

Bibliometric Analysis of Global Scientific Research on SARS-CoV-2 (COVID-19)

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Abstract

Background and Aim: Since late 2019, an unknown-origin pneumonia outbreak detected in Wuhan city, Hubei Province, China. We aimed to build a model to qualitatively and quantitatively assess publications of research of COVID-19 from 2019 to 2020.

Materials and Methods: Data were obtained from the Web of Science (WOS), PubMed, and Scopus Core Collection on March 02, 2020, and updated on March 10. We conducted a qualitative and quantitative analysis of publication outputs, journals, authors, institutions, countries, cited references, keywords, and terms according to bibliometric methods using VOS viewer c software packages.

Results: Initially, we identified 227 papers, of which after an exclusion process, 92 studies were selected for statistical analyses. China accounted for the highest proportion of published research (44 papers, 40.48%), followed by the United States (21 papers, 19.32%), and Canada (7 papers, 6.44%). Adjusted by gross domestic product (GDP), ranked first, with 0.003 articles per billion GDP. In total, the top 10 journals published 47 articles, which accounted for 51.08% of all publications in this field. A total of 6 studies (05.52%) were supported by National Natural Science Foundation of China. Chinese Academy of Sciences ranked second (2, 2.76%).

Conclusion: Bibliometric and visualized mapping may quantitatively monitor research performance in science and present predictions. The subject of this study was the fast

growing publication on COVID-19. Most studies are published in journals with very high impact factors (IFs) and other journals are more interested in this type of research.

Keywords: Scientific collaboration network; co-citation network; keywords co-occurrence network; journal analysis; cited reference analysis

Highlights

1. Bibliometric description and mapping provided a birds-eye view of information on Covid-19 related research
2. Readers to comprehend the history of published Covid-19 articles in just a few minutes.
3. We evaluated the research strength of countries and institutions,
4. Scholars might refer to in order to find cooperative institutions.
5. During our research using the selected database, we tried to guarantee comprehension and objectivity.

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27 occurrence network; journal analysis; cited reference analysis

28 **Introduction**

29 Since late 2019, an unknown-origin pneumonia outbreak detected in Wuhan city,
30 Hubei Province, China [1]. Though the outbreak of corona virus disease 2019,
31 SARS-CoV-2 (COVID-19) occurred in China first, it rapidly spread globally. Today,
32 146 countries and territories are reporting confirmed and suspected cases of COVID-
33 19 [2]. Numerous etiological studies have conducted to find the detailed biological
34 features of COVID-19 so far. Following the global outbreak and spread of the virus,
35 the World Health Organization (WHO) issued a statement on January 11, 2020,
36 announcing the outbreak of the COVID-19 as the sixth major public health
37 emergency worldwide [3]. Thus, to prevent the spread of this new coronavirus, it is
38 necessary health-care staffs and decision maker, governments and the people to
39 work together. Moreover, it is recommended that all potentially exposed subjects to
40 be isolated for 14 days, suggesting isolation is the best way to contain this epidemic
41 [4].

42 Extracting information from basic and clinical research related to COVID-19 could be
43 crucial for the improvement and development of the diagnosis, treatment and
44 preventive strategies against this viral infection. A large number of epidemiological
45 and clinical evidences have emerged, and a great deal of research has been
46 published as well. Bibliometric studies is a method of investigating scientific
47 achievements in a particular field of science through secondary analysis of the
48 knowledge of published articles; so, it can help researchers appreciate the earlier
49 and existing statuses of COVID-19 efficiently, predict and choose forthcoming
50 advance directions, and design upcoming research [5, 6]. However, up to now,

51 bibliometric studies on COVID-19 include inherent limitations and are rare. Due to
52 the rapid growth of publishing articles in this field, the aim of this article is to assess
53 the publication pattern of Covid-19 research globally. This study systematically
54 assessed the publication distribution, stratified by geography, institution, funding
55 sponsors, journals, and more. We also assessed the frequency of keywords and
56 then employed Bibliometric mapping tools to demonstrate developments on Covid-
57 19. Results were analyzed to further understand the structure of this field and to
58 anticipate developments on Covid-19 research. Furthermore, this study can provide
59 information for funding agencies to establish related guidelines on Covid-19 research.

