INVESTIGATING THE SCIENTIFIC LANDSCAPE OF GLOBAL RESEARCH ON MEDICAL EDUCATION RELATED TO CORONAVIRUS DISEASE-2019 (COVID-19): A BIBLIOMETRIC ANALYSIS AND VISUALIZATION

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ABSTRACT

Introduction: *This study aims to inspire researchers to conduct future studies within this subject area through a bibliometric analysis of publications that focused on COVID-19-related medical education.*

Materials and methods: *The data of the study were obtained by determining publications from the Web of Science Core Collection (WoSCC) bibliographic database that focused on COVID-19-related medical education and then analyzed according to bibliometric methodology. VOSviewer software and visualization maps were used to report the analytical findings obtained from the collected data.*

Results: *The findings showed that the number of publications that focused on COVID-19-related medical education increased steadily and consistently and that these publications focused on different topics such as "medical students," "telemedicine," "pandemic," "undergraduate," and "e-learning." It was determined that the United States, the United Kingdom, China, and Singapore were the top contributors to the articles published on COVID-19-related medical education and that most publications consisted of "theoretical studies." In addition, the results of this study revealed that in order to contribute to the rapid dissemination of scientific knowledge produced during the pandemic, the editorial (referee/blind review) and publication processes of journals were conducted quicker than usual for articles pertaining to COVID-19.*

Conclusion: *This study revealed the research trends and current status of publications that focused on COVID-19-related medical education through bibliometric analysis and provided important findings for the future research vision of this subject area. To the best of the authors' knowledge, no other comprehensive bibliometric analysis of publications with a focus on COVID-19-related medical education has been conducted thus far. The current study, therefore, contributes to the knowledge base on COVID-19-related medical education by offering scientometric analysis of the existing literature and knowledge.*

Keywords: *COVID-19, medical education, coronavirus, bibliometric analysis, visualization.*

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Introduction

Medical education is one of the longers and thereby more tiring of healthcare education programs. Prolonged educational studies, clinical practices, insomnia, and heavy workloads can all place serious pressure on medical students[(1)], yet the most important goal of medical school students is still the successful completion of their courses. However, with the emergence of COVID-19, medical students and educators alike have been faced with unprecedented challenges[(2, 3)]. The new type of coronavirus that emerged in the Hubei Province of China in late 2019, spread worldwide rapidly during the early part of 2020. Due to the sudden and widespread increasing rates of cases reported, the World Health Organization's (WHO) Emergency Committee declared a global health emergency,

followed by radical measures to prevent the spread of the pandemic in many countries[4-9]. Among the measures taken were stay-at-home orders, societal lockdown, curfews, and even quarantine.(10) As a result of the clinical analysis of the COVID-19 virus, it was determined that it was rapidly communicable from person to person through inhalation[11], and as a result, schools and universities worldwide were forced to close their doors to face-to-face education[8, 12, 13]. The future of education at every level has become uncertain due to the mass closure of educational institutions and even universities. Medical education, especially undergraduate medical programs, has been significantly affected by the general and prolonged uncertainty[14].

Social distancing was one of the key measures recommended by the World Health Organization to prevent the spread of COVID-19, which was largely accepted on a global scale, resulting in schools being forced to close their doors. Such a drastic and sudden change resulting in changes to the traditional teaching and learning methods employed[15]. The closure of educational institutions and universities led to more intensive usage of what was largely considered innovative methods so as to ensure some degree of normality and continuity in national education systems[16, 17].

For example, distance learning, which was also a preferred method prior to the COVID-19 era, is just one of the innovative ways employed during the pandemic as compensation for lack of face-to-face learning, with classes conducted within online environments following university campuses having been vacated by their student populations. As a result, academicians began working from home offices, and the methods of clinical-based teaching changed significantly, resulting in the cancellation of many traditional assessment practices for medical students[18]. During this process, institutions attempted to continue educational activities remotely through the affordances of online technologies[19]. The pandemic also disrupted the traditional structure of medical education, which is predominantly structured as face-to-face learning. As a result, medical students experienced a largely unfamiliar learning process; while medical graduates started working with a clinical environment ,they too were unfamiliar with[20].

Due to the sudden imposed disruptions to medical education due to COVID-19, universities sought new methods for the continuance of medical education. A variety of work has been conducted in order to develop the medical education curriculum and to bring new online teaching methods into play so that some practical skills can be learned by medical students within an online environment[17, 21]. Due to the rapid spread of the virus in training and research hospitals, the lack of personal protective equipment, and concerns related to encountering asymptomatic cases, training in the pre-clinical curriculum shifted to online environments. Even students undertaking their hospital rotations had to complete clinical skill assessments and practices within a virtual environment[22-24]. However, online teaching was not totally new as it was already seen as an effective tool used in the education of medical students prior to the COVID-19 outbreak[25]. In addition, the popularity of virtual anatomical models and simulations used in medical education has increased owing to recent technological developments[26]. However, it is clear that the use of technology-supported tools and methods has increased considerably during the COVID-19 pandemic. In this context, asynchronous (e.g., pre recorded videos, podcasts) and synchronous (e.g., simultaneous live video conferences) distance education methods utilizing virtual classrooms quickly began to be used widely in online distance medical education[27].

