

## Bibliometric Analysis of Scientific Production on COVID-19 in Colombia

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**Abstract**

**Objective:** To conduct a bibliometric analysis to describe the results of research on COVID-19 in Colombia.

**Materials and methods:** We included articles related to COVID-19 in Colombia, between January 2020 and August 2022, indexed in the Scopus database. Articles such as reviews, notes, errata, editorials, letters to the editor, surveys, doctoral theses, master's these and other non-scientific documents were excluded. The bibliometric indicators of production, visibility, impact and collaboration were analyzed.

**Results:** This is the first bibliometric analysis of the literature on COVID-19 in Colombia. We found an exponential increase in scientific production since the beginning of the pandemic, mostly of journal articles, in the area of health, written mainly by Colombian authors, with great international collaboration, and published in national journals and a few international journals with high visibility.

**Conclusions:** The imperative need to respond to the questions generated by the arrival of a pandemic of the magnitude such as that of COVID-19, represented an impulse for Colombian authors from different areas of knowledge, mainly health, to publish scientific articles in an accelerated way. This generates international recognition and visibility by contributing with the necessary evidence to impact the mitigation of the pandemic.

**Keywords:** Coronavirus Infections, COVID-19, SARS-CoV-2, Bibliometrics, Colombia, Journal Impact Factor.

**1. Introduction**

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus, which was first identified in Wuhan, Hubei Province, central China. COVID-19 is responsible for the 2019-2020 pandemic

declared by the World Health Organization (WHO) on March 11, 2020 [1]. As of now, the number of confirmed cases of COVID-19 worldwide, according to the WHO, stands at 617,597,680 cases, including 6,532,705 deaths; with the Americas being the second

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most affected continent after Europe [2]. In Colombia, as of October 7, 2022, there have been 6,307,372 confirmed cases of COVID-19 with 141,794 fatalities [3].

Given the novelty and, consequently, the lack of knowledge about the disease, scientific production related to COVID-19 experienced a significant increase with the aim of describing the situation, generating questions, and providing substantial evidence [4]. In the field of health, the scientific community responded swiftly to provide information on how to control the pandemic and in the development of tests, treatments, and vaccines [5]. However, as a result of this need, there has been a reduction in the typical time required for scientific articles to be reviewed, accepted, and published in academic journals [6].

Due to the crucial role that research plays in the context of COVID-19 infection, it is necessary to conduct studies that demonstrate the quality and quantity of scientific literature related to this topic [7]; among the numerous available studies, bibliometric analysis stands out, which assesses the pace of scientific production, its trends and regularity, as well as the interaction of contributing institutions [8]. Given the ongoing production of articles, the results of bibliometric analyses can vary depending on the search time frame, included databases, or the terms used; thus, studies show that China and the United States have demonstrated leadership in scientific production, followed by countries such as England, Italy, Germany, and Saudi Arabia [9,10]. From a thematic perspective, there is a notable focus on research in epidemiological and virological topics [11].

Bibliometric analyses are used to measure the quality of publications, providing the opportunity for a comprehensive assessment of trends and progress in scientific production, enabling researchers and policymakers to develop public health initiatives related to the disease [12,13]. However, to date, the dynamics of Colombian research in the context of this pandemic remain unknown, as most bibliometric studies on SARS-CoV-2 present publication trends with Latin American and global coverage. Therefore, the purpose of this research is to characterize Colombian scientific production on COVID-19.

## 2. Methodology

A descriptive bibliometric study was conducted. The articles

included in this bibliometric analysis were retrieved from the Scopus database, as it is one of the primary databases for abstracts and citations, with numerous documents and high-quality indexed publications.