60 **Materials and Methods**

61 **Sources of the Data and Search Strategy:** The data in this article were based on
62 the Web of Science (WOS), PubMed, and Scopus from 2019 to 2020. An initial
63 comprehensive online search was performed on a single day, March 02, 2020, to
64 avoid daily updating bias since the database is still open, and updated on March 10.
65 The search key words were referred to MESH terms from PubMed and then were
66 used as follows: TITLE-ABS-KEY("Wuhan coronavirus") OR TITLE-ABS-
67 KEY("Wuhan seafood market pneumonia virus") OR TITLE-ABS-KEY("COVID19
68 virus") OR TITLE-ABS-KEY("COVID-19 virus") OR TITLE-ABS-KEY("coronavirus
69 disease 2019 virus") OR TITLE-ABS-KEY("SARS-CoV-2") OR TITLE-ABS-
70 KEY("SARS2") OR TITLE-ABS-KEY("2019-nCoV") OR TITLE-ABS-KEY("2019 novel
71 coronavirus") OR TITLE-ABS-KEY("2019 novel coronavirus infection") OR TITLE-
72 ABS-KEY("COVID19") OR TITLE-ABS-KEY("coronavirus disease 2019") OR TITLE-
73 ABS-KEY("coronavirus disease-19") OR TITLE-ABS-KEY("2019-nCoV disease") OR
74 TITLE-ABS-KEY("2019 novel coronavirus disease") OR TITLE-ABS-KEY("2019-
75 nCoV infection") OR TITLE-ABS-KEY("covid 19") AND (LIMIT-

76 TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019). Regarding
77 manuscript types, only original articles and other document types were included.
78 Ethical approval was not necessary, since the data were downloaded from the public
79 databases and did not involve any interactions with human or animal subjects.

80 **Data Collection:** The txt data download was imported into Microsoft Excel and VOS
81 viewer. Bibliometric indicators were extracted from the data, including publication
82 number, citation frequency, and H index .the data were analyzed both quantitatively
83 and qualitatively. To adjust for economic condition and population size, statistics on
84 gross domestic product (GDP) and population sizes from the World Bank and the
85 Central Intelligence Agency for the most recent report were used in the study. H-
86 index is calculated as a measure of scientific research impact that reflects both the
87 number of publications and the number of citations per publication: a scholar has
88 published h papers, each of which has been cited in other papers at least h times.

89 **Statistical analysis:** VOS viewer was used to analyze the relations among highly
90 cited references and productive authors. It is commonly used for mapping and
91 clustering of co citation network analysis. It also clusters citation terms and portrays
92 the key words by color. The density of occurrence of information is portrayed by the
93 size of the circle.(5)

94 **Results**

95 **Countries Contributing to Global Publications.** Initially, 227 papers were
96 retrieved, dating back to 2019. After an exclusion process (**Figure 1**), 92 studies
97 were selected for statistical analyses. **Figure 2** shows that articles in all countries
98 and top three countries on Covid-19 researches.

99 **Figure1:** the inclusion and exclusion process of COVID-19 Research.

100 **Figure 2:** the number of worldwide and the top 3 countries publications on Covid-19
101 research

102

103 In terms of the most productive countries, China accounted for the highest proportion
104 of published research (44 papers, 40.48%), followed by the United States (21
105 papers, 19.32%), and Canada (7 papers, 6.44%). Adjusted by gross domestic
106 product (GDP), ranked first, with 0.003 articles per billion GDP. Adjusted by
107 population, United States came to the fore with United States articles per million
108 populations (**Table 1**).

109 **Table 1:** the 10 most productive countries related to COVID-19 research.

110 Citation and H-Index Analysis. According to the analysis of the Scopus database, all
111 articles related to Covid-19 had been cited a total of 364 times, an average of 3.95
112 times per paper. Specifically, the top 10 Covid-19 studies (with the highest citation
113 frequency) accounted for 307 citations (84.34% of 364). In terms of countries, the
114 China has the most citations (327) and the highest H-index (8). United States ranked
115 second with 19 citations and an H-index of 2 (**Table 1**).

116 **Distribution of Institutes Focusing on Covid-19 research:** The University of Hong
117 Kong, Huazhong University of Science and Technology and Zhongnan Hospital of
118 Wuhan University with six articles were top of the list. The top productive institutions
119 can be viewed in the **Figure 3**.

120 **Figure 3:** the number of publications on **COVID-19** research from the top 10
121 contribution institutes

122

123 **Distribution of Published Journals and Funding Agencies Focusing on Covid-**

124 **19:** Euro Surveillance has the greatest number of publications on Covid-19 Research
125 with 10 papers. Journal of Medical Virology and Lancet Journal were on the second
126 level either with 7 papers (**Figure 3**). In total, the top 10 journals published 47
127 articles, which accounted for 51.08% of all publications in this field. The top 10
128 funding bodies are shown in **Table 2**. A total of 6 studies (05.52%) were supported
129 by National Natural Science Foundation of China. Chinese Academy of Sciences
130 ranked second (2, 2.76%).

