



## **Saudi Scientific Contribution to COVID-19 Published Research**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Background:** Credible scientific information plays a key role in the control of epidemics and pandemics.

**Objectives:** To determine the contribution of Saudi published research in Covid-19 scientific information as regards topics, study types, institutional and geographical distribution of Covid-19 research publications.

**Methods:** In this descriptive study, we conducted a literature search in Pubmed and Google Scholar by using the search terms: "Covid-19" OR "SARS-COV-2" And "Saudi". Abstracts of the articles were reviewed to identify relevant articles, and the data were analyzed using Epi Info statistical package.

**Results:** Out of the total 1,322 publications, 641 (48%) were review articles, 410 (31%) were original research articles and 195 (15%) were record-based clinical articles. Cross-sectional surveys comprised 84.6% of the original research; 57.9% of these surveys were conducted among the general population while 42.1% were among healthcare professionals. The highest proportion of publications was from universities (71%) and Riyadh (40.4%) province. The articles were published in 586 journals; among these 23 (3.9%) were Saudi journals.

**Conclusion:** Saudi researchers have made a significant contribution to COVID-19 publications. However, a scarcity of analytical and experimental studies was observed. Researchers need to focus on these study designs to better guide clinicians and policymakers for evidence-based guidelines and policies in the local context.

**Keywords:** COVID-19; database searching; health care surveys; journals; pandemic; PubMed; research design; SARS-Cov2.

## 1. INTRODUCTION

Credible scientific information plays a key role in the control of outbreaks, epidemics, and pandemics. With limited and rapidly changing information about an epidemic or pandemic, needs assessment and planning mainly depend on timely research. An immediate collection and dissemination of quality information are specifically important in the case of newly emerging diseases to create awareness among the general population and to provide information to health care providers and policymakers for management and control of the emerging disease [1]. Moreover, research activities are vital for identifying the cause, designing preventive and control measures, and for developing specific drugs [2,3].

In 2020, COVID-19 emerged as a pandemic and a global public health problem. Being a new disease, scientific information was needed on all aspects of COVID-19 including clinical features, pathogenesis, and possible regimens for treatment and prevention. Moreover, it was also important to explore the perceptions and level of awareness regarding COVID-19, among the general population as well as health care workers. Realizing the importance of timely scientific information, COVID-19 became the main focus of research for medical institutions as well as researchers, and thousands of scientific articles, addressing various aspects of COVID-19, have been published as of now [4-8]. Researchers from various disciplines including clinicians, public health professionals, sociologists, psychologists, statisticians, and pharmacists contributed to COVID-19 research [9]. It is stated that in the history of scientific publishing such a great volume of research focused on a single topic has never been produced in a short period [10]. It is important and informative to review the published research to determine its contents as well as geographical distribution.

Various forms of scientific communications for COVID-19 were reported including research articles, letters to the editor, editorials, and review papers [11]. Similarly, a variety of topics were addressed by researchers including epidemiology, pathogenesis, clinical features, treatment, prevention, and control of COVID-19. To explore the whole spectrum of COVID-19, it is

important to conduct research with a variety of study designs. Observational studies regarding COVID-19 help determine the incidence, prevalence, risk factors, and clinical features of the disease while interventional studies can guide important treatment, control, and prevention strategies.

To determine the status of published COVID-19 research, several studies addressing the bibliometric aspects, such as countries, institutions, authors, and journals, have been published [1,4,12-15]. Other studies have looked into the publications from different perspectives, such as the topics of research and study designs [11,16-23].

Countries around the world must strive to conduct quality research on COVID-19 to completely understand all aspects of the disease locally and globally. Research, that determines various aspects of disease within the local context, is necessary to manage and control the disease locally [5].

