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**Global research production pertaining to gastrointestinal involvement in COVID-19:
A bibliometric and visualised study**

Gastrointestinal involvement ⁴ in COVID-19

Abstract

BACKGROUND

Coronavirus disease 2019 (COVID-19) is a global pandemic that can cause diarrhoea, nausea/vomiting, and abdominal pain, among other gastrointestinal (GI) symptoms.

AIM

In this study, the countries, collaborations, institutions, journals, citations, and terms of published studies on gastrointestinal involvement in COVID-19 were analysed. As a result, a bibliometric review of these publications can point to hot topics and possible research directions.

METHODS

The Scopus database was used to search the global literature on gastrointestinal involvement in COVID-19 written during 2020. The bibliometric review of these publications was also performed using VOSviewer.

RESULTS

Scopus had published 95,615 documents on COVID-19 in all areas of research at the time of data collection. In total, 1,267 publications on the topic of gastrointestinal and COVID-19 in Scopus were identified. Research articles ($n = 606$; 47.83%), letters (293;

23.13%), and reviews (186; 14.68%) were the most popular types of documents. The most productive countries and institutions in this field were the USA and *Huazhong University of Science and Technology*, respectively. The most cited paper was Xiao *et al.*, which was published in *Gastroenterology* as a brief communication, with 798 citations. This paper provides evidence for gastrointestinal infection of COVID-19 and its possible faecal-oral transmission route. In the term cluster analysis, there were two frontiers in this field: GI manifestations among COVID-19 patients and the implications of COVID-19 for the gastroenterologist.

CONCLUSION

GI manifestations among COVID-19 patients and implications of COVID-19 for the gastroenterologist are of progressive interest, especially in the early stages of a pandemic outbreak. Therefore, it is recommended to focus on research about this topic by the connection between GI manifestations and potential COVID-19 outcomes.

Key Words: COVID-19; Gastrointestinal, Symptoms, Bibliometric, Scopus

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Core Tip: This bibliometric analysis provides the first concise summary of global GI publications related to COVID-19. It highlights the benefits of bibliometric analysis in a systematic and structured way to measure the productivity of studies. GI manifestations among COVID-19 patients and the implications of COVID-19 for the gastroenterologist are of progressive interest, especially at the early stage of a pandemic outbreak. The results will form the basis for future research and guide decision-making in research related to GI symptoms and treatments in COVID-19.

INTRODUCTION

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In December 2019, the coronavirus disease (COVID-19) outbreak caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) spread quickly from China to nearly every country in the world, and is now considered the world's most significant public health threat, causing a massive crisis for global health^[1-3]. The 2019 new coronavirus (2019-novel coronavirus, 2019-nCoV) was named by the World Health Organisation (WHO), with COVID-19 being given as the disease name^[4]. As of March 13, 2021, there were over 118 million confirmed cases worldwide, with more than 2.6 million associated global deaths, according to a WHO report^[5].

In most studies, patients with COVID-19 have gastrointestinal (GI) manifestations, such as diarrhoea, nausea, anorexia, vomiting, abdominal pain, and GI bleeding^[6-11], in addition to fever and common respiratory symptoms including cough, and shortness of breath^[3, 12]. However, some patients have developed various fatal complications including severe pneumonia, pulmonary oedema, acute respiratory distress syndrome (ARDS), septic shock, and organ failure^[13-15]. Several studies have shown that SARS-CoV-2 can interact with angiotensin-converting enzyme 2 (ACE2) receptors on ileal enterocytes and colon epithelial cells, implying a tropism for the GI tract^[7]. The pathophysiology of GI symptoms is unclear, but it appears that SARS-CoV-2 binds to ACE2, which regulates amino acid homeostasis and microbiome balance in the intestine, causing a change in physiological function that leads to GI symptoms^[16-18].