131 **Figure 4:** the number of publications of the top 10 popular journals on COVID-19
132 research.

133

134 **Figure 5:** Distribution of document by subject area

135

136 Most of the subject areas in the publication of the article on Covid-19 are as follows:
137 Medicine (79 papers, 52.0%), Immunology and Microbiology (39 papers, 25.7%) and
138 Biochemistry, Genetics and Molecular biology (9 papers, 5.9%) (**Figure 4**)

139 **Table 2:** Top 10 related funding sponsor

140 **Characteristics of top 10 Covid-19 articles cited most frequently:** In total, the top
141 10 articles contributed 307 citations, accounting for 84.34% of citations related to
142 Covid-19 (**Table 3**). **Hotspots of Research on Covid-19:** VOS viewer was used to
143 analyze keywords extracted from the titles and abstracts of 552 articles included in
144 this study. As a result, 84 keywords, which appeared more than 10 times, were
145 included and shown in the map. These could be stratified into three clusters: High-

146 frequency keywords in cluster 1 were “Coronavirus” (224 times), “Cov” (125 times),
147 and “death” (41 times). For the characteristics-related research in cluster 2, the top
148 keywords are comprised of “patient” (107 times), “symptom” (52 times), and
149 “year”(40 times). In cluster 3 were “Country” 58 times), “epidemic” (49 times), and
150 “sars” (36 times).

151 **Figure 6:** the analysis of key words. The mapping on key words of Covid-19.
152 For analyzing data in VOS viewer, we used ISI, PubMed, and Scopus as database.
153 The keywords were divided into three clusters: In general, the smaller the distance
154 between two terms, the larger the number of co-occurrences of the terms. A large
155 size of a circle represents that the keyword appears more frequently. The line means
156 that the topics connected on the same line are separated from each other by a
157 comma, a semicolon, or a tab.

158

159 **4. Discussion**

160 In this study, we tried to provide an overview of the world situation in the field of
161 publication of COVID-19. The results indicate that at this ISI, researchers from
162 around the world started publishing the article just on month ago and the number of
163 articles in this field is still growing quickly.

164 Bibliometric and visualized mapping may quantitatively monitor research
165 performance in science and present predictions [7]. This type of studies had impact
166 on other scientific and professional communities. In the case of antimicrobial
167 resistance surveillance, for example, because real-time surveillance data are often
168 unavailable and limited, scholars have used Scientometrics and found that it

169 provides a fast, reliable, and global overview of research [8]. As a result, Bibliometric
170 studies may be a meaningful reference. In this study, we evaluated Covid-19.
171 Studies with respect to the contributing countries, institutions, journals, and funding
172 sponsors.

173 In the case of global trends of research on Covid-19, the possibility that the
174 increasing trend will go on longer than that expected from the proposed model,
175 because the application of Covid-19 as a fast-spreading and super-contagious virus
176 might arouse more attention. In terms of country analysis, China published 44
177 articles and was the leading country in terms of scientific productivity so far.
178 Considering the factors of a large population and GDP, we performed an adjustment
179 and found that published 0.003 articles per trillion GDP and 3.15 articles per million
180 population. Moreover, we found that although the United States published 21 articles
181 and was in second place, its total citations and H-index were 19 and 2, respectively.
182 In terms of journals, we observed that the Euro Surveillance Bulletin "European Sur
183 Les Maladies Transmissibles " European Communicable Disease Bulletin published
184 far more Covid-19 research papers, with 10 articles, than other journals. It was
185 indicated that future development within Covid-19 would likely. Considering the field
186 of research focuses on Covid-19, and the details of the top cited articles, we found
187 that the top studies had been cited 307 times, which indicated that these studies
188 might be classic and fundamental for further studies and should be read by those
189 new to the Field. As shown in Bibliometric mapping of keywords, it was observed
190 that the focus on Covid-19 research is gradually shifting to most basic and
191 experimental studies.

192 The article titled "Clinical features of patients infected with 2019 novel coronavirus in
193 Wuhan, China" has been cited the most, at 88 times in total was published in "The

194 Lancet” in 2020 [1]. This article point the 2019-nCoV infection caused clusters of
195 severe respiratory illness similar to severe acute respiratory syndrome coronavirus
196 and was associated with ICU admission and high mortality. As for the prospective
197 application of the VOS viewer map, we suggest that authors could select research
198 topics from the map and demonstrate its importance as frontier hotspot by the map
199 ,and funding agents might be suggested to invest in these orientations.

