



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

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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

To perform a bibliometric analysis of the global research production pertaining to GI involvement in COVID-19.

METHODS

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

RESULTS

Scopus had published 95615 documents on COVID-19 in all areas of research at the time of data collection. In total, 1267 publications on the topic of GI and

COVID-19 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 United States and Huazhong University of Science and Technology. 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 GI 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 gastroenterologists were of interest, especially in the early stages of the pandemic.

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

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Core Tip: This bibliometric analysis provides the first concise summary of global gastrointestinal (GI) publications related to coronavirus disease 2019 (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 gastroenterologists were of interest, especially in the early stage of the pandemic. The results will form the basis for future research and guide decision-making in research related to GI symptoms and treatments in COVID-19.

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INTRODUCTION

In December 2019, coronavirus disease (coronavirus disease 2019, 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 was named SARS-CoV-2 by the World Health Organization (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, 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-analyses have indicated that during the pandemic, there was an increase in the number of publications discussing the impact of COVID-19 on the GI system in several 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 topics in this field[29-32]. Therefore, the purpose of this study was to report a bibliometric analysis of the global research production pertaining to GI 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 acted in accordance with the methodological approach of previous research[33,34].

Search strategies

The search was restricted to publications between January 1 and December 31, 2020. The following search strategy was 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/Keyword: "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: We confined the publications that we obtained in Step 1 to those with the terms gastrointestinal and related words in their title. The terms relevant to GI that were entered into the Scopus engine were selected from previous GI meta-analyses[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 shared a core.

Bibliometric analysis

The data collected included the following bibliometric parameters: type of documents, number of publications, citation count, country, institution, and journals. The impact index per article is presented for the top ten most-cited papers as determined by *Reference Citation Analysis* (RCA). Baishideng Publishing Group Inc. owns RCA, an open, multidisciplinary citation analysis database (Pleasanton, CA, United States) (<https://www.referencecitationanalysis.com/>).

Visualise analysis

VOSviewer 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 based on the number of publications in which they appear together, according to co-occurrence analysis [40]. Therefore, the aim of this study was 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 95615 documents on COVID-19 in all areas of research at the time of data collection. In total, 1267 publications on the topic of GI and COVID-19 were identified during the period of study (January 1 to December 31, 2020). A total of 1267 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.

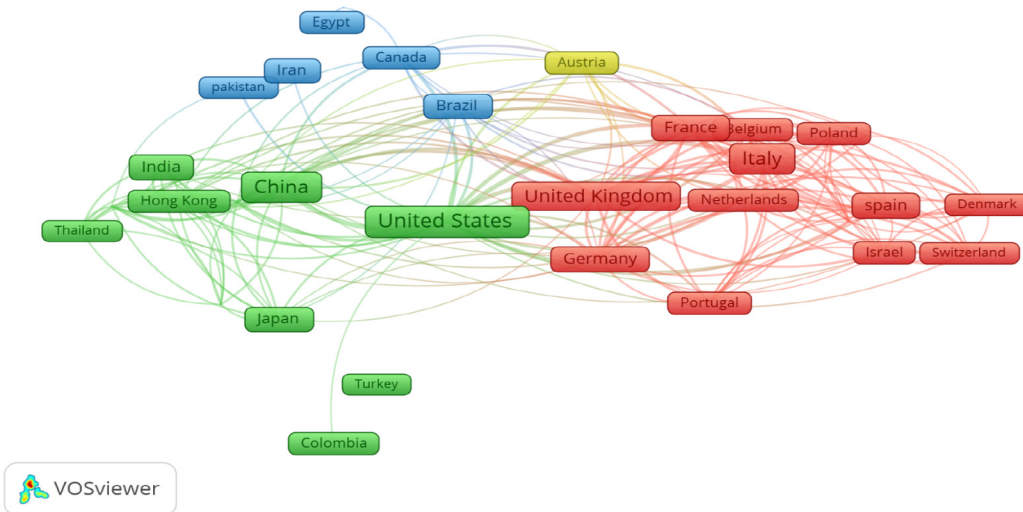
Active countries and international research collaboration

The United States was the leader in this field, with 278 publications (21.94%). Other top countries were 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). There were 33 countries included (the minimum number of publications for each country was 10), 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.