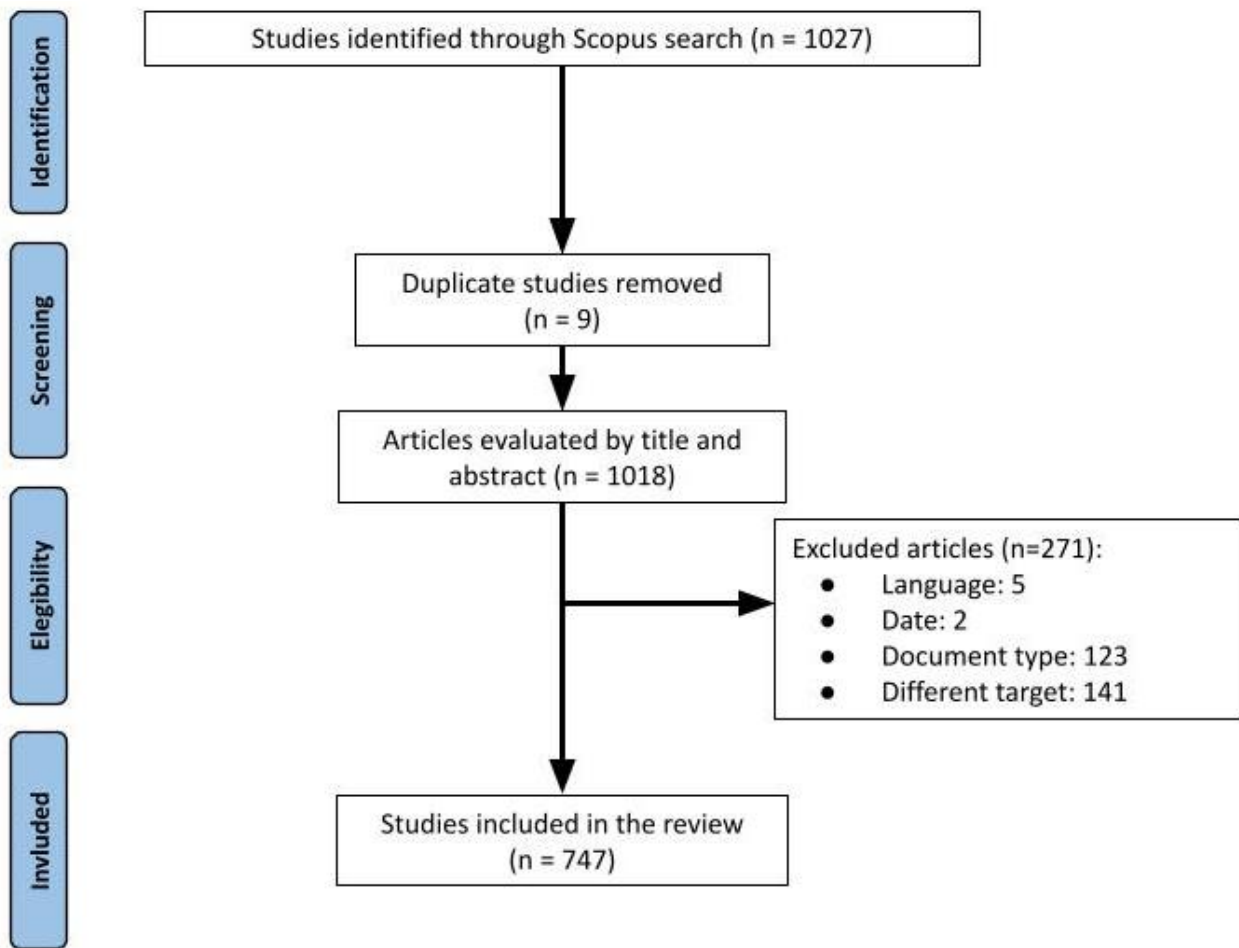
### 2.1 Search strategy

The search included articles from January 1st, 2020, when the first publications from Colombia on COVID-19 appeared, until August 31, 2022. The search strategy used for document retrieval was (((((((covid-19) OR (sars-cov-2)) OR (coronavirus disease 2019)) OR (2019-ncov)) OR (covid 19)) OR (covid19)) OR (covid-2019)) AND (Colombia) in the fields of title, abstract, and keywords.