200

201 **Strengths and Limitations.**

202 This Bibliometric description and mapping provided a birds-eye view of information
203 on Covid-19 related research for readers to comprehend the history of published
204 Covid-19 articles in just a few minutes. In addition, we evaluated the research
205 strength of countries and institutions, which scholars might refer to in order to find
206 cooperative institutions. During our research using the Scopus database, we tried to
207 guarantee comprehension and objectivity. However, we must consider the following
208 limitations.

209 Firstly, only publications written in English were included this study, which, inevitably,
210 missed some significant studies on Covid-19 published in other languages.
211 Secondly, as the publication on COVID-19, is growing very quickly, even daily, it is
212 very difficult to extend the findings and generalizing the results. Thirdly, there were
213 still differences between real research conditions and the Bibliometric analysis
214 results, since some recently published papers do not have high citation frequency,
215 as reported by Stephan et al., in Nature [9]. Lastly, the data in this study are open to
216 expansion, with new studies being published each day, and the increasing trend of
217 publication number might go on for longer than is expected from the proposed
218 model.

219 **Conclusions**

220 The subject of this study was the fast growing publication on COVID-19. Most
221 studies are published in journals with very high impact factors (IFs) and other
222 journals are more interested in this type of research. Future studies, the association
223 of these two topics, and related keywords will be explored to provide more
224 comprehensive results. In addition to the bibliometric analysis of the selected
225 databases, this study focuses solely on published sources; it is recommended that
226 future studies of published sources in Cochrane library, EmBase and other
227 databases also be considered. Overall, since the topic of using information
228 technology in medical virology is widely considered in countries around the world, it
229 seems necessary to provide relevant educational programs to empower medical
230 experts to optimally use these tools in their professional work.

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Table 1: the 10 most productive countries related to COVID-19 research.

country/territory		Percentage	N per million population	N per billion GDP	Total citation	h-index
China	44	40.48	3.15	0.003	327	8
United States	21	19.32	6.41	0.001	19	2
Canada	7	6.44	1.88	0.004	1	1
France	6	5.52	8.95	0.002	9	1
United Kingdom	6	5.52	9.02	0.002	8	1
Italy	5	4.6	8.27	0.016	5	1
South Korea	4	3.68	7.74	0.002	4	1
Taiwan	4	3.68	1.69	0.004	1	1
Brazil	3	2.76	1.43	0.001	5	1
Netherlands	3	2.76	1.74	0.003	10	1

Table 2: Top 10 related funding sponsor

Funding Sponsor	N	%
National Natural Science Foundation of China	6	5.52
Chinese Academy of Sciences	3	2.76
National Basic Research Program of China (973 Program)	3	2.76
Chinese Academy of Medical Sciences	2	1.84
Fudan University	2	1.84
Ningbo University	2	1.84
Sanming Project of Medicine in Shenzhen	2	1.84
Science and Technology Major Project of Guangxi	2	1.84
Beijing Science and Technology Planning Project	1	0.92
Bill and Melinda Gates Foundation	1	0.92

Table 3: Top 10 Covid-19 research with the most citation frequency.

No	Title	First author	Journal	IF	Year	Citations	Main Conclusion
1	Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China	Huang, Chaolin	The Lancet	10.28	2020	88	The 2019-nCoV infection caused clusters of severe respiratory illness similar to severe acute respiratory syndrome coronavirus and was associated with ICU admission and high mortality.
2	A novel coronavirus from patients with pneumonia in China, 2019	Zhu, Na	New England Journal of Medicine	70.67	2020	56	Different from both MERS-CoV and SARS-CoV, 2019-nCoV is the seventh member of the family of coronaviruses that infect humans.
3	A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster	Chan, Jasper Fw	The Lancet	10.28	2020	49	Person-to-person transmission of this novel coronavirus in hospital and family settings, and the reports of infected travelers in other geographical regions
4	Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study	Chen, Nanshan	The Lancet	10.28	2020	34	The 2019-nCoV infection was of clustering onset, is more likely to affect older males with comorbidities, and can result in severe and even fatal respiratory diseases such as acute respiratory distress syndrome. In general, characteristics of patients who died were in line