Several systematic reviews and meta-analysis studies have indicated that during the epidemic, there was an increase in the number of publications discussing the impact of COVID-19 on the gastrointestinal system in a variety of countries ^[6, 9-11, 19-27]. To date, there has not been a global bibliometric review of research related to GI and COVID-19. Bibliometrics aims to determine the depth of information in a given field^[28]. In other areas of COVID-19, this approach has been used to quantify and categorise research output, allowing for mapping the area in question based on the most involved authors, institutions, countries, citations, journals, and hot issues in this field^[29-32]. Therefore, the purpose of this study is to report a bibliometric analysis of the global research

production pertaining to gastrointestinal involvement in COVID-19 to determine the most widely cited papers and most prolific countries, institutions, and journals related to this topic. Our results will help to guide priority setting and policy formulation for long-term strategies to improve the outcomes of COVID-19 patients with GI manifestations.

MATERIALS AND METHODS

Data Sources

The publications were retrieved on the same day from the Scopus on March 20, 2021, to prevent bias due to the daily database updates. Since Scopus is the most commonly accepted and regularly used database for analysing scientific articles in the field of bibliometrics, it was chosen as the search engine. Although we recognise the existence of other databases, we behave in compliance with the methodological approach of previous research^[33, 34].

Search Strategies

The search was restricted to publications during the period of time between January 1, 2020 and December 31, 2020. The following was the search strategy used in this bibliometric study to retrieve data:

Step 1: To achieve the goals of this bibliometric review, the terms related to COVID-19 entered into the Scopus engine were chosen from the literature related to COVID-19^[35-38]. All of the following “terms” were used as “Article Title/Abstract/Keywords”: "COVID 19" OR "2019 novel coronavirus" OR "coronavirus 2019" OR "SARS-CoV-2" OR "SARS-CoV 2" or "coronavirus disease 2019" OR "2019-novel CoV" OR "2019 ncov" OR "COVID 2019" OR "corona virus 2019" OR "nCoV-2019" OR nCoV2019 OR "nCoV 2019" OR 2019-ncov OR COVID-19 OR "Severe acute respiratory syndrome coronavirus 2" OR Novel Coronavirus.

Step 2: After that, we confined the publications that we obtained in step 1 to those with the terms "gastrointestinal and related words" in their title. The words relevant to gastrointestinal that were entered into the Scopus engine were selected from previous

gastrointestinal Meta-analysis^[6, 39]. All of the following “terms” were entered as “Article Title”: gastrointestinal OR "GI tract" OR gastr* OR Diarrh* OR Constipation OR Vomiting OR *intestin* OR dysphagia OR "Abdominal pain" OR Nausea OR heartburn OR Bowel OR Gut OR digest* OR stomach OR duodenal OR colon OR colorectal anorectum. The asterisk (*) was used as a truncator or wildcard to capture all of the term variants that share a core.

Bibliometric analysis

The data collected included the following bibliometric parameters: type of documents, number of publications, citation count, country, institution, and journals.

Visualise analysis

VOSviewer software (version 1.6.16, Leiden University, Leiden, The Netherlands) was used for bibliometric visualisation^[40]. In this study, VOSviewer was used for collaborative patterns between countries and term co-occurrence analysis. As a result, we decided to build and visualise the network terms used in the title/abstract of publications to define the hot topics in this field. The relationship between terms is established based on the number of publications in which they appear together, according to co-occurrence analysis^[40]. Therefore, the aim of this study is to identify research areas as hot topics, and it is a valuable indicator for tracking scientific progress^[41].

RESULTS

Volume and types of publications

Scopus had published 95,615 documents on COVID-19 in all areas of research at the time of data collection. In total, 1,267 publications on the topic of gastrointestinal and COVID-19 in Scopus were identified during the period of study (January 2020 to December 31, 2020). A total of 1,267 documents (1.33%) were used in this study. Research articles ($n = 606$; 47.83%), letters (293; 23.13%), and reviews (186; 14.68%) were the most popular types of documents.

Active countries and international research collaboration

The United States is the leader in this field, with 278 publications (21.94%). Other top published countries are China (222, 17.52%), Italy (184, 14.52%), and the United Kingdom (159, 12.55%) (Table 1). Several studies reported the symptoms of GI to be present in 2.6% and 75% patients with COVID 19 infection (Table 1)^[42-51]. There were 33 countries included (the minimum number of publications for each country was over ten), and their network collaboration maps were visualised by VOSviewer (Figure 1). The top four countries by centrality were the United States, China, Italy, and the United Kingdom. According to their centrality, these countries showed close collaboration with each other and a strong research influence with other countries.