Table 1 List of the top 10 countries pertaining to gastrointestinal publications involvement in coronavirus disease 2019

Ranking	Country	No. of documents	%	Study population	Sample size	Prevalence of GI symptoms (%)	Common GI symptoms
1 st	United States	278	21.94	Multicentre Cohort Study [48]	318	61.3	Loss of appetite, diarrhoea, and nausea
2 nd	China	222	17.52	Retrospective study[51]	1320	14.5	Diarrhoea, anorexia, and nausea and vomiting
3 rd	Italy	184	14.52	Prospective case-control study[47]	34	8.8	Diarrhoea, abdominal pain, and nausea
4 th	United Kingdom	159	12.55	Prospective observational cohort study[42]	20, 133	23	Diarrhoea, nausea/vomiting, and abdominal pain
5 th	Spain	61	4.81	Retrospective study[49]	76	75	Diarrhoea, nausea/vomiting, and abdominal pain
6 th	France	59	4.66	Retrospective study[45]	114	2.6	Diarrhoea
7 th	Germany	56	4.42	Retrospective study[43]	50	> 16	Diarrhoea, nausea/vomiting
8 th	India	51	4.03	Prospective study[44]	252	10.3	anorexia, nausea, vomiting, abdominal pain
9 th	Australia	37	2.92	Epidemiological study[50]	295	> 16	Diarrhoea, nausea/vomiting, and abdominal pain
10 th	Iran	33	2.60	Retrospective study[46]	611	25.4	Nausea/ vomiting, diarrhoea, and abdominal pain

GI: Gastrointestinal.



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Figure 1 Network visualisation map of international research collaborations among the top 33 active countries with at least 10 articles published each.

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, *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

Table 2 List of the top 10 institutions pertaining to gastrointestinal publication involvement in coronavirus disease 2019

Ranking	Institution	Country	n	%
1 st	Huazhong University of Science and Technology	China	33	2.60
2 nd	Humanitas Research Hospital	Italy	32	2.53
3 rd	Humanitas University	Italy	30	2.37
4 th	Tongji Medical College	China	29	2.29
5 th	INSERM	France	27	2.13
6 th	Chinese University of Hong Kong	China	26	2.05
7 th	Fondazione Policlinico Universitario Agostino Gemelli IRCCS Università Cattolica del Sacro Cuore	Italy	25	1.97
8 th	Università degli Studi di Roma La Sapienza	Italy	22	1.74
9 th	Università degli Studi di Milano	Italy	21	1.66
10 th	Università degli Studi di Padova	Italy	20	1.58
10 th	University Hospitals Birmingham NHS Foundation Trust	United Kingdom	20	1.58

Table 3 List of the top 10 journals pertaining to gastrointestinal publications involvement in coronavirus disease 2019

Ranking	Journal	n	%	Impact factors
1 st	<i>Gastroenterology</i>	57	4.50	17.373
2 nd	<i>American Journal of Gastroenterology</i>	34	2.68	10.171
2 nd	<i>Inflammatory Bowel Diseases</i>	34	2.68	4.261
2 nd	<i>Lancet Gastroenterology and Hepatology</i>	34	2.68	14.789
5 th	<i>Digestive and Liver Disease</i>	33	2.60	3.570
6 th	<i>British Journal of Surgery</i>	29	2.29	5.676
7 th	<i>Alimentary Pharmacology and Therapeutics</i>	25	1.97	7.515
8 th	<i>Clinical Gastroenterology and Hepatology</i>	21	1.66	8.549
9 th	<i>Colorectal Disease</i>	20	1.58	2.769
10 th	<i>Journal of Gastroenterology and Hepatology</i>	18	1.42	3.437

Impact factors were retrieved from the 2019 Journal Citation Reports (Clarivate Analytics).

the highest number of global research productions pertaining to GI 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 10 most cited publications had citation counts ranging from 269 to 798. Furthermore, the ten most cited articles have an impact index per article of 189 to 617.5 (**Table 4**).