The first case of COVID-19 in Saudi Arabia was reported in March 2020. More than 800,000 cases have been reported as of now [24]. Like other countries in the world, researchers from Saudi Arabia conducted research on COVID-19 to explore various aspects of the disease in the local context, and also to determine the perception and response of the local community regarding COVID-19. However, in the literature review, we were not able to find any study reviewing and summarizing COVID-19 research conducted in Saudi Arabia. Therefore, this study is designed to explore the characteristics of published COVID-19 scientific communications from Saudi Arabia. It is documented that for a pandemic, the research interest is greatest during its first year [25]. Thus, the current study focused on the COVID-19 scientific contribution from Saudi Arabia during the first year of the pandemic. The purpose of this study was to analyze quantitatively the Covid-19 scientific communication from Saudi Arabia, published in international journals and documented in PubMed and Google Scholar; to determine the topics related to Covid-19 addressed by researchers in Saudi Arabia; to determine the distribution of Covid-19 research publications in Saudi Arabia according to provinces and institutions; and to identify the gaps regarding

Covid-19- related topics which are not taken up by researchers in Saudi Arabia. This study will help to identify potential gaps in the Saudi COVID-19 research which in turn guides the directions for future research.

## 2. METHODS

This was a descriptive study to explore salient features of COVID-19 scientific communications from Saudi Arabia. For retrieving published material, we conducted literature searches in two electronic databases: Pubmed and Google Scholar.

PubMed is freely available and is a widely used database for the search and retrieval of medical literature. It is a repository containing more than 31 million records of biomedical literature [26,27]. Google Scholar search engine is also commonly used for searching scholarly literature. For a specific search term, Google Scholar is reported to return twice as many relevant articles as compared to PubMed [27]. Furthermore, Google Scholar searches can retrieve information from a variety of sources including publishers' websites, databases, and institutional repositories [28,29]. Therefore, using a combination of Google Scholar and PubMed is recommended to retrieve a wide range of medical literature [29].

We used the search terms: "Covid-19" OR "SARS-COV-2" And "Saudi" for our search. Broad search terms such as "Covid-19" OR "SARS-COV-2" were used to include as many relevant articles as possible. To retrieve the articles published from Saudi Arabia, we used 'Saudi' as a keyword. A Pubmed search was conducted from June 2020 to October 2021, and all relevant articles were included in the study. To broaden our literature search for the articles published during the first year of the pandemic (2020), we conducted the literature search on Google Scholar by using the filter for the year 2019-2020.

All scientific publications identified within PubMed and Google Scholar were included in this study. Thus, original research, reviews, case reports and case series, editorials, letters to the editors, perspectives, commentary, and responses to articles, were included. The articles with the first author from an institution in Saudi Arabia or the second author from Saudi Arabia (if the study was conducted in Saudi Arabia) were included. The research conducted within Saudi Arabia was included even if the authors were not from institutions within the country. The articles

were excluded if the first author was from an institution in Saudi Arabia, but the study was conducted in another country. The review article with the first author outside Saudi Arabia but second/subsequent authors from Saudi Arabia were also excluded. Furthermore, we excluded the articles published in languages other than English.

The title of the articles and corresponding abstracts were reviewed for identifying published material from Saudi Arabia, and the information was saved in an Excel worksheet. A tabulated list of the published material was prepared including information about article title, author name, the institution of the first author, type of institution, geographical location of the institution, month of publication, and journal name. Furthermore, information about the published article including the main domain, study design, and the topic/subject addressed by the article was also extracted.

The variables for this study were defined as follows:

### 2.1 First author's Institution Group

The institutions of the authors were grouped into universities, the Ministry of Health, international institutions, and other institutions in Saudi Arabia. For the research conducted in Saudi Arabia with the author's location outside Saudi Arabia, the institution was classified as an 'International institution'.