It has been observed that many of the improvements in medical education have been developed and applied in the face of the largest health emergency in living memory and widespread difficulties experienced by all parties. During the COVID-19 pandemic, curriculum changes that focus on infection control, pandemic modeling, population, and public health issues have been added to the agenda[24, 28]. The rapid development and reorganization of available medical resources have also been one of the main focuses of these difficult times in order to prevent the spread of the coronavirus disease within communities, as a means to meeting the increasing patient burden, and to ensure the provision of adequate care to those who contracted the virus.

The ongoing nature of the COVID-19 outbreak has sharply increased the need for healthcare professionals on a global scale. To address these shortcomings, some countries have begun discussing the active role of medical students in combating the pandemic as a means of helping to overcome the crisis[29, 30]. Some medical students have been eager to take on additional, and new responsibilities in tackling the pandemic, whilst others have shared their concerns regarding the potential for infection,

and thus placing their families at significant risk[31]. According to Southworth & Gleason[32], rapid innovations have been seen in medical education, as well as in the evaluation of the educational changes brought about by the pandemic. While the implementation of technology-based learning has become a necessity very much during the pandemic, the advantages and potential obstacles warrant consideration and evaluation in greater detail. Online formats for the delivery of classes can undoubtedly provide ease of access to educational materials, as well as in the selection of time and location to receive the lesson[14].

Additionally, written exams in medical education have also been conducted online during the current crisis. However, despite these more obvious advantages, the greatest potential downside to online medical education is in communication. Developing interpersonal skills and confidence to communicate with patients, discuss patient care with colleagues, and present academic studies is a key skill that medical students need to develop from the outset of their medical education. Although video-based education can provide a good option for the enhancement of interactions during preclinical education, there are undoubtedly shortcomings to be recognized in this area[33].

In medical education, whether or not online teaching methods will become part of the solution in the pre-clinical stage of medical education, and to what degree virtual and simulation-based technology will be included in clinical education will no doubt become more clear in the future. However, it is possible to say that the COVID-19 pandemic has initiated a paradigm shift for the type of innovation mentioned here[14]. In addition, as the period of normalization begins following the COVID-19 pandemic, online teaching should not be considered as simply an emergency substitute for face-to-face clinical training within medical schools. In essence, the professional identities of medical school students cannot be solely developed within a virtual environment.

Therefore, educators must provide students with learning opportunities as well as practical role modeling within a real clinical setting[29]. It may therefore be considered beneficial to combine online lectures and webinars with face-to-face education in order to continue the benefits of increased real-time attendance during the early years of medical school. Despite the many benefits of online education, being a newly qualified doctor requires close attention to patients and spending time on the wards. It is possible that future clinical rotations may be limited with respect to crises such as another pandemic. From this perspective, alternative learning methods should continue to be developed so as to ensure that the next generation of physicians is adequately prepared to enter the profession[34, 35].

Consequently, it may be said that the COVID-19 pandemic has had profound implications on the planning of medical education, as well as on program execution and evaluation [36, 37].

During this period, although many articles on COVID-19 and medical education have been published, the number of bibliometric studies examining the relationship of these two issues from a holistic perspective have been very few in the relevant literature.

In addition, it has been observed that the scope of the current literature's bibliometric studies is limited regarding this issue. For this reason, the current study aimed to conduct a bibliometric analysis of scientific articles, with a focus on the relationship between COVID-19 and medical education, based on articles published in journals indexed in the Web of Science database. This study aims to inspire researchers in future studies by conducting a bibliometric analysis of the top 100 most-cited articles that examined the relationship between COVID-19 and medical education.

Within the framework of this general purpose, the sub-goals of the research can be expressed as follows:

• To identify the most frequently used keywords in the 100 most-cited articles with a focus on COVID-19-related medical education;

• To analyze journals that focused on COVID-19-related medical education and published the 100 most-cited articles;

• To examine the countries that contributed to the publication of the 100 most-cited articles that focused on COVID-19-related medical education and the cooperation between them:

• To reveal the research models used in the 100 most-cited articles that focused on COVID-19-related medical education;

• To examine the sample/working groups of the 100 most-cited articles that focused on COVID-19-related medical education;

• To identify the time-to-publication period of the 100 most-cited articles that focused on COVID-19-related medical education.

Material and methods

Study Design

The study constituted a bibliometric analysis of the top 100 most-cited scientific publications with a focus on COVID-19-related medical education. Bibliometric analyses define the research models of publications and also allow for in-depth content analysis[38]. The examination of the 100 articles with the most citations within the scope of the current research was reported according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

The PRISMA flowchart, as shown in Figure 1, presents the search flow in the determination and scanning of resources for analysis[39]. The criteria of the search conducted in the Web of Science Core Collection (WoSCC) bibliographic database according to the purpose of the research constitutes the limitations of the current study.