							with the MuLBSTA score, an early warning model for predicting mortality in viral pneumonia
5	Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding	Lu, Roujian	The Lancet	10.28	2020	23	2019-nCoV is sufficiently divergent from SARS-CoV to be considered a new human-infecting betacoronavirus. Although their phylogenetic analysis suggests that bats might be the original host of this virus, an animal sold at the seafood market in Wuhan might represent an intermediate host facilitating the emergence of the virus in humans. Importantly, structural analysis suggests that 2019-nCoV might be able to bind to the angiotensin-converting enzyme 2 receptor in humans.
6	Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China	Wang, Dawei	JAMA - Journal of the American Medical Association	51.273	2020	15	n this single-center case series of 138 hospitalized patients with confirmed NCIP in Wuhan, China, presumed hospital-related transmission of 2019-nCoV was suspected in 41% of patients, 26% of patients received ICU care, and mortality was 4.3%..
7	Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a	Wu, J.T	The Lancet	10.28	2020	14	Given that 2019-nCoV is no longer contained within Wuhan, other major Chinese cities are probably sustaining localised outbreaks. Large

	modelling study						<p>cities overseas with close transport links to China could also become outbreak epicentres, unless substantial public health interventions at both the population and personal levels are implemented immediately. Independent self-sustaining outbreaks in major cities globally could become inevitable because of substantial exportation of presymptomatic cases and in the absence of large-scale public health interventions. Preparedness plans and mitigation interventions should be readied for quick deployment globally.</p>
8	Cross-species transmission of the newly identified coronavirus 2019-nCoV	Ji, Wei	Journal of Medical Virology	2.049	2020	11	<p>their findings suggest that 2019-nCoV has most similar genetic information with bat coronavirus and most similar codon usage bias with snake. Taken together, these results suggest that homologous recombination may occur and contribute to the 2019-nCoV cross-species transmission.</p>
9	Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the	Zhao, Shi	International Journal of Infectious Diseases	3.538	2020	9	<p>The mean estimate of R0 for the 2019-nCoV ranges from 2.24 to 3.58, and is significantly larger than 1.their findings indicate the potential of 2019-nCoV to cause outbreaks</p>

	outbreak						
10	Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan	Chan, Jasper Fw	Emerging microbes & infections	4.36	2020	8	Remarkably, its orf3b encodes a completely novel short protein. Furthermore, its new orf8 likely encodes a secreted protein with an alpha-helix, following with a beta-sheet(s) containing six strands. Learning from the roles of civet in SARS and camel in MERS, hunting for the animal source of 2019-nCoV and its more ancestral virus would be important for understanding the origin and evolution of this novel lineage B betacoronavirus. These findings provide the basis for starting further studies on the pathogenesis, and optimizing the design of diagnostic, antiviral and vaccination strategies for this emerging infection.