### 2.2 Article eligibility and selection criteria

The obtained results were exported to a CSV file, including citation information (author(s), document title, year, source title, volume, number, pages, citation count, source, document type, and DOI), bibliographic information (affiliations, series identifiers, PubMed ID, editor(s), language, correspondence address, and abbreviated source title), abstracts, keywords (author and index keywords), and references. With this search strategy, 1027 records were retrieved. The Biblioshiny bibliographic tool was used for data processing, and it was exported as an Excel file. The elimination of duplicate documents and the exclusion of articles based on title and abstract were carried out using Microsoft Excel 2016 software. Before the selection process, a training meeting was held to standardize definitions.

Therefore, the inclusion criteria for this bibliometric analysis are as follows: articles from journals, reviews, conference papers, books, and book chapters indexed in Scopus, related to COVID-19 in Colombia; publication date after January 1, 2020; language in English and Spanish. Regarding exclusion criteria, the following document types were not included: book reviews, conference reviews, notes, errata, editorials, letters to the editor, surveys, doctoral theses, master's theses, and other non-scientific documents; unavailable full documents. The final sample for the bibliometric analysis consisted of 747 documents (Figure 1). Subsequently, the database was loaded into Biblioshiny for bibliometric information analysis, including scientific production, sources, authors, content, thematic evolution, citation network, co-citation, and collaboration.



**Figure 1:** Selection and screening process of the records according to the PRISM flow chart.

Impact factors of journals and authors were consulted from Scopus and Scimago Institution Rankings reports. Information about journal indices such as CiteScore, SJR, the current quartile, H-index, the subject area of each journal, and the country were included. The primary difference between CiteScore and SJR is that SJR measures weighted averages of citations depending on the subject field and prestige of the citation source [14]. Additionally, the analysis was conducted based on models such as Bradford's Law, which explains the quantitative relationship between journals and scientific articles contained in a bibliography on a specific topic, positing that the majority of articles are concentrated in a small group of specialized journals [15]; on the other hand, Lotka's Law states that the majority of articles are concentrated in a small

group of highly productive authors [16]. The VoSViewer tool, v1.6.15, was used for keyword co-occurrence analysis.

### 3. Results

#### 3.1 Metadata analysis

Table 1 presents the main information of the articles obtained in the search. A total of 747 documents were retrieved in the period between 2020 and 2022, primarily composed of journal articles (90%). Out of the 4,317 authors, 98.7% have documents with multiple authorship; furthermore, 691 documents with multiple authors were found, with only 56 documents authored by a single individual. This is related to the collaboration index, which in this case is 0.402.

ÍTEM	RESULTS
Documents	747
Sources (Journals, books, etc)	445
Period	2020-2022
Plus Keywords	3585
Author Keywords	2003