### 2.2 Classification of Scientific Communications

Scientific communications were classified into four main domains including original research, record-based clinical articles, reviews, and others. The group 'reviews' included all scientific communications utilizing secondary data/information. Thus, in addition to narrative and systematic reviews, this domain included clinical guidelines/ recommendations, editorials, letters to the editors, perspectives, commentary, and responses to articles. Record-based clinical articles included all those articles for which secondary data from healthcare facilities or public health organizations were used including case reports, case series, and retrospective cohort studies. The main subjects of the articles were classified as prevention, guidelines /recommendations, clinical profile, diagnosis, epidemiology, pathogenesis, treatment, and others.

To match the requirement of our project, we used the classification of study designs utilized for literature reviews [30]. Because of a high volume of published surveys, they were further explored with regard to the category of participants and the topic addressed. The participants were classified into two main categories including the general population and healthcare personnel, including students of various healthcare disciplines.

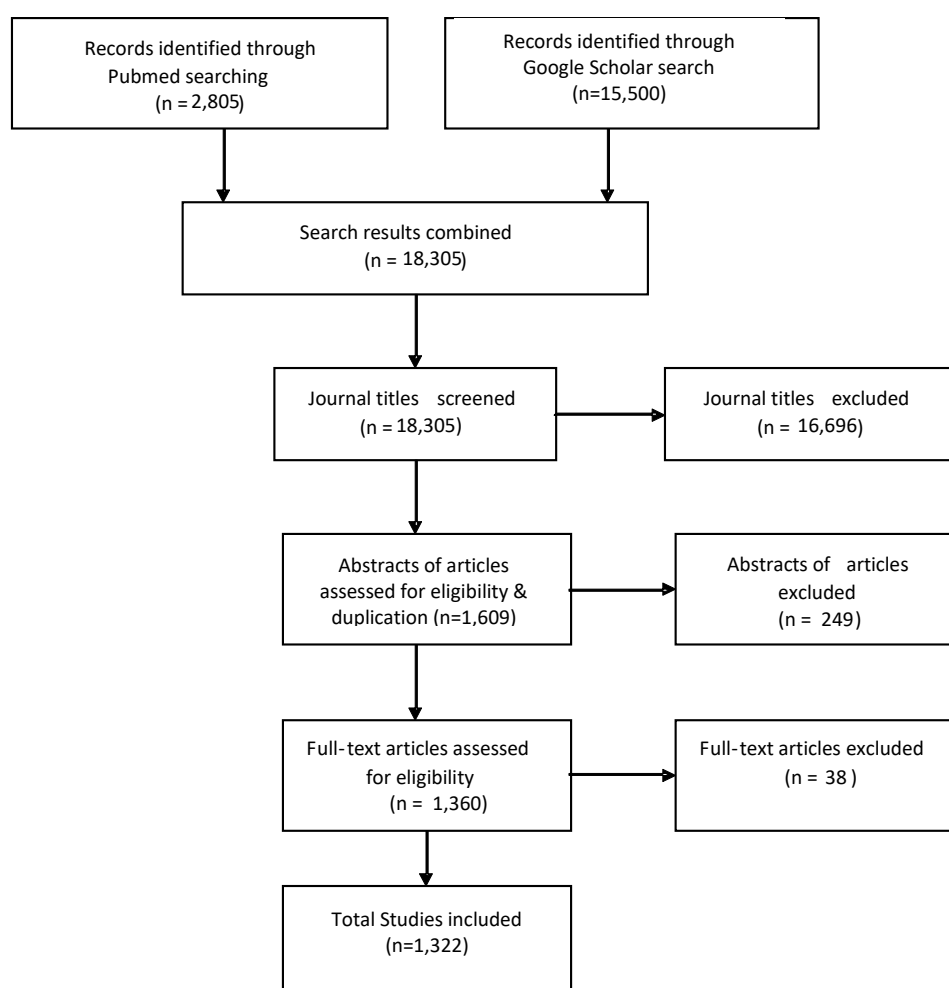
The data were transferred from an Excel worksheet and analyzed using the statistical package Epi Info version 3.5.4. Frequencies and proportions of various variables were calculated.