Most frequent terms (research themes)

Using VOSviewer, we examined the term occurrence from 1267 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 GI 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”.

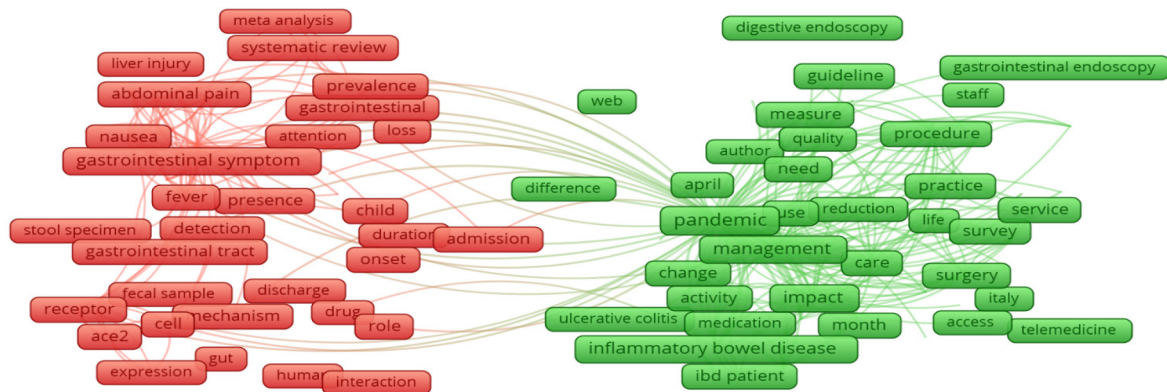
DISCUSSION

The use of bibliometric analysis to review the patterns and development of various fields and areas of

Table 4 List of the top 10 cited articles for gastrointestinal publications involvement in coronavirus disease 2019

Ranking	Ref.	Title	Source title	Cited by	Impact index per article ¹
1 st	Xiao <i>et al</i> [58], 2020	“Evidence for Gastrointestinal Infection of SARS-CoV-2”	<i>Gastroenterology</i>	798	617.5
2 nd	Xu <i>et al</i> [59], 2020	“Characteristics of pediatric SARS-CoV-2 infection and potential evidence for persistent fecal viral shedding”	<i>Nature Medicine</i>	525	384.0
3 rd	Gu <i>et al</i> [52], 2020	“COVID-19: Gastrointestinal Manifestations and Potential Fecal–Oral Transmission”	<i>Gastroenterology</i>	507	342.5
4 th	Pan <i>et al</i> [55], 2020	“Clinical characteristics of COVID-19 patients with digestive symptoms in Hubei, China: A descriptive, cross-sectional, multicenter study”	<i>American Journal of Gastroenterology</i>	464	352.5
5 th	Wu <i>et al</i> [57], 2020	“Prolonged presence of SARS-CoV-2 viral RNA in faecal samples”	<i>Lancet Gastroenterology and Hepatology</i>	451	374.5
6 th	Jin <i>et al</i> [53], 2020	“Epidemiological, clinical and virological characteristics of 74 cases of coronavirus-infected disease 2019 (COVID-19) with gastrointestinal symptoms”	<i>Gut</i>	362	277.0
7 th	Cheung <i>et al</i> [10], 2020	“Gastrointestinal Manifestations of SARS-CoV-2 Infection and Virus Load in Fecal Samples From a Hong Kong Cohort: Systematic Review and Meta-analysis”	<i>Gastroenterology</i>	356	269.5
8 th	Lamers <i>et al</i> [54], 2020	“SARS-CoV-2 productively infects human gut enterocytes”	<i>Science</i>	338	317.5
9 th	Yeo <i>et al</i> [60], 2020	“Enteric involvement of coronaviruses: is faecal–oral transmission of SARS-CoV-2 possible?”	<i>Lancet Gastroenterology and Hepatology</i>	323	202.0
10 th	Tian <i>et al</i> [56], 2020	“Gastrointestinal features in COVID-19 and the possibility of faecal transmission”	<i>Alimentary Pharmacology and Therapeutics</i>	269	189.0

¹The impact index per article is presented based on *Reference Citation Analysis* [source: Baishideng Publishing Group Inc. (Pleasanton, CA 94566, United States)].