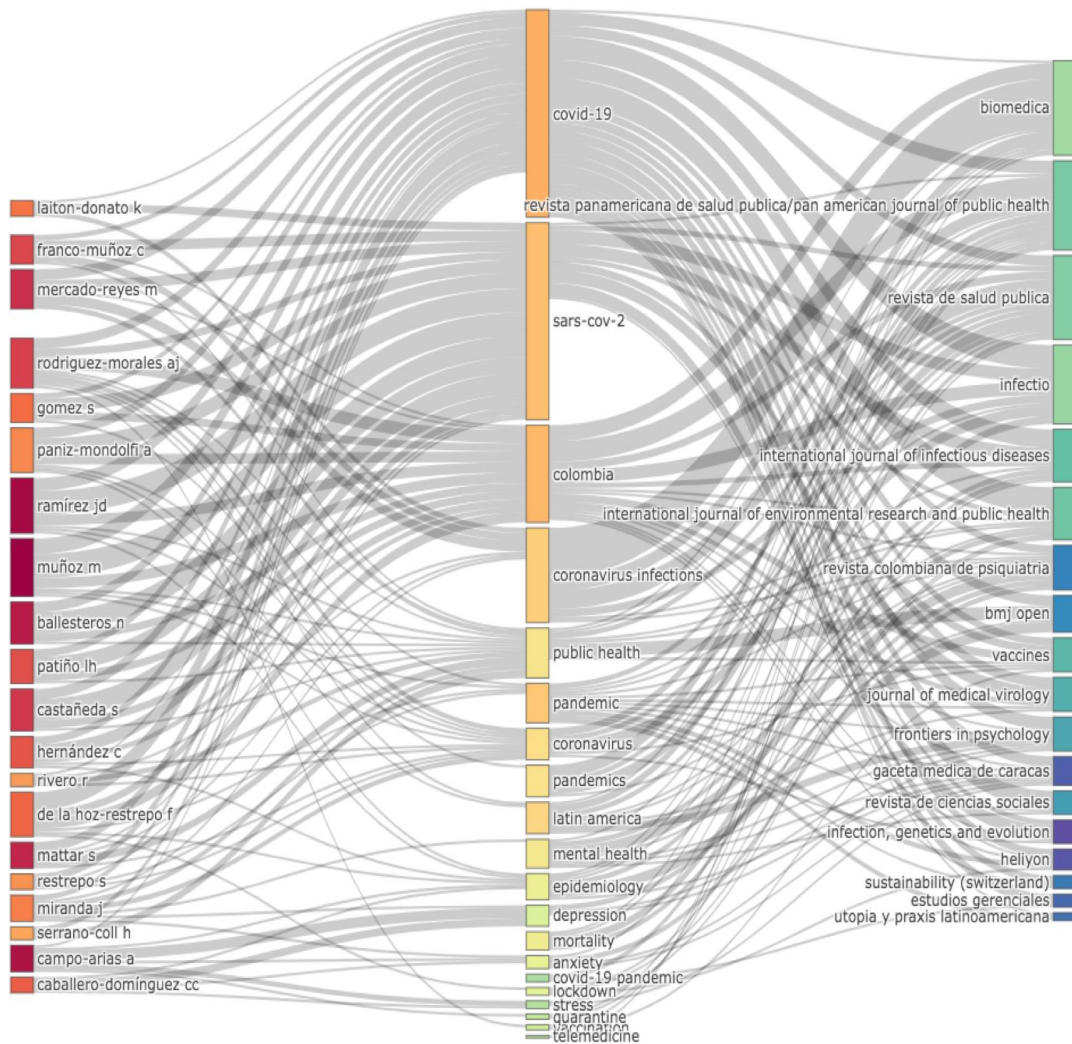
Mean citation per document	5884
References	28692
<b>AUTHORS</b>	
Authors	4317
Authors with single author documents	55
Authors with multiple author documents	4262
Documents with single author	56
Documents with multiples authors	691
Documents per author	0,173
Authors per document	5,851
Co-authors per document	7,02
Collaboration index	0,402
<b>TYPES OF DOCUMENTS</b>	
Journal articles	678
Book chapters	8
Conferences	32
Reviews	29

**Table 1: General information of the articles**

The annual growth rate was 27.64%. In the first year of the pandemic in Colombia, 151 articles were published, while the following year saw 350 articles published, marking the year with the highest productivity, demonstrating a significant increase in interest in this field. However, because the dataset information was retrieved in August 2022, the number of articles for that year is lower compared to the previous year.

Figure 2 displays a Sankey diagram representing the most relevant authors in the field (first column), along with the primary keywords (second column) used in their publications, and the most

relevant sources (third column) where these keywords appear. It is observed that the terms 'COVID-19' and 'SARS-CoV-2' are the most frequently used keywords in the articles of this analysis. Other relevant keywords include 'Colombia,' 'coronavirus infections,' 'public health,' and 'pandemic,' all closely related to the central topic. Additionally, it is noteworthy that four terms related to mental health and COVID appear: 'mental health,' 'depression,' 'anxiety,' and 'stress,' demonstrating the relevance of the various consequences of COVID-19 on the mental well-being of the population.



