

The Status and Trends of Coronavirus Research: A Global Bibliometric and Visualized Analysis

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Objectives:

Coronavirus belong to order *Nidovirales*, family *Coronaviridae* and subfamily *Coronavirinae* with high pathology to mammalian, vertebrates and avian hosts. The structure of coronavirus consists of the single-stranded positive-sense viral RNA, Nucleocapsid protein, Envelope protein, Membrane glycoprotein and Spike protein. SARS-CoV and MERS-CoV, two highly transmissible and pathogenic viruses, emerged in humans in 2002 and 2012 respectively and resulted in spread and pathogenic infection in humans. In December 2019, a patient with pneumonia infected by a novel coronavirus was found in Wuhan, China. Since then, an increasing number of cases of infectious pneumonia have been identified in Wuhan and the whole country. Now the epidemic has spread abroad. However, studies on qualitative and quantitative characteristics of global research of coronavirus are limited. Evaluation of the current status and trends of coronavirus research and predicting promising popular topics and directions in the field are more essential. Publication, as a central part of scientific research, is a significant indicator for research contribution. Bibliometrics combined with visualized mapping has been recognized as an effective means of assessing scientific progress. Information from online literature databases and metrology characteristics were analyzed via bibliometric analysis, which can be used to quantitatively and qualitatively evaluate the trends in the research community over time. Bibliometric analysis is also applied to policy making and clinical guidelines. The aim of our study is to assess the status and trends of coronavirus research globally and discover the popular topics for researchers interested in coronavirus.

Methods:

Publications related to the studies of coronavirus research from January 1, 2003 to February 6, 2020 were retrieved from the Science Citation Index-Expanded (SCIE) of the Web of Science database. A total of 9294 publications were included. The data source was studied and indexed by bibliometric methodology. For visualized study, bibliographic coupling analysis, co-authorship analysis, co-citation analysis, co-occurrence analysis and the analysis of publication trends in coronavirus research were conducted by VOS (visualization of similarities) viewer and GraphPadPrism 6 software.

Results:

The present study purposes to assess coronavirus research with visualized and bibliometric analysis, which can be applied to present the current status and make predictions in a certain research field. COVID-19 will add another new climax to coronavirus research. USA was the most contributors to publications. In terms of publication number, The University of Hong Kong, Virology and United States Department of Health Human Services ranked first in institutions, research orientations and funding agency, respectively. In terms of total number of publications, total citation frequency and H-index, USA made the highest contributions to the research globally and could be regarded as the pioneer and the leading country in the field of coronavirus research. However, Netherlands had the highest average number of citations and ranked 4th in H-index, Thailand ranked 4th in average number of citations but ranked 20th in H-index, which demonstrated that both Netherlands and Thailand have played an outstanding part in coronavirus research. As a result of the number of related publications, there was a mismatch between H-index and average number of citations, both was used for representing the quality of publications and the academic impact of a country. Although China ranked the second only to the USA in these aspects, it was 15th in average citation frequency. Bibliographic coupling occurs when two works contain citations of the third work in their bibliographies. In our study, a similarity relationship among different publications was established by bibliographic coupling analysis in terms of journal, institution and country. *Journal of Virology*, *Virology*, *Virus Research*, *Emerging Infectious Diseases* and *Journal*

of General Virology, may be the core journals of coronavirus research. Latest research progress in this area is more likely to be reported by the aforementioned journals. The University of Hong Kong, Chinese Academy of Sciences and The Chinese University of Hong Kong with the most TLS were regarded as the leader institution in coronavirus research, which also demonstrated that China has made excellent efforts in coronavirus research after SARS. First-class research institutions played a significant and fundamental role in improving the academic level of a country. The authors, shown in Figure 5c, may be the ones who contributed the most in the field and their further studies and latest publications should be closely monitored to obtain the latest advancement in coronavirus research. The collaboration among different countries, institutions and authors were evaluated by co-authorship analysis and the top of results with higher total link strength showed that the authors/institutions/countries were willing to work with others. For example, Yuen, KY, The University of Hong Kong and USA were the optimum choices for us to cooperate with. Co-citations analysis is utilized to assess the impact of a study by counting the number of times they were cited. The present results indicated that the mechanism studies about coronavirus had the greatest total frequency of citation and many meaningful references were provided. *Journal of Virology* was the journal with the highest citation frequency in the field and the achievement of Woo, PCY, Peiris, JSM and Lau, SKP were widely recognized.

According to the co-occurrence analysis, popular topics and latest research directions were identified. The map of a co-occurrence network was shown in Figure 8a by analyzing the keywords appearing in title and abstract from all included studies. All keywords could be divided into four research directions including "Pathological research", "Epidemiology research", "Clinical research" and "Mechanism research". Our study could make a further clear for the trends of future research, even though the results were consistent with the common sense in the field. The overlay visualization map was the same as the co-occurrence map but in color. Different color stands for different years of the publications. Based on the results, "Crystal structure", "Spike protein", "Respiratory syndrome coronavirus", "Receptor binding domain" and "Vaccine" may become the next popular subjects in coronavirus research. Meanwhile, the research in the mechanism of related diseases have been emerging widely in recent years. In addition, the clinical research for infectious diseases may become a popular topic in the next few years especially after COVID-19 in Wuhan.

Conclusion:

The current study presented the global status and trends in coronavirus research. The USA with the most contributions to the research plays a leading role in global research on coronavirus. Although there was a discrepancy among the academic impact, the quality and the quantity of publications from China, China has been making efforts to be an excellent contributor owning outstanding research institutions such as The University of Hong Kong and Chinese Academy of Sciences. Notably, more and more studies about coronavirus will be published in *Journal of Virology*, *Virology*, *Virus Research* in the coming years. The latest research directions, such as "Crystal structure", "Spike protein", "Respiratory syndrome coronavirus", "Receptor binding domain" and "Vaccine", are likely to be pioneers in this field and conduct the direction of future studies, which may contribute to recognizing and defeat COVID-19. Much research has been reported on vaccines based on spike proteins for SARS and MERS, which can inspire us to vaccine research for COVID-19 based on spike protein or other structures from COVID-19 and help countermeasures against future spread and pathogenic infection of novel coronavirus in human.

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