### 3. RESULTS

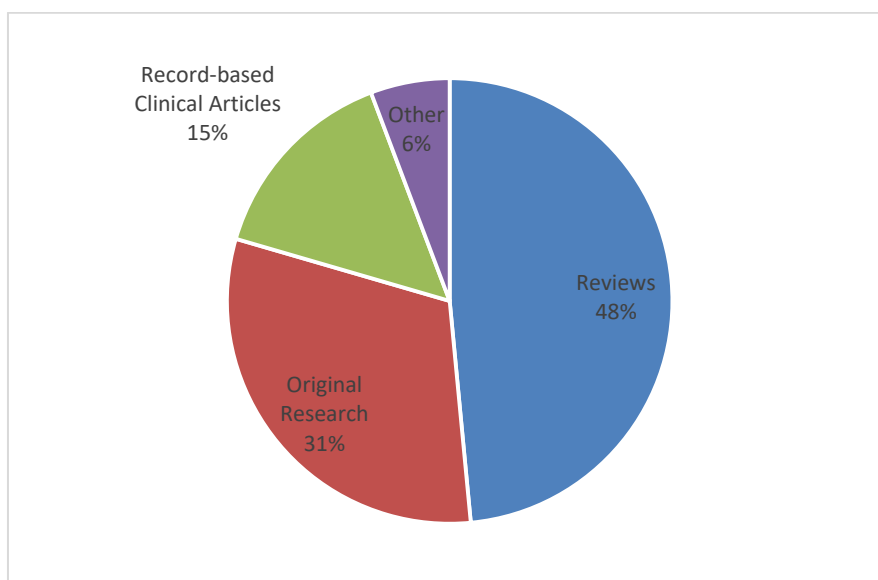
During the period of our literature search, a total of 18,305 published articles were retrieved by

using the keywords stated in the Methods section. After excluding articles not meeting the inclusion criteria and removing duplicate articles, a total of 1,322 articles were included in the study (Fig. 1).

A total of 795 articles were retrieved for the year 2020 while 527 articles were retrieved for the year 2021. The first COVID-19 article from Saudi Arabia was published in February 2020, and publication output progressively showed an increase. During the year 2020, the number of articles increased from 3 in February to 106 in November. Out of the total 1,322 publications, 641 (48%) were review articles, 410 (31%) were original research articles and 195 (15%) were record-based clinical articles (Fig. 2).



**Fig. 1. Flow chart of article search and inclusion of Covid-19 Scientific Publications from Saudi Arabia**



**Fig. 2. Distribution of Covid-19 publications according to main domains: Saudi Arabia**

Table 1 details the distribution of study types of Covid 19 scientific publications from Saudi Arabia. A total of 631 (43.6%) scientific publications were review articles, letters to the editor, and editorials, followed by cross-sectional studies (n=556, 42.1%).

Among the total 410 original research, 347 (84.6%) were cross-sectional surveys. Because of the substantial proportion of surveys and their peculiar nature, the surveys were separately analyzed regarding their target audience and the topic addressed. Among the remaining 975 publications, the most addressed topic was the treatment of COVID-19 (n=186, 19.1%) followed by the epidemiology of COVID-19 (n=174, 17.8%) (Table 2).

The surveys (n=347) were further analyzed. A total of 201 (57.9%) surveys were conducted among the general population while 146 (42.1%)

surveys had healthcare professionals (including students of various healthcare disciplines) as their participants. Almost half of the surveys (n=159, 45.8%) explored the impact of Covid 19 on the mental, social, and educational aspects of the participants. Around one-third of surveys (n=116, 33.5%) addressed the knowledge, attitudes, beliefs, and practices of the participants regarding preventive measures for COVID-19. The remaining 20.7% of surveys were conducted on miscellaneous topics such as health and telemedicine; e-learning and online education; the role of social media, the willingness of health care workers to work during COVID-19, and the willingness of the general public to undergo various medical procedures during COVID-19. The majority of the surveys (81.8%) were conducted by universities while 9.2% (n=32) were done by the Ministry of Health, Saudi Arabia.