Figure

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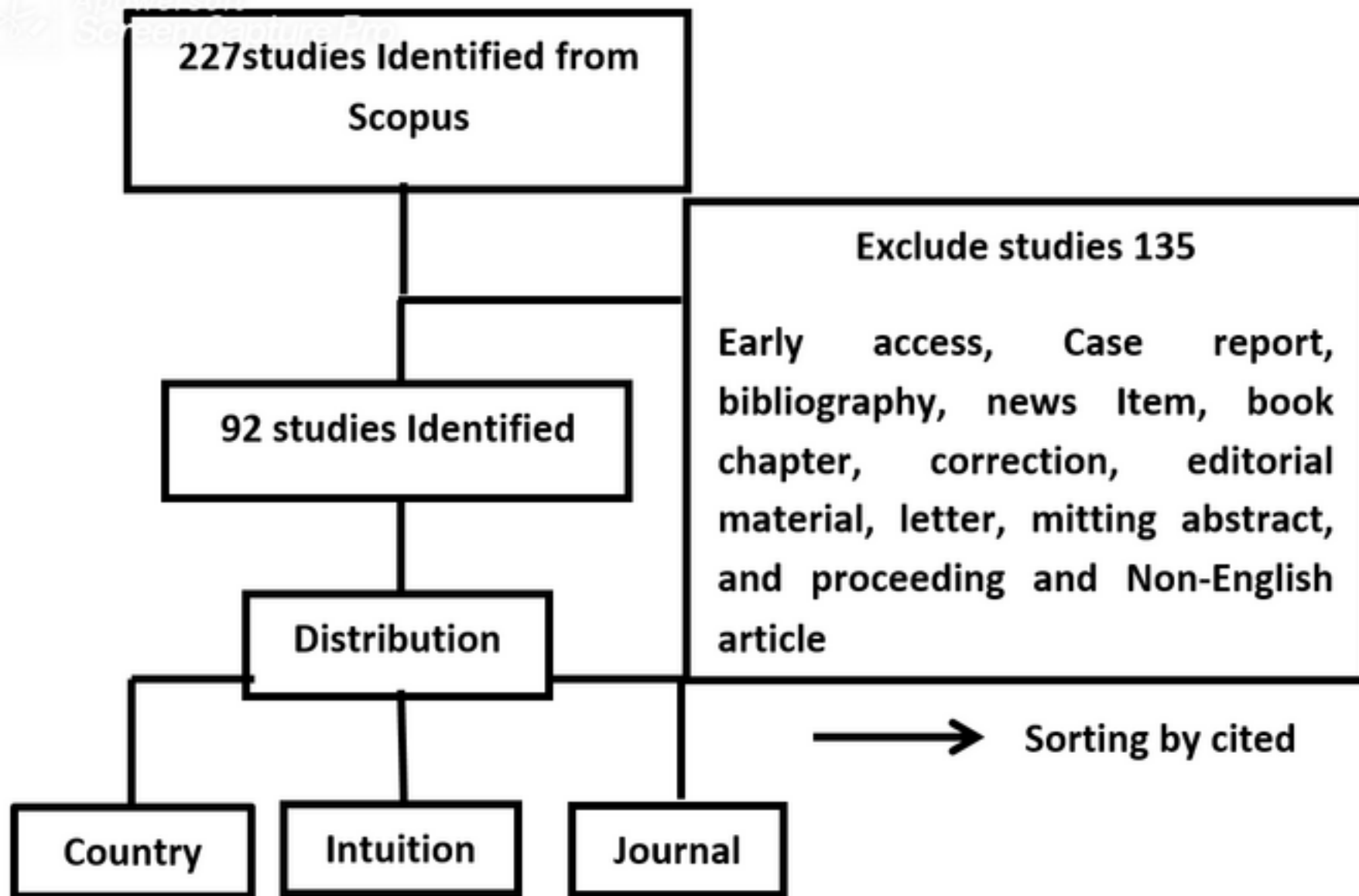
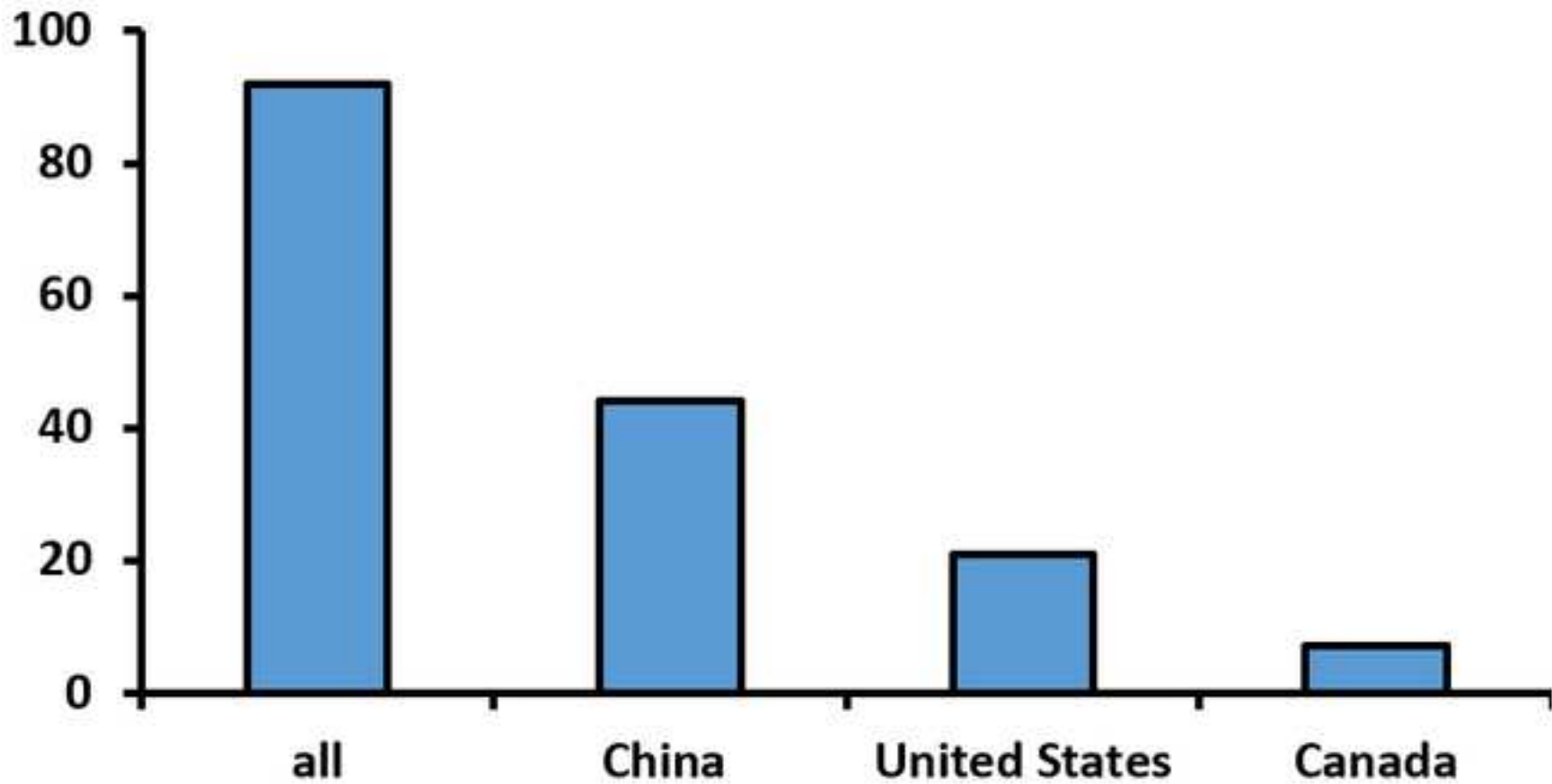