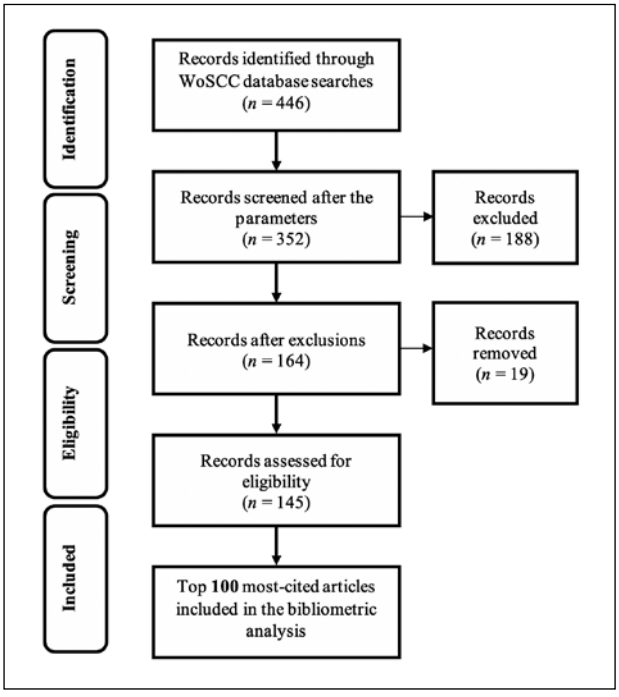

Figure 1: PRISMA search strategy flow diagram[39].

Data search and identification

The Web of Science Core Collection (WoSCC) bibliographic database was reviewed in order to identify publications that focused on COVID-19-related medical education and which had been published between January 1 and December 31, 2020. The data were obtained from the WoSCC bibliographic database on February 16, 2021, by determining publications focused on COVID-19-related medical education. The WoSCC bibliographic database covers a large number of high-quality international scientific journals with the highest impact factor and provides detailed and reliable information on articles: it is widely considered the primary database used in bibliometric research. (40,41) From this point of view, only publications from journals indexed in the WoS database were included in the current study.

The search query for the Web of Science (WoS) was the following: TS = ("covid" OR "COVID-19" OR "2019-nCoV" OR "COVID-19 pandemic" OR "SARS-CoV-2" OR "novel coronavirus" OR "SARS-COV") AND TS = ("medical education" OR "medical students" OR "medical staff" OR "medical school" OR "Academic medicine" OR "learning in medicine" OR "faculty of medicine" OR "medical Teacher" OR "Medical Student" OR "student of medicine"). In this context, these search criteria constitute the limitations of the current study.

Data extraction and data analysis

A total of 446 publications indexed in the WoSCC bibliographic database were identified in line with the purpose of the current study.

Of these publications, basic research articles, letters to editors, and review articles, etc. were included in the scope of the study. Considering a large number of articles included, the researchers conducted an in-depth review, identified the 100 most-cited publications, and created a separate dataset of these items in order to avoid possible mistakes. During this process, differences of opinion were discussed until a consensus was reached between the researchers, and expert opinion was sought were deemed necessary so as to reach an agreement.

Within the scope of the research, only the 100 most-cited publications that focused solely on COVID-19-related medical education were examined according to their subject (based on keywords), journal, country, method, sample/study group, and time-to-publication period.

The data obtained were analyzed according to bibliometric methodology[38-42], and content analysis[43-45]. Visualization maps were created using VOSviewer software,(46) and graphs from GraphPad Prism[47].

Results and discussion

A total of 446 articles was obtained within the scope of the current research, which were then ranked according to the number of citations they had

each amassed. The top 100 articles with a focus on COVID-19-related medical education (according to their having been cited the most) were analyzed in the context of different themes. The findings obtained were reported under different themes such as journals, countries, most frequently used keywords (subject), research model, sample/study group, and time-to-publication.

Figure 2 shows the monthly distribution of the 100 most-cited articles, the total number of publications per month, and the graphical representation of the average citations per article.

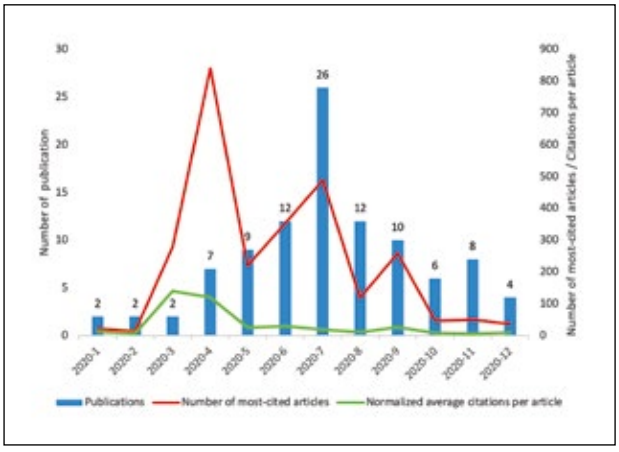

Figure 2: Descriptive characteristics of top 100 most-cited publications.

When Figure 2 is examined, it can be stated that the number of publications that focused on COVID-19-related medical education reached the highest level in July 2020, and that the number of publications had increased regularly over the preceding months. When we look at the citations of the published articles, it can be seen that the number of citations increased in parallel with the number of publications. According to the data presented in Figure 1, it is possible to say that the number of articles published on COVID-19-related medical education increased steadily and consistently.