**Figure 2:** Sankey diagram (authors, keywords y sources)

### 3.2 Source analysis

Table 2 lists the top 10 sources where the highest number of articles have been published, their impact factors, subject areas, and the corresponding countries. It can be observed that, among the top five journals, three are from Colombia and two from the United States. The journal 'Biomédica' has the highest number of publications on COVID-19 in Colombia, with 22 articles, followed by 'Infectio,' 'Plos One,' 'Revista de Salud Pública,' and 'Revista Panamericana de Salud Pública.' The 10 listed journals primarily focus on the health field, with eight of them in the field of medicine,

one in psychology, and 'Plos One' being multidisciplinary but also including medical articles in its publications. Regarding impact indices, it is generally observed that journals with higher impact factors have fewer articles, mostly being international journals. The journals 'Inter J of Infectious Diseases' and 'Journal of Medical Virology' are the two journals with the highest scores in SJR and CiteScore, being the journals with the highest visibility in terms of COVID-19 publications in Colombia. It is noteworthy that all local journals are still in Quartile Q4 with H-indices lower than international journals.



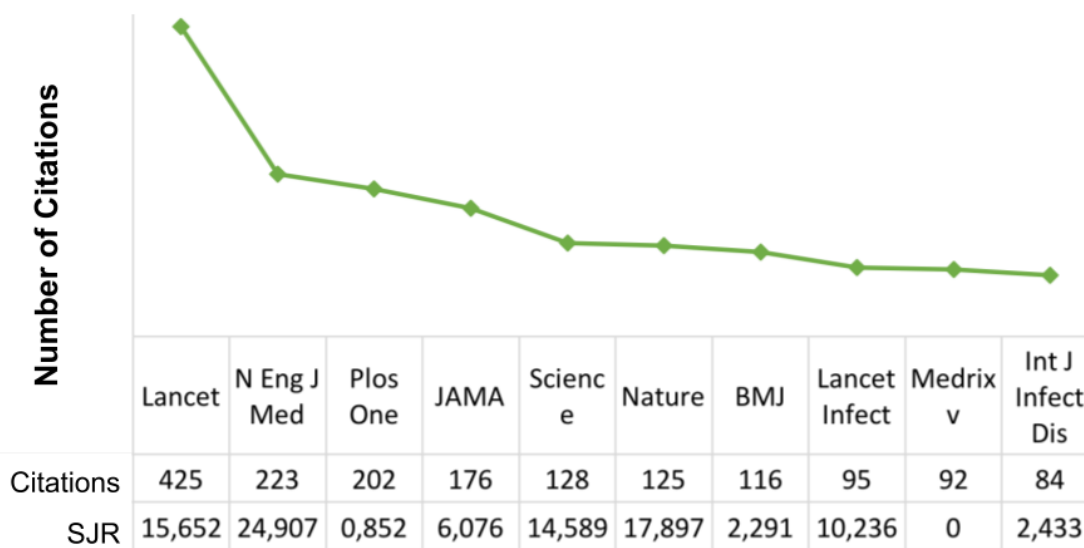
Sources	Articles	Cite Score	SJR	Quartile	H-index	Thematic area	Country
Biomédica	22	1,2	0,2	Q4	30	Medicine	Colombia
Infectio	16	1,2	0,1	Q4	10	Medicine	Colombia
Plos One	14	5,6	0,8	Q1	367	Multidisciplinary	USA
Revista de Salud Pública	14	0,8	0,1	Q4	25	Medicine	Colombia
Revista Panam. de Salud Pública	14	3	0,6	Q2	59	Medicine	USA
Inter J of Environment-al Research and Public Health	11	4,5	0,8	Q2	138	Medicine	Switzerland
Inter J of Infectious Diseases	10	10,8	2,4	Q1	104	Medicine	Netherlands
Vaccines	9	4,5	1,0	Q1	50	Medicine	Switzerland
Journal of Medical Virology	8	18,8	2,6	Q1	137	Medicine	USA
Frontiers in Psychology	7	4	0,8	Q1	133	Psychology	Switzerland

SJR: Scimago Journal & Country Rank.