Active institutions/organisations

Table 2 shows the top 10 institutions in terms of publication numbers. The *Huazhong University of Science and Technology*, China ($n=33$ publications), *Humanitas Research Hospital*, Italy ($n=23$ publications), the *Humanitas University*, Italy ($n=30$ publications), and the *Tongji Medical College*, China ($n=29$ publications) were the top four productive and influential institutions, indicating that they have achieved significant scientific achievements and research capability.

Active journals

Regarding journals, the *Gastroenterology* ranked first with 457 publications (4.50%), followed by *American Journal of Gastroenterology* ($n = 34$; 2.68%), *Inflammatory Bowel Diseases* ($n = 34$; 2.68%), and *Lancet Gastroenterology and Hepatology* ($n = 34$; 2.68%). Table 3 presents the top 10 most popular journals with the highest number of global research productions pertaining to gastrointestinal involvement in COVID-19.

Top cited documents

The number of citations is an important measure of the impact and recognition that a paper has received from the scientific community. Table 4 presents the 10 most cited studies found in the Scopus database. The top ten most cited publications had citation counts ranging from 269 to 798^[10, 52-60].

Most frequent terms (research themes)

Using VOSviewer, we examined the term occurrence from 1,267 publications. As seen in Figure 2, 270 words were identified and grouped into two clusters based on the number of times they appeared in the titles and abstracts of all publications. The red cluster involved gastrointestinal manifestations including terms such as “gastrointestinal”, “symptoms”; “nausea”, “vomiting”, and “diarrhoea”. The green cluster involved implications of COVID-19 for the gastroenterologist including terms such as “recommendations”, “procedure”, “impact”, “surgery”, “endoscopy”, “strategy”, “practice”, and “prevention”.

DISCUSSION

The use of bibliometric analysis to review the patterns and development of various fields and areas of research is becoming more common. The current data analysis reflects various facets of gastrointestinal publication involvement in COVID-19, including the top countries, institutions, cited articles, journals generating COVID-19 publications, and hot topics in this field. It is critical to determine scientific output through bibliometric analysis to guide researchers on what has already been developed and what is currently being researched so that future research can resolve information gaps.

Following the COVID-19 pandemic, ² high-income countries such as the United States, China, Italy, the United Kingdom, Spain, France, and Germany are the world leaders in GI publications involvement in COVID-19. A potential reason for these findings is the high prevalence of COVID-19 in countries that experienced the initial outbreak^[61-66]. In the most recent studies, nearly 60% of the COVID-19 publications in the Web of Science come from the United States, China, Italy, and the United Kingdom^[67]. According to the research performed here, the USA contributed the most scientific papers published during the COVID-19 pandemic. This is due to the fact that it has the most scholarly journals of search sites in use, as well as being a country where scholars from all over the world want to publish their findings^[68]. China is second in the ranking. This is demonstrated by the fact that China has over 3.61 million licensed doctors^[13].

Furthermore, Chinese institutions contributed various papers to the COVID-19 research initiative and played a crucial role in the epidemic response^[69].

This study has found that, generally, many publications focused on gastrointestinal manifestations among COVID-19 patients and implications of COVID-19 for the gastroenterologist. So far, COVID-19-related research has involved disease transmission, virology and immunology, epidemiology, clinical characteristics, non-pharmaceutical interventions, detection and diagnosis, treatment, vaccines, and other categories including the psychological status of the medical staff and public during the epidemic^[67, 70].

The current study discusses the top ten cited publications for gastrointestinal publications involvement in COVID-19 using bibliometric review. Just three articles addressed GI intervention in COVID-19 patients, while the rest of the widely cited literature centred on GI characteristics and disease features in COVID-19 patients. The most cited paper was Xiao *et al.*^[58] which was published in *Gastroenterology* as a brief communication, with 798 citations. This paper provides evidence for the gastrointestinal infection of COVID-19 and its possible faecal-oral transmission route. The second paper was by Xu *et al.*^[59] from *Nature Medicine* as a brief communication. According to the results of this study, ¹rectal swab testing may be more helpful than nasopharyngeal swab testing in assessing the efficacy of management and the timing of quarantine termination. However, replication-competent virus in faecal swabs has not been demonstrated in this study, which is necessary to confirm the possibility of faecal-oral transmission. The third most cited paper is written by Gu *et al.*^[52] in *Gastroenterology* as a commentary, which stated that COVID-19 could be present in the oral cavity and faeces of infected people. Moreover, this study recommended that the initial digestive symptoms of COVID-19 should be made to be alert for early isolation, detection, diagnosis, and intervention.