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Figure 2 Network visualisation map of the most frequent terms in titles/abstracts of the retrieved literature pertaining to gastrointestinal publications involvement in coronavirus disease 2019. The terms were divided into two clusters based on the various colours created by default, namely, gastrointestinal manifestations coronavirus disease 2019 (COVID-19) patients (red), and implications of COVID-19 for gastroenterologists (green). The large icon indicates the terms that appeared at a high frequency. Among the 13932 terms, only 270 (defined as terms that occurred > 15 times) appeared in titles and abstracts in all publications.

research is becoming more common. The current data analysis reflects various facets of GI 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, high-income countries such as the United States, China, Italy, the United Kingdom, Spain, France and Germany are the world leaders in GI publications 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, the United States contributed the most scientific papers published during the COVID-19 pandemic. This is due to the fact that it has the most academic journals on the search sites in use, as well as being a country where researchers from all over the world want to publish their findings[68]. China was 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 pandemic response[69].

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

The current study used a bibliometric review to discuss the top 10 cited publications about GI involvement in COVID-19. 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 GI infection in COVID-19 and its possible faecal-oral transmission route. The second most-cited paper was by Xu *et al*[59] from *Nature Medicine* as a brief communication. According to the results of that study, rectal swab testing may be more helpful than nasopharyngeal swab testing in assessing the efficacy of management and timing of quarantine termination. However, replication-competent virus in faecal swabs was not demonstrated in the study, and this is necessary to confirm the possibility of faecal-oral transmission. The third most-cited paper was 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, that study recommended that the initial digestive symptoms of COVID-19 should be an alert for early isolation, detection, diagnosis and intervention.

Therefore, our study provides an understanding of the research on GI symptoms in COVID-19, and citation rates can indicate important 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 cytokine release syndrome, and the probability of faecal-oral transmission all require further research in larger populations, especially prospective validation 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 dropout of false-positive or false-negative results is also expected. We attempted to be as comprehensive as possible, using all terms related to GI and COVID-19 listed in the literature. However, there was a possibility of missing some terms. Therefore, we did our best to retrieve all GI 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 rapidly changing existence of COVID-19 science. The final limitation is that the authors did not search all scientific databases; however, this limitation is present in almost all bibliometric studies.

CONCLUSION

This research offers a detailed overview of the position of GI publications in COVID-19 research evolution during the early stages of the outbreak. In a short timespan (1 year) following the start of the COVID-19 pandemic, 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 many publications focused on GI manifestations among COVID-19 patients and the implications of COVID-19 for gastroenterologists. 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 coronavirus disease 2019 (COVID-19) patients. Gastrointestinal (GI) symptoms such as diarrhoea, 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 GI system in a variety of countries during the outbreak, according to several systematic reviews and meta-analyses. There has not been a comprehensive bibliometric analysis of research on GI and COVID-19. The aim of bibliometrics is to determine the depth of knowledge in a given area.

Research objectives

The purpose of this study was to report a bibliometric analysis of the global research pertaining to GI 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 GI and COVID-19.

Research results

The current data analysis reflects various facets of GI-related publications 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 gastroenterologists were of increasing concern, especially in the early stages of the pandemic. 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.

FOOTNOTES

Author contributions: Zyoud SH designed the study, collected the data, analyzed the data, made major contributions to the manuscript's existing literature search and interpretation, and drafted the manuscript; Al-Jabi SW participated in the study design, was involved in interpretation of the data, made revisions to the initial draft, and answered the reviewers' comments; Jairoun AA and Shahwan MJ corrected the manuscript and answered the reviewers' comments; all authors provided a critical review and approved the final manuscript before submission.

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