Table 1 presents the distribution of journals in which the 100 most-cited articles were published. Accordingly, it can be seen that a significant majority of the articles were published in journals in the medical field: Medical Teacher (f = 7), Medical Education (f = 5), Academic Medicine (f = 5), Journal of Medical Education and Curricular Development (f = 4), and Cureus (f = 4).

Along with this, the co-occurrence network of journals where the 100 most-cited articles on COVID-19-related medical education were published is illustrated in Figure 3.

		Based on 100 most-cited articles			Based on all publications in each journal
Rank	Journal name	TP	TC	CPP	Journal Impact Factor™ (JIF)*
1	Medical Teacher	7	72	10.29	2.654
2	Medical Education	5	88	17.60	4.570
3	Academic Medicine	5	66	13.20	5.354
4	Journal of Medical Education & Curricular development	4	29	7.25	-
5	Cureus	4	120	30.00	-
6	JAMA: Journal of the American Medical Association	3	246	82.00	45.540
7	BMC Medical Education	3	39	13.00	1.831
8	Psychiatry Research	2	115	57.50	2.118
9	Neurosurgery	2	17	8.50	4.853
10	Medical Education Online	2	20	10.00	1.970
11	Lancet Infectious Diseases	2	83	41.50	24.446
12	Lancet	2	45	22.50	60.390
13	Indian Pediatrics	2	23	11.50	1.186
14	Frontiers in Public Health	2	32	16.00	2.483
15	Balkan Medical Journal	2	10	5.00	1.533
16	Annals of Medicine & Surgery	2	13	6.50	-
17	Annals of Internal Medicine	2	50	25.00	21.317
18	Anatomical Sciences Education	2	30	15.00	3.759
19	Academic Radiology	2	10	5.00	2.488

Table 1: Distribution of journals that published 100 most-cited articles.
*Notes: TP = Total publication; TC = Total citations; CPP = Citation per publication; Includes journals which published 2+ articles; *2019 data provided by Clarivate Analytics Journal Citation Reports (JCR).*

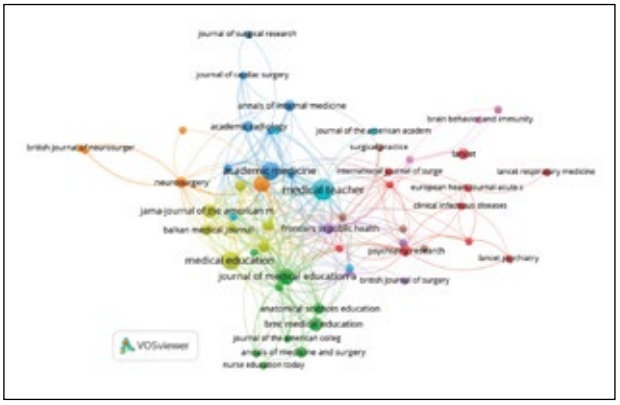

Figure 3: Co-occurrence network of journals which published 100 most-cited articles.

When Figure 3 is examined, it can be seen that the journals in which the 100 most-cited articles were published are each considered as prestigious journals and that these are published in the English

language, and each has a high impact factor. Fan et al[48]. stated that English is considered the worldwide language of communication accepted by the global scientific community.

For this reason, publications in well-known, high-level international journals are known to reach more researchers in less time, and that the data in these publications are disseminated further and therefore used in practical applications faster. During the early stages of the COVID-19 outbreak, most of the publications in China were published in the Chinese language. Müller et al[49]. stated that medical publications written in Chinese are not listed by some of the more comprehensive databases (for example, Pubmed), and therefore many such publications are not taken into consideration.Table 2 shows the contributions of various countries to the publication of the 100 most-cited articles and also the number of citations each has attracted since their initial publication. Accordingly, it can be said that the United States was the top contributor (37%) to the 100 most-cited articles on COVID-19-related medical education. Furthermore, the top three publishing countries on this topic were the United States, the United Kingdom, and China, which combined contributed to approximately 59% of the 100 most-cited articles. This finding indicates that these three countries have a larger place in the articles published on COVID-19-related medical education.

Country	Number of publications	Number of citations	Citation density
United States	37	796	21.51
United Kingdom	13	270	20.77
China	9	917	101.89
Singapore	7	68	9.71
Canada	5	51	10.20
India	5	52	10.40
Australia	3	22	7.33
Iran	3	109	36.33
Jordan	3	41	13.67
Saudi Arabia	3	37	12.33
Turkey	3	15	5.00

Table 2: Number of publications by country based on 100 most-cited publications.
Note: Includes countries that contributed to 3+ publications.

The collaboration network among the countries that contributed to the publication of the 100 most-cited articles that focused on COVID-19-related medical education within the scope of the current research is illustrated in Figure 4.