**Table 2: Top 10 of the most relevant sources with Colombian publication**

Figure 3 presents the most cited sources among the articles included in this search. The most cited journal was 'The Lancet' with a total of 425 citations, doubling the citations of 'The New England Journal of Medicine' and 'Plos One.' This means that among the top 10, 'The Lancet' comprises 1/4 of the citations, despite this, 'The New England Journal of Medicine' has a higher SJR index. On the other hand, 'Plos One' has one of the lowest indices on

the list but has a high number of citations, demonstrating that it has very good visibility despite having a low SJR. Other journals listed among the most cited include 'JAMA,' 'Science,' 'Nature,' 'BMJ,' 'The Lancet Infectious Diseases,' and 'International Journal of Infectious Diseases.' 'Medrxiv' is a free online distribution and archiving server for the publication of preliminary reports of unpublished works (preprints), founded in 2019 [17].



N Eng J Med: New England Journal of Medicine; JAMA: Journal of the American Medical Association; BMJ: British Medical Journal; Int J Infect Dis: International Journal of Infectious Diseases ; SJR: Scimago Journal & Country Rank.

**Figure 3: Top 10 most cited local sources**

The growth of the literature was evident through Bradford's Law, as the majority of articles are concentrated in a limited number of journals. Thus, in Zone 1 (core), articles are concentrated in a small number of journals (8.5%) compared to Zone 2, where 37% of the journals are located, and Zone 3, with 54.3%.

### 3.3 Authors analysis

Table 3 presents the top 10 authors with the most scientific contributions related to COVID-19 in Colombia, all of whom are Colombian authors. 50% of them are affiliated with the University of Rosario, 20% with the National Institute of Health, and 30%

with other institutions. The two authors with the highest number of articles are Marina Muñoz and Juan David Ramírez, each with 14 documents, with an equal local impact, but higher than the group. However, according to Scopus, Ramírez has a higher scientific impact with an H-index of 33, unlike Muñoz, who has an index of

12. On the other hand, Rodríguez-Morales AJ has 10 publications, but his H-index according to Scopus is 52, surpassing the rest of the authors, demonstrating that, despite not being the author with the highest impact in the search conducted, he has a much higher global impact.

Author	N. Documents	Affiliation	Country	H-Index	
				Scopus	Local
Muñoz M	14	U. Rosario	Colombia	12	7
Ramírez JD	14	U. Rosario	Colombia	33	7
Campo-Arias A	12	Health Psychology and Psychiatry Research Group	Colombia	15	6
Ballesteros N	11	U. Rosario	Colombia	5	6
Mattar S	11	U. Córdoba	Colombia	22	6
Mercado-Reyes M	11	National Health Institute	Colombia	18	6
Castañeda S	10	U. Rosario	Colombia	5	6
Rodríguez-Morales AJ	10	Fundación Universitaria Autónoma de las Américas	Colombia	52	5
Franco-Muñoz C	9	National Health Institute	Colombia	7	5
Patino LH	9	U. Rosario	Colombia	9	5

**Table 3: Top 10 more relevant authors**

The top 10 authors whose articles were most cited within this review (Supplementary table 1) differ from the top 10 authors with the most publications, highlighting the preeminence of the

quality, validity, and reliability of information over the quantity of publications. Additionally, it is observed that these authors have only one article, but it was cited with significant frequency

Author	Local citations	Articles	Article name
Ariza-Varón M	15	1	Psychosis associated with suspected Sars-Sov-2 encephalitis with response to steroids: A case report
Ávila AM	15	1	
Beltrán MA	15	1	
González AF	15	1	
Marín-Medina DS	15	1	
Álvarez JF	14	1	Economía social y Covid-19: Una mirada internacional
Bouchard MJ	14	1	
Marcuello C	14	1	
Aranguren DA	8	1	Virtual and in-person accompaniment of hospitalized patients during the Covid-19 pandemic in Colombia
Cantor-Cruz F	8	1	

**Supplementary Table 1: Top 10 most cited authors locally**

Regarding the global contribution, it was found that authors from 43 countries have collaborated in the production of the articles. Colombia was the country with the most contributions, with a total of 298 articles, the majority of which were single-country publications (SCP). On the other hand, the rest of the countries stood out for publishing multi-country publications (MCP), demonstrating a high number of international collaborations. In terms of collaboration with authors from the United States, 40 articles were published, of which 31 were MCP. Spain contributed

24 articles (17 MCP), Peru 17 (12 MCP), Mexico 16 (12 MCP), and the United Kingdom 13 (10 MCP).