**Table 1. Distribution of COVID-19 scientific publications according to study types: Saudi Arabia (n=1322)**

Study Type	Frequency	Percentage
Review Article/Letter to the Editor/Editorial	631	47.7
Cross sectional studies (e.g., surveys and record reviews)	556	42.1
Case report/Case series/Case study	83	6.3
Meta-analysis	15	1.1
Cohort study	15	1.1
Case-control studies	9	0.7
Qualitative study	5	0.4
Study protocol	5	0.4
Clinical trials	3	0.2
<b>Total</b>	<b>1322</b>	<b>100</b>

**Table 2. Distribution of COVID-19 scientific publications [Excluding surveys (n=347)] according to the main topic: Saudi Arabia**

The topic of Scientific Publication	Frequency	Percentage
Treatment	186	19.1
Epidemiology	174	17.8
Clinical Profile	139	14.3
Guidelines/Recommendations	121	12.4
Prevention	77	7.9
Pathogenesis	69	7.1
Diagnosis	68	7.0
Others	141	14.5
<b>Total</b>	<b>975</b>	<b>100.0</b>

Fig. 3 displays the distribution of articles according to institution groups. The highest proportion of publications was from universities (n=945, 71%). The Ministry of Health institutions contributed 12% of the total scientific publications.

On analyzing the distribution of publishing journals, it was found that the articles were published in 586 peer-reviewed journals. Out of the total 586 journals, 23 (3.9%) were national journals. Journal articles retrieved from Saudi journals, accounted for 14.1% (n=187) of the total articles.

The province with the highest number of publications was the Riyadh region, having 40.4% of all retrieved articles. Jeddah contributed 14.1% of the total articles followed by the Eastern region (13.8%) and Makkah (4.7%) province (Table 3).

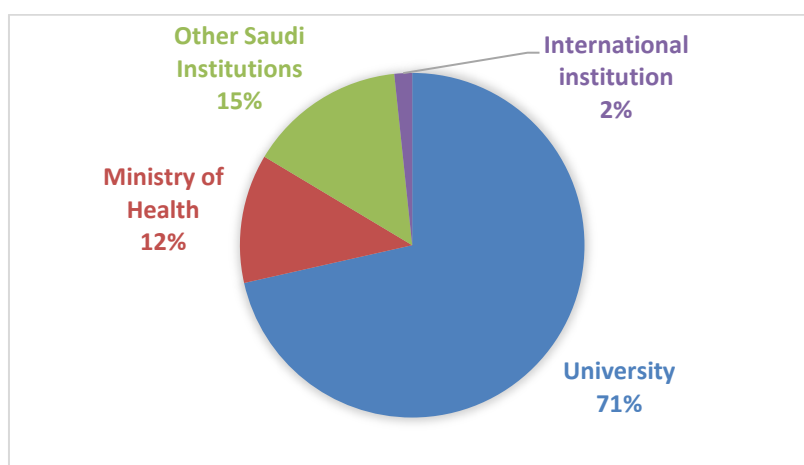
#### 4. DISCUSSION

The importance of scientific literature to combat outbreaks and pandemics is undisputable, as it meets the needs of information for healthcare providers as well as decision-makers. As the COVID-19 pandemic progressed, a surge of scientific publications was observed. Being a new disease, it was important to share all available information about the disease to design interventions to control COVID-19. Globally, most countries made their efforts to explore this new disease scientifically [8]. However, it is important to assess the scientific publications of individual countries in terms of their volume, topics, and implications on health care. Also, it is important to identify the lack of studies in specific areas that would have been helpful if conducted in the local context. Therefore, the current study analyzed the COVID-19 publications from Saudi Arabia regarding their frequency, main domains,

topics, study types, institutions, and geographical distribution.