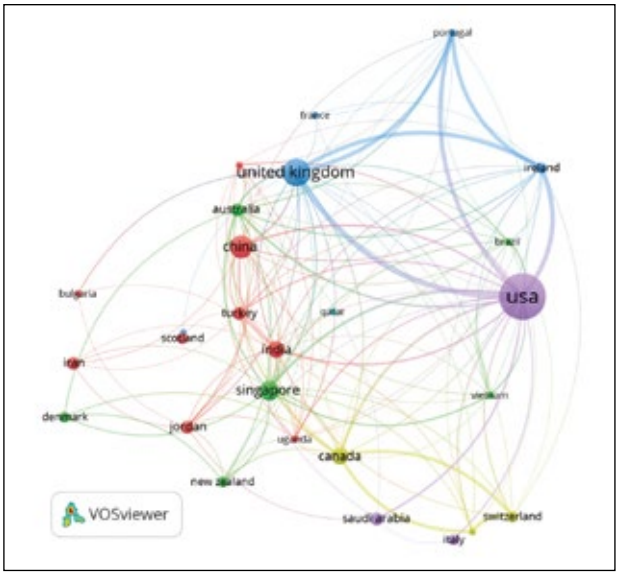

Figure 4: Collaboration network among countries based on number of publications.

When Figure 4 is examined, it can be determined that the 100 studies with the most citations were conducted by researchers from 27 different countries. In addition, the four countries with the highest number of researchers were the United States (f = 37), the United Kingdom (f = 13), China (f = 9), and Singapore (f = 7). It can also be seen that some of the studies were conducted with more than one researcher from different countries. In this context, whilst researchers from the Unites States worked with researchers from 16 different countries, those from the United Kingdom worked with colleagues from 11 other countries, Singapore with eight countries, and China with five countries. Researchers from the other 23 countries (India, Canada, Turkey, et al.) did not conduct studies with researchers from any other countries.

It was determined that the articles that focused on COVID-19-related medical education mostly originated from the United States, the United Kingdom, China, and Singapore. De Felice & Polimeni(50) stated not being surprised that the United States and China were among the most productive countries, having to contribute to the most articles on coronavirus research. Due to its economic strength and the largescale existing research infrastructure at its universities, the United States has played an active role in researching the prevention, control, diagnosis, and treatment of the potential global risks presented by the COVID-19 virus. The United States has been more successful in encouraging and participating in international collaborations due to adequate funding and resource availability, advanced equipment, and

skilled researchers, and also superior conditions for basic medical research or experimental trials[51]. In other bibliographic research on COVID-19 research, the prominent position of publications from the United States, China, and Europe is clearly demonstrated[52-55]. The results of a study by Pal[56] showed that the 100 most-cited publications were contributed by the United States and China, followed by Italy, England, India, France, Canada, and Germany.

The main common feature of these countries is that they have each been seriously affected by the COVID-19 outbreak. In another bibliometric study, Hossain[57] examined the cross-country co-authorship status of academics who collaborated on COVID-19 research. According to their findings, it was determined that the academics who cooperated the most internationally at a global level were from China, the United States, the United Kingdom, and Italy, respectively.

In the current study, the publications which focused on COVID-19-related medical education were examined in terms of subject distribution (according to the most frequently used keywords), and the findings are presented in Figure 5.

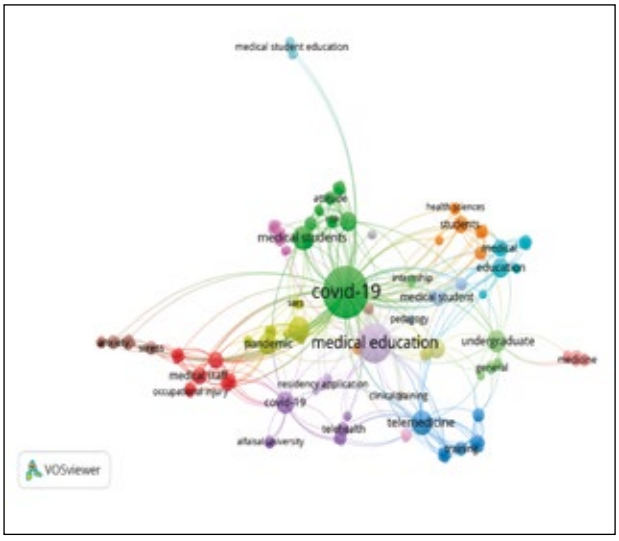

Figure 5: Co-occurrence network diagram of most frequent keywords.

As a result of the analysis made on the 100 published articles with the most citations, it was determined that a total of 180 different keywords were used in the 100 articles and that the most frequently used keywords other than "COVID-19" and "medical education" were "medical student" (f = 6), "telemedicine" (f = 6), "pandemic" (f = 5), "undergraduate" (f = 5), "e-learning" (f = 4), and "education" (f = 4). In addition, it was determined that the keyword "medical student" was associated with 23 different keywords, with some of these keywords is "knowledge," "online teaching," and "anatomical learning." It was determined that the keyword "telemedicine" was associated with 31 different keywords, including "training," "telehealth," and "clinical training."

The worldwide effect of the COVID-19 outbreak also led to significant changes in medical school curricula, especially in terms of content presentation and assessment[58, 59]. The disallowing of face-to-face meetings, conferences, lectures, and training, as well as the closure of simulation laboratories, further interrupted medical education[60,61].