In this case, 3,810 authors (88.3%) published a single document, demonstrating low productivity (Lotka Index = 0); 11.6% had moderate productivity (Lotka Index 0-1) by publishing between 2 and 9 articles, and less than 1% of the authors had high productivity (Lotka Index >1) by publishing between 10 and 14 articles.

### 3.4 Affiliation Analysis

Of the top 10 institutions that have contributed the most articles in the field, 9 are Colombian, and only 1 is international. Out of these, 9 are universities. The National Institute of Health has the highest number of documents with 179 articles attributed to it, followed by the University of Rosario with 150 articles and the National University with 127 articles.

### 3.5 Document analysis

Table 4 displays the top 10 documents that received the most citations regarding COVID-19 in Colombia. The most cited document was 'Health equity and COVID-19: global perspectives'

by an Israeli author, with 230 citations, followed by 'Covid-19 Confinement and Changes of Adolescents Dietary Trends in Italy, Spain, Chile, Colombia, and Brazil' by a Spanish author, with 151 citations. Two articles by Colombian authors were also included in the list: 'Effect of Ivermectin on Time to Resolution of Symptoms Among Adults With Mild COVID-19,' published in an international journal, and 'A new emerging zoonotic virus of concern: the 2019 novel coronavirus (Covid-19),' published in a national journal. The topics covered in these studies mainly revolve around health quality, quality of life, treatments, changes in habits, mental health, infection characteristics, among others, all associated with COVID-19.

Article name	Author	Country	Journal	N. Citations
Health equity and COVID-19: global perspectives	Efrat Shadmi	Israel	Int J for Equity in Health	230
Covid-19 Confinement and Changes of Adolescent's Dietary Trends in Italy, Spain, Chile, Colombia and Brazil	María Belén Ruiz-Roso	Spain	Nutrients	204
Effect of Ivermectin on Time to Resolution of Symptoms Among Adults With Mild COVID-19	Eduardo López-Medina	Colombia	JAMA	151
COVID-19 vaccine acceptance among pregnant women and mothers of young children: results of a survey in 16 countries	Malia Skjefte	USA	European J of Epidemiology	148
Changes of Physical Activity and Ultra-Processed Food Consumption in Adolescents from Different Countries during Covid-19 Pandemic: An Observational Study	María Belén Ruiz-Roso	Spain	Nutrients	99
Falling living standards during the COVID-19 crisis: Quantitative evidence from nine developing countries	Dennis Egger	USA	Science Advances	93
Healthcare worker infections and deaths due to COVID-19: A survey from 37 nations and a call for WHO to post national data on their website	Hakan Erdem	Turkey	Int J of Infectious Diseases	92
Pharmacists at the frontline beating the COVID-19 pandemic	Nadia Bukhari	United Kingdom	J of Pharmaceutical Policy and Practice	77
Perceived efficacy of COVID-19 restrictions, reactions and their impact on mental health during the early phase of the outbreak in six countries	Martin Jensen Mækelæ	Norway	Royal Society Open Science	67
A new emerging zoonotic virus of concern: the 2019 novel coronavirus (Covid-19)	José Millán-Oñate	Colombia	Infectio	67