The number of publications on any given topic reflects the importance of the topic, as well as the interest of the research community in that topic. In our study, we noticed a progressive increase in the number of publications after the first COVID-19 article was published in Saudi Arabia in February 2020. A similar pattern of progressive increase in a number of publications has been reported by studies conducted in other parts of the world [1,4,7]. This rapid increase in the number of publications may be attributed to the availability of electronic research databases and real time data that could be analyzed instantly to provide information regarding this novel disease.

Conducting a review of existing literature, and sharing experiences and opinions are valuable in the event of an emerging disease. In the current study, approximately half of the scientific publications included reviews, commentaries, opinions, and experiences. Similar to our findings, a study from Africa reported 48.6% of the publications in this domain include commentary and perspectives [5]. Another study analyzing the global research on COVID-19 from January to May 2020 found reviews comprising approximately half of the scientific publications [11]. Similarly, around one-third of the scientific publications from Arab countries were found in this domain in a study conducted in March 2020 analyzing the COVID-19 publications during the initial days of the pandemic [31]. This dominance of reviews, commentaries, and opinions in the initial days of the pandemic can be explained by the fact that scarce data was available about the new disease and the scientific community tried to understand the disease by reviewing the literature and sharing their perspectives regarding COVID-19. In our study, original



**Fig. 3. Distribution of Covid-19 Publications according to Institution Group: Saudi Arabia (n=1322)**

**Table 3. Geographical distribution of Covid-19 Publications: Saudi Arabia**

Place	Frequency	Percentage
Riyadh	534	40.4
Jeddah	187	14.1
Eastern Region	182	13.8
Makkah	62	4.7
Asir	57	4.3
Qassim	56	4.2
Medinah	44	3.3
Jazan	41	3.1
Hail	35	2.6
Taif	31	2.3
Jouf	24	1.8
Najran	21	1.6
Al Ahsa	10	0.8
Tabuk	4	0.3
Baha	3	0.2
Al jouf	2	0.2
Northern Border	3	0.3
International	26	2.0
<b>Total</b>	<b>1322</b>	<b>100</b>

research comprised 31% of the total scientific publications. Varying proportions of original research are reported by different studies; 65.08% from Arab countries [31], 46.6% from Africa [5], 42.7% from India [32], and 38.9% from Iran [8].

Globally, researchers from various disciplines have contributed to exploring COVID-19 by addressing a variety of topics. Thus, professionals from computer sciences, data science, sociology and psychology among others have published their original work and perspectives on COVID-19 [9]. In our study, several topics were addressed by researchers

from various disciplines. However, the most addressed topic was COVID-19 treatment (19.1%) followed by its epidemiology (17.8%), and clinical features (14.3%). A study conducted on publications from Arab countries found epidemiology, pharmacological research, and clinical features of COVID-19, as the main research areas addressed by researchers [31]. Other studies conducted during the initial days of the pandemic have also found a similar pattern [4,8,31,32-35]. In Africa, a quarter (25%) of the scientific publications in the early days of the pandemic addressed the topics related to the preparedness and response to the pandemic by the countries [5]. Impact on health and life of

people as well as clinical features and transmission of COVID-19 were also commonly discussed topics found in this study. However, the authors noted a deficiency of clinical trials concerning treatment and vaccines [5]. Although treatment was the most common topic addressed in our study, most of the articles were review articles, theoretically discussing various treatment options. Original research for treatment and prevention in the local context is important to determine the most suitable therapeutic and preventive measures for the local population. Therefore, this gap needs to be filled by prioritizing research topics, accordingly.