Although "first-hand training" is considered to be a key concept in medical education, it has become difficult and risky to conduct such medical education in these negative conditions. For this reason, information technology tools such as distance learning, online education, telemedicine, pre-recorded (asynchronous) and live-streamed (synchronous) lectures, simulation tools, online collaboration, and discussion platforms have become widely used in order to address the disruptions to medical education during the COVID-19 outbreak[60, 62, 63]. Given the need for healthcare professionals in controlling the ongoing COVID-19 pandemic, e-learning has been adopted in many settings so as to ensure the continuity of medical education[64].

Although there have been few studies on the effectiveness of online courses in the clinical rotation setting, they could potentially be used to support traditional forms of teaching and learning. Technology has also impacted many other aspects of life over recent decades.

Therefore, the fact that technology has now entered the field of medical education is considered to be largely normal[65], and somewhat as an evolutionary inevitability. Studies on COVID-19 and medical education have stated that it is possible to reduce the spread of the virus through the use of online teaching-learning tools. For this reason, these tools, which are used to provide and support education in extraordinary conditions, have also been shown to be of help in protecting the health of both doctors, medical educators, as well as medical students themselves.

The findings obtained from analyzing the research methods employed in the 100 most-cited studies that focused on COVID-19-related medical education within the scope of the current research are presented in Table 3.

Publication type	Number of publications	Number of citations	Citation density
Theoretical studies*	70	1923	27.47
Empirical quantitative studies	25	762	30.48
Empirical qualitative studies	5	44	8.80
Mixed method studies	-	-	-

Table 3: Number of publications and citations by publication type.
**Theoretical studies include literature reviews, systematic reviews, and meta-analyses.*

When Table 3 is examined, it can be seen that three different methods were used in the 100 most-cited studies.

In this context, it was determined that 70 of the 100 were "theoretical studies," plus 25 "quantitative studies" and five "qualitative studies."

The findings of the current bibliometric study can be said to be consistent with other studies in the literature. As an example, Kaya & Erbay[66] stated that among the COVID-19 publications, there were mostly "theoretical studies" such as "editorial materials, early accesses, letters, and reviews." In bibliometric analyses conducted by Aristovnik, Ravšelj & Umek[67] and also by Hamidah, Sriyono & Hudha[68], the researchers indicated that "theoretical studies" such as "letters, reviews, notes, editorials" were quite common in the COVID-19 literature.

In China, where the COVID-19 virus first appeared, numerous publications were produced during the early days of the pandemic. As China was the country most affected by the COVID-19 pandemic at that time, the COVID-19 research conducted by their institutions significantly contributed to the early knowledge on the virus[55].

As science progresses cumulatively, each new study based on previous research results in a new development. Efforts spent on all types of studies are therefore considered to be of value, as all research activities contribute towards finding solutions to the key issues, and ultimately, to advance the science itself[66]. For this reason, research conducted on COVID-19, especially in the early stages of the pandemic when the properties of the virus were not yet known, made very important contributions to the scientific world.

Figure 6 illustrates a density visualization map of the sample/study group of the 100 most-cited articles examined within the scope of the current research.

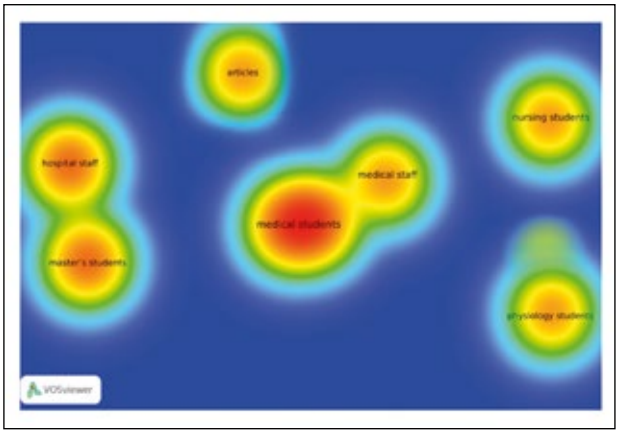

Figure 6: Density visualization map of sample/study group in 100 most-cited publications.

According to the findings illustrated in Figure 6, it was determined that medical students (f = 22) were predominantly included in samples in the 100 most-cited articles, followed by medical staff (f = 2), and nursing students (f = 2).

Furthermore, when all the studies within the scope of the current research are evaluated, it can be stated that seven different sample types were preferred in total. Since the first moment that COVID-19 was identified, medical students and healthcare professionals have been at significantly higher risk of contracting the virus due to the frontline, patient-centric nature or their work[69]. Therefore, it may be said that COVID-19 has affected medical students and healthcare professionals more than other groups. In this context, various studies have been conducted that have examined the psychological conditions experienced by healthcare workers due to COVID-19[70-73]. In the current study, topics covered the most in studies in which medical students were sampled included distance medical education, medical education curriculum, problems in distance education, as well as measurement and evaluation in distance education.

Within the scope of the current research, the time-to-publication period of the 100 most-cited studies was analyzed, and the findings are presented in Figure 7. At this stage, the period between the submission date of each study to the publisher and the subsequent actual publication date was determined in order to determine the time-to-publication period of the articles.