**Table 4: Top 10 more cited documents**

### 3.6 Content analysis

The top 10 words in order of frequency are 'human,' 'Colombia,' 'coronavirus disease 2019,' 'COVID-19,' 'pandemic,' 'SARS-CoV-2,' 'female,' 'adult,' 'male,' and 'pandemics' (Figure 4); some of them may not be easily discernible at first glance due to the overlapping circles. The figure highlights the grouping of words

into five colors, implying that in the green group, terms associated with the virus in general, the pandemic, and terms related to mental health are prominent. The yellow group contains scientific terms related to the field of immunology, such as 'genetics,' 'SARS-CoV-2,' 'virus antibody,' 'phylogeny,' 'mutation,' and others. Terms in the red group are primarily clinical aspects like 'mortality,'





literature. Additionally, an important pattern of international collaboration was observed, highlighting the authors' need to engage in collaborative work with other countries to gain different perspectives on the topic. According to the Scimago ranking, Colombia has published 150,096 documents, ranking 48th out of 242 countries, with an H-index of 356, placing it 46th. Scimago also confirms that since 2020, the number of published documents, citations, and international collaborations has been increasing, particularly in the field of medicine [22].

On the other hand, it is important to highlight the quality of the journals in which these works were published because the impact of a journal, as measured by the quartile and the H-index, is directly associated with the number of citations and, consequently, its visibility. Despite the increase in scientific production in Colombia, these works were mostly published in low-impact journals, which poses a challenge for Colombian research. The goal is to publish articles in international journals ranked in quartiles 1 and 2, assuming better quality of the work and, consequently, wider reach. It is important to recognize that publishing articles in reputable journals can be challenging, especially when the topic is novel and relevant, such as COVID-19, which results in many submissions to the same journal, creating competition for publication opportunities. Regarding authors with the most significant contributions of scientific products on COVID-19 in Colombia, it was found that 50% of the publications were authored by researchers affiliated with the University of Rosario, and in second place, with 20% of scientific contributions, authors from the National Institute of Health were prominent. However, in the list of the most cited authors among the articles, it was observed that the authors with the most publications are not the same as those who are most cited. This is because authors often make the mistake of focusing on quantity rather than quality, resulting in products that lack the characteristics required to be highly cited. Additionally, they are not published in high-impact journals, which reduces their visibility. This is an area for improvement in Colombian scientific writing [23].

Among the institutions that have contributed the most articles on the subject, the National Institute of Health ranks first with 179 articles from its affiliation, followed by the University of Rosario with 150 articles. Regarding the most frequently used keywords, those related primarily to the virus, medicine, and to a lesser extent, psychology stand out. These are the fields where the most publications have been made on the topic. This is similar to what was found in a bibliometric analysis conducted at the Latin American level, where the keywords were very similar in terms of virology, but when it was conducted in 2020, some topics such as treatments, vaccines, and chronic complications were not the most cited [11].

In the conduct of this study, some limitations were encountered. While the search for scientific production in Colombia was conducted in a significant database like SCOPUS, the results do not encompass the entirety of research on COVID-19. Furthermore, a

search in semi-published literature databases was not performed, which could have contributed additional records; however, the quality of such records could not be guaranteed. Additionally, a significant number of articles were excluded based on their study design, as the intention was to include articles primarily from academic journals that provided better information and had a more rigorous methodology. Moreover, in these types of studies, there is the limitation of not having the capacity to assess the quality of each of the published documents, and it is worth noting that, for reasons of time, articles or institutions that published from 2020 have a higher likelihood of being cited than those published in recent months.

This research has significant national implications as it is the first bibliometric analysis of COVID-19 in Colombia, providing a tool to support decision-making that can strengthen public policies. While a considerable number of articles were found, Colombia is still far from being a leading country in research; therefore, the aim is to generate a response from institutions to encourage publication and achieve a higher number of articles per author. Furthermore, this review enables researchers to know which journals they could submit their articles to or from which sources they can obtain a greater amount of information on the subject.

In conclusion, this article provides a concise overview of the state of research in Colombia and how the pandemic served as a catalyst for the increased production of scholarly articles in the country, resulting in a high number of publications in the initial years of the pandemic. Despite this exponential growth in scientific output, there are areas that require improvement, such as the quality of the published products. Enhancing quality would enable articles to be published in higher-impact journals, thus having a greater impact on global research. Furthermore, it is important to encourage all Colombian institutions to participate in scientific production, as currently, the majority of production is concentrated in a few entities.

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