses [18] and immune exhaustion has been suggested as an explanation for the inverse association between chronic hepatitis B infection and COVID-19 [19]. Further work is necessary to illuminate the impact of SARS-CoV-2 on patients with viral infections.

A small minority of publications are not indexed in PubMed and their exclusion from the current study may impact its scope. The exclusion of non-English-language publications may introduce bias and reduce global representation in the results.

### Conclusions

The COVID-19 pandemic threatened global public health and impacted economic and cul-

tural activities. It also led to an explosion of scientific literature. An evaluation of publication quality and quantity may inform future research into the association between COVID-19 and chronic disease. Hematology and immunology produced a medium volume of publications with a high mean citation rate. A rapid increase in papers in a particular research area may indicate the need for further treatment options when the disease coexists with COVID-19 whereas the absence of a research chain from clinic to mechanism demands more study.

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### Disclosure of conflict of interest

None.

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