In our study, the highest proportion of study type was literature reviews including review articles, letters to the editor, and editorials (47.7%) followed by cross-sectional studies (42.1%). It has been noted that during the first 16 weeks of the pandemic the bulk of scientific publications comprised of narrative reviews, expert opinions, and commentaries, followed by case reports and case series [7]. Liu et al. (2020) also found that most publications were expert opinions and editorials [36]. This can be attributed to the lack of availability of adequate data regarding COVID-19 during the early days of the pandemic. In the current study, only 3 clinical trials were noted. Other researchers have also reported a paucity of clinical trials [1,5,7]. Although randomized controlled trials are considered the gold standard for assessing new treatments and innovations in pharmacologic and non-pharmacologic treatment modalities, they require time, effort, and specialized expertise.

Observational studies including case reports, case series, and cross-sectional studies have a vital role at the beginning of a pandemic as they can provide valuable information about the clinical features, prognosis, and epidemiology of the disease. Also, they are comparatively quick and easy to conduct. In our study, a substantial proportion (84.6%) of the original research was surveys while a very small proportion of study types (1.8%) comprised case-control and cohort studies. Guleid et al. (2021) reported 108 (17.8%) surveys out of a total of 606 primary research articles from Africa [5]. Further research is needed to explore any change in the type of studies with time and availability of more data regarding COVID-19 in Saudi Arabia.

Universities are considered the hub of research activities. Most of the biomedical publications are reported to be produced by medical universities

or colleges [37,38]. In our study, the majority (71%) of the publications were from universities. On the other hand, Lou et al.(2020) reported that out of 183 articles published from 14 January to 29 February 2020, the highest number [78 (42.6%)] were published from hospitals, followed by universities [64 (35%)] and the research institution [39 (21.3%)] [2]. In Saudi Arabia, the high proportion of COVID-19 research conducted by universities can be explained by the fact that generally, the universities have better expertise and resources to conduct research as compared to other institutions.

An important finding in our study was that the articles were published in a wide variety of peer-reviewed journals, and out of the total 586 journals, only 23 (3.9%) were national journals. This needs to be further explored why a very small proportion of articles were published in the national journals despite the availability of numerous well-reputed, indexed, peer-reviewed medical journals in Saudi Arabia.

Exploring the geographic distribution of scientific publications in a country gives an idea of scientific activities in various parts of that country. Our study found that the highest proportion (40.4%) of the published articles was from Riyadh province. Previous similar studies from Saudi Arabia have also found the highest number of scientific publications from Riyadh [37,39-41]. Riyadh, being the capital city, has numerous academic institutions, tertiary care and teaching hospitals, and the central offices of the Ministry of Health, leading to the availability of facilities and expertise for conducting research. Moreover, Riyadh province also includes many other cities with large hospitals and academic institutions.

Our study has some limitations. First, we did not search all scientific databases. However, we searched two of the most commonly used databases to include maximum publications. Second, our study provides only quantitative analysis of COVID-19 scientific publications from Saudi Arabia and does not explore their quality or usefulness in healthcare practice. Third, we searched only for studies published in English, thus missing the articles published in the Arabic language. Fourth, misclassification in research topics of the articles is expected as two or more topics seemed appropriate in some articles. However, despite the limitations of our study, we consider this study the first step for further in-depth analyses to determine the quality,



usefulness, and gaps in COVID-19 research in Saudi Arabia.

## 5. CONCLUSION

Saudi researchers have made a significant contribution to COVID-19 publications, and a variety of topics have been covered by them. The epidemiology of COVID-19 and its treatment were commonly discussed topics. Most of the studies were conducted by universities. The majority of the published articles were reviews and cross-sectional studies, including surveys and those based on the available records at health care facilities. There was a scarcity of analytical and experimental study designs, which are placed higher on the evidence pyramid as compared to cross-sectional studies. Based on the results of our study, we recommend planning and implementing analytic and experimental studies to better guide clinicians and policymakers to manage the disease and designing evidence-based policies in the local context.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

Ethical approval was obtained from Qassim Regional Research Ethics Committee.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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