Of the examined 100 most-cited articles, only 45 included both an article submission date and a subsequent publication date. In light of the findings illustrated in Figure 7, it was considering the editorial (referee/blind review) and publication

processes of the 100 most-cited articles, those published the quickest (f = 20) had between 1 and 10 days from submittal to publication, whereas others were published over periods varying from 11 up to 135 days. The average time-to-publication of the articles that included publication dates (f = 45) within the scope of the current study was determined as 9 days. In a study conducted by Helliwell et al[74]. it was determined that the time-to-publication period of studies related to COVID-19 that were published between November 1, 2019, and March 24, 2020, was an average of just 5 days.

According to Horbach[75], the rapid dissemination of relevant scientific knowledge has great importance in times of widespread crises affecting whole societies, which includes the current COVID-19 outbreak. In a study that examined the publication process of 14 medical journals both during and prior to the COVID-19 pandemic, it was concluded that medical journals tremendously accelerated the publication processes for articles related to coronavirus.

As a result of the shortened editorial evaluation periods of these journals, the time between article submission and subsequent publication decreased by 49% on average.

However, the same research also revealed that no change was seen in the time-to-publication period for articles not related to COVID-19. However, the unusually fast-paced road to publication whilst beneficial for the faster dissemination of information, can also raise concerns about the legitimacy and robustness of the peer review process, and as a result, the quality of the resulting publications which may have been unusually rushed through review in order to achieve rapid publication. Horbach[75], Karakose et al[76]. and also Homolak, Kodvanj & Virag[77] claimed that there was a period of intense scientific knowledge being produced in the early stages of the COVID-19 outbreak, but that serious issues emerged in terms of the reliability and usability of the published information.

In this context, Boschiero et al.[78] also stated that some of the swiftly published publications on COVID-19 have since been withdrawn. It has been stated that these withdrawals may have negative consequences, especially for public and health policies that may have used or applied the "findings" or "recommendations" found in published works, and may therefore result in the rejection of evidence-based medicine by local or national governments, as seen since in the case of Brazil.

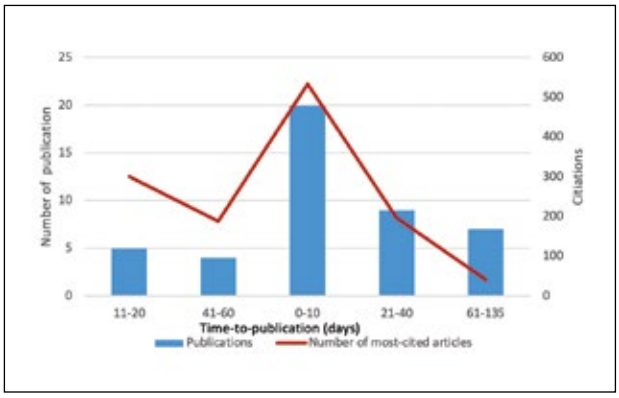

Figure 7: Distribution of time-to-publication period for 100 most-cited publications.

Conclusion

The current research covers the bibliometric analysis of published articles that focused on COVID-19-related medical education from a broad perspective. In this context, examining the thematic structures of the 100 most-cited articles may present an opportunity to view and more clearly assess the impact of COVID-19 on medical education. In the publications included within the study's scope, it was observed that the education of medical students, online learning, and distance education were intensively studied.

However, when the relevant literature was examined in detail, it can be seen that the number of studies that focused on the psychosocial and socioeconomic effects of the COVID-19 pandemic on medical students has clearly been insufficient. Therefore, further research on the psychological and social effects of COVID-19 may help to compensate for the insufficient level of current literature in this area. Another important point that can be deduced for researchers wanting to focus on this topic in the future, based on the results of the current study, may be related the research methods seen in the current literature.

Whilst there have been numerous theoretical and review articles written on the subject of COVID-19, researchers opting in the future to conduct empirical studies within this field according to qualitative, quantitative, or mixed methods based on evidence will significantly help contribute to increasing the reliability of the results published in this area of research.

In addition, identifying the current research trends in these articles and revealing the most preferred methods may help to guide researchers in future studies on similar subjects.

Limitations and future directions

Although the current study revealed important findings from the analysis of articles that focused on COVID-19-related medical education, it also undoubtedly has certain limitations. Within the scope of the research, analyses were conducted that took into account the 100 most-cited publications that examined the relationship between COVID-19 and medical education in the WoSCC bibliographic database. However, in order to evaluate the relationship between COVID-19 and medical education from a much broader perspective, it may be useful to conduct more comprehensive reviews involving other databases such as SCOPUS, PubMed, or Google Scholar, etc. Furthermore, it may be recommended to conduct scientific studies using qualitative, quantitative, or mixed research methods on larger samples/study groups so as to analyze the possible effects of COVID-19 on medical education in greater detail.