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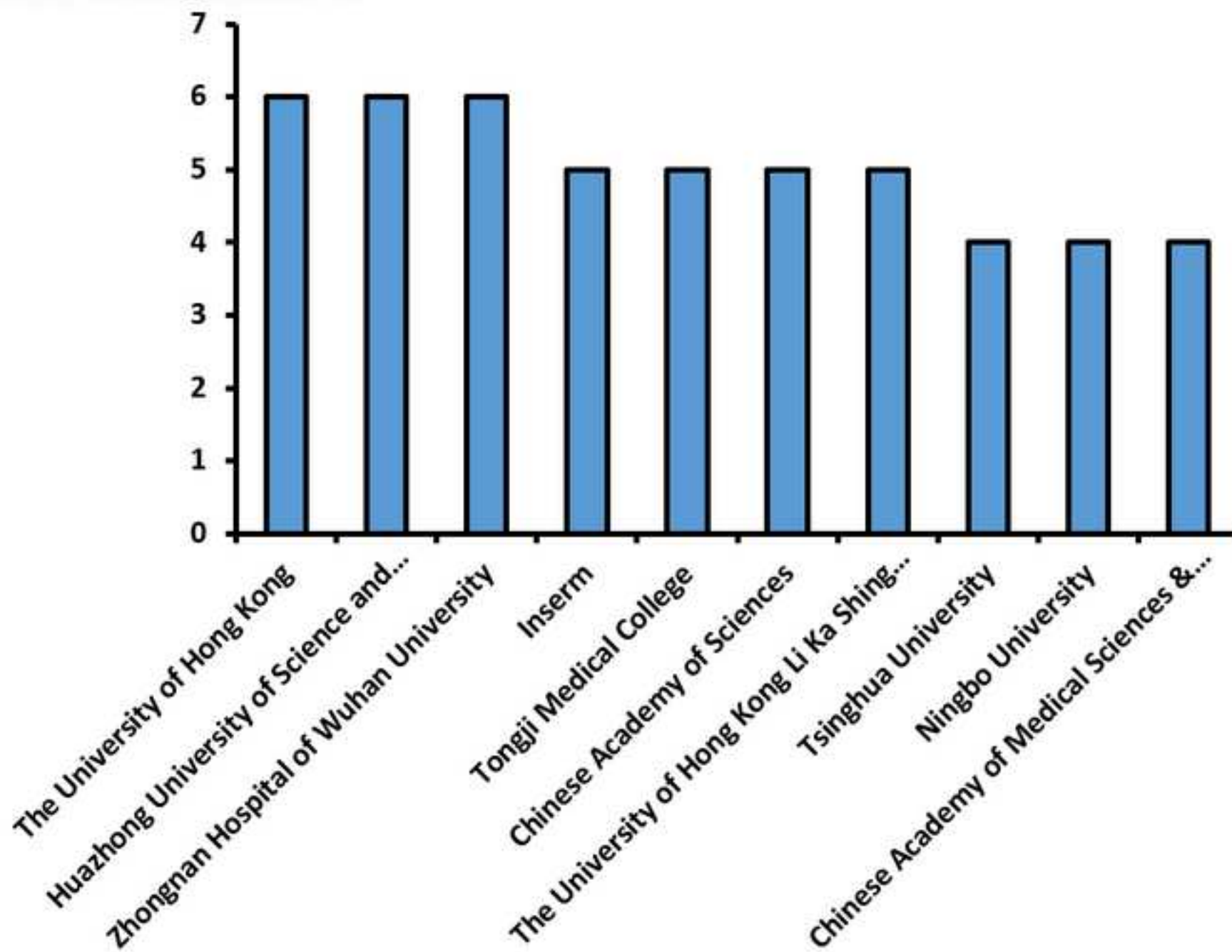