Therefore, our study provides an understanding of the research that has influenced COVID-19 on GI systems, and citation rates can indicate important potential research topics, development trends in COVID-19 and GI-related research, and provide a

reference for research cooperation. However, the mechanism of intestinal infection, its relationship to CRS, and the probability of faecal-oral transmission all require further research in larger populations, especially validation studies as prospective studies with well-designed questions.

This bibliometric analysis provides the first concise summary of global GI publications related to COVID-19. It highlights the benefits of bibliometric analysis in a systematic and structured way to measure the productivity of studies. However, no search strategy is flawless, and the drop out in false positive or false negative results is also expected. The author attempted to be as comprehensive as possible, using all terms related to GI and COVID-19 Listed in the literature. However, the possibility of missing some terms exists. Therefore, the author did his utmost to retrieve all gastrointestinal publications concerning COVID-19 and sought to verify their study approach using techniques introduced in previously published bibliometric studies. Furthermore, the number of citations will fluctuate over time due to the limited time after the pandemic began and the rapidly changing existence of COVID-19 science. The final limitation is that the authors did not search all scientific databases. This limitation is present in almost all bibliometric studies.

CONCLUSION

This research offers a detailed guide and macroscopic overview of the position of gastrointestinal publications in COVID-19 scholarly research evolution and performance during the early stages of the outbreak. In a short time span (one year) following the start of COVID-19 pandemic, ² high-income countries such as the United States, China, Italy, the United Kingdom, Spain, France, and Germany became the global leaders of GI-related publications, and were responsible for the bulk of the literature written in this field. This study has found that, in general, many publications focused on GI manifestations among COVID-19 patients and the implications of COVID-19 for the gastroenterologist. While GI symptoms play an important role in COVID-19, there are still many knowledge gaps about their pathophysiology and

prognostic value. Prospective studies with well-designed questions can be used to perform further research. The results of this bibliometric study will act as a basis for future research and guide decision-makers for research related to GI symptoms and treatment in COVID-19.

ARTICLE HIGHLIGHTS

Research background

Fever and respiratory symptoms are common in COVID-19 patients. Gastrointestinal (GI) symptoms such as diarrhea, vomiting, and stomach pain may also occur in some patients.

Research motivation

There was an increase in the number of publications addressing the effect of COVID-19 on the gastrointestinal system in a variety of countries during the outbreak, according to several systematic reviews and meta-analysis reports. There hasn't been a comprehensive bibliometric analysis of research on GI and COVID-19 yet. The aim of bibliometrics is to determine the depth of knowledge in a given area.

Research objectives

The purpose of this study is to report a bibliometric analysis of the global research production pertaining to gastrointestinal involvement in COVID-19 to determine the most widely cited papers and most prolific countries, institutions, and journals related to this topic.

Research methods

We searched Scopus for publications during 2020, and selected articles focused on gastrointestinal and COVID-19.

Research results

The current data analysis reflects various facets of gastrointestinal publication involvement in COVID-19, including the top countries, institutions, cited articles, journals generating COVID-19 publications, and hot topics in this field. It is critical to determine scientific output through bibliometric analysis to guide researchers on what has already been developed and what is currently being researched so that future research can resolve information gaps.

Research conclusions

COVID-19 GI manifestations and implications for the gastroenterologist are of increasing concern, especially in the early stages of a pandemic outbreak. As a result, it is suggested that research on this subject be focused on the connection between GI manifestations and potential COVID-19 outcomes.

Research perspectives

Our results will help to guide priority setting and policy formulation for long-term strategies to improve the outcomes of COVID-19 patients with GI manifestations.

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