2019-2020





Affiliation



Figure

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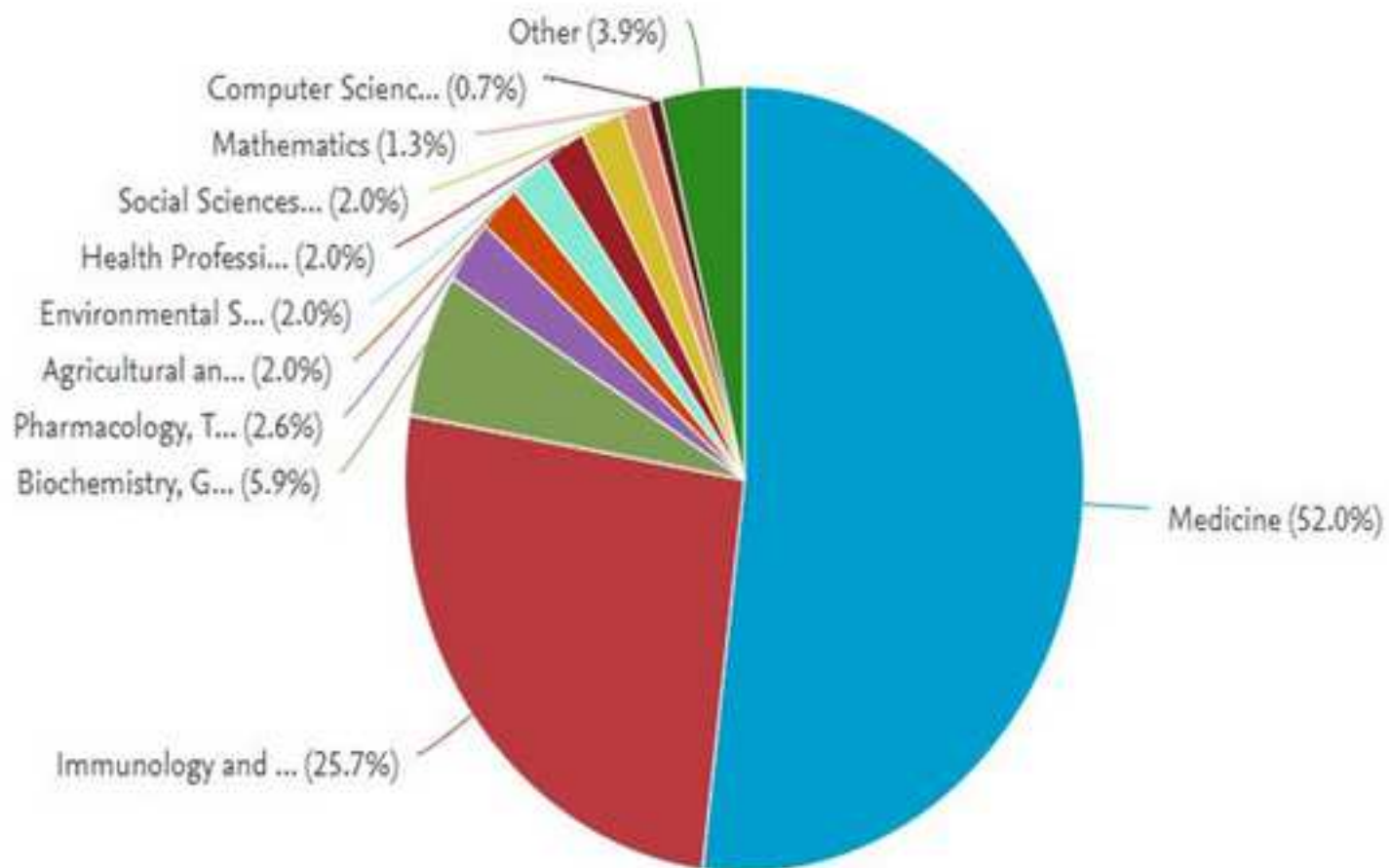


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