References

1) Fino E, Martoni M, Russo PM. Specific mindfulness traits protect against negative effects of trait anxiety on medical student wellbeing during high-pressure periods. Adv in Health Sci Educ 2021; 1-17.
2) de Andres Crespo M, Claireaux H, Handa AI. Medical students and COVID-19: lessons learnt from the 2020 pandemic. Postgrad Med J 2021; 97: 209-210.
3) Karakose T. Global Education in the shadow of the novel coronavirus: Reflections on the impact of COVID-19 outbreak on education systems. Ed Process Int J 9(4): 201-204.
4) Abbas J. Crisis management, transnational healthcare challenges and opportunities: The intersection of COVID-19 pandemic and global mental health. Research in Globalization 2021; 100037.
5) Doganer A, Zhang ZJ. An Infodemiological Analysis of Google Trends in COVID-19 Outbreak: Predict Case Numbers and Attitudes of Different Societies. J Database Manage 2021; 32(2): 1-19.
6) Karakose T, Malkoc N. Behavioral and interpersonal effects of the COVID-19 epidemic on frontline physicians working in Emergency Departments (EDs) and Intensive Care Units (ICUs). Acta Medica Mediterr 2021a; 37: 437-444.
7) Mahase E. Covid-19: WHO declares pandemic because of "alarming levels" of spread, severity, and inaction. Bmj 2020; 368.
8) Rajab MH, Gazal AM, Alkattan K. Challenges to online medical education during the COVID-19 pandemic. Cureus 2020; 12(7): e8966.
9) Velavan TP, Meyer CG. The COVID-19 epidemic. Trop Med Int Health 2020; 25(3): 278-280.
10) Storr VH, Haeffele S, Lofthouse JK, Grube LE. Essential or not? Knowledge problems and COVID-19 stay-at-home orders. South Econ J 2021; 87: 1229-1249.
11) Paules CI, Marston HD, Fauci AS. Coronavirus infections-more than just the common cold. Jama 2020; 323(8): 707-708.
12) Karakose T. The impact of the COVID-19 epidemic on higher education: Opportunities and implications for policy and practice. Ed Process Int J 2021; 10(1): 1-7.
13) Karakose T, Demirkol M. Exploring the emerging COVID-19 research trends and current status in the field of education: A bibliometric analysis and knowledge mapping. Ed Process Int J 2021; 10(2): 7-27.
14) Sahi PK, Mishra D, Singh T. Medical education amid the COVID-19 pandemic. Indian pediatr 2020; 57(7): 652-657.
15) Adedoyin OB, Soykan E. Covid-19 pandemic and online learning: the challenges and opportunities. Interact Learn Envir 2020; 1-13.
16) Bolatov AK, Seisembekov TZ, Askarova AZ, Baikanova R.K, Smailova DS, Fabbro E. Online-learning due to COVID-19 improved mental health among medical students. Med.Sci.Educ 2021; 31(1): 183-192.
17) Sandhu P, de Wolf M. The impact of COVID-19 on the undergraduate medical curriculum. Med Educ Online 2020; 25(1): 1764740.
18) Torda A. How COVID-19 has pushed us into a medical education evolution. Intern Med J 2020; 50(9): 1150-1153.
19) Tengiz F, Koç EM. COVID-19 Pandemi Dönemi İzmir Katip Çelebi Üniversitesi Tıp Fakültesi Eğitim Öğretim Deneyimi. Tıp Eğitimi Dünyası 2021; 20: 67-71.
20) Hilburg R, Patel N, Ambruso S, Biewald MA, Farouk SS. Medical education during the COVID-19 pandemic: learning from a distance. Adv Chronic Kidney Dis 2020; 27(5): 412-417.
21) Kopp AR, Rikin S, Cassese T, Berger MA, Raff AC. Gendlina I. Medical student remote eConsult participation during the COVID-19 pandemic. BMC Med Educ 2021; 21(1): 1-10.
22) Byrnes YM, Civantos AM, Go BC, McWilliams, TL, Rajasekaran K. Effect of the COVID-19 pandemic on medical student career perceptions: a national survey study. Med Educ Online 2020; 25(1): 1798088.
23) Rose S. Medical student education in the time of COVID-19. Jama 2020; 323(21): 2131-2132.
24) Wayne DB, Green M, Neilson EG. Medical education in the time of COVID-19. Science Advances 2020; 6(31): 1.
25) Birch E, de Wolf M. A novel approach to medical school examinations during the COVID-19 pandemic. Med Edu Online 2020; 25(1): 1785680.
26) Zhang X, Yang J, Chen N, Zhang S, Xu Y, Tan L. Modeling and simulation of an anatomy teaching system. Vis. Comput Ind Biomed Art 2019; 2(1): 1-8.
27) Papapanou M, Routsi E, Tsamakis K, Fotis L, Marinos G, Lidoriki I, ... & Schizas D. Medical education challenges and innovations during COVID-19 pandemic. Postgrad Med J 2021; 140032.

28) Rubin EJ, Harrington DP, Hogan JW, Gatsonis C, Baden LR, Hamel MB. The urgency of care during the Covid-19 pandemic - Learning as we go. N Engl J Med 2020; 382: 2461-2462.
29) Klasen JM, Meienberg A, Bogie BJ. Medical student engagement during COVID-19: Lessons learned and areas for improvement. Med Educ 2020; 55(1): 115-118.
30) Michno DA, Tan J, Adelekan A, Konczalik W, Woollard ACS. How can we help? Medical students' views on their role in the COVID-19 pandemic. J Public Health-UK 2021; 1-11.
31) Gallagher TH, Schleyer AM. "We signed up for this!"-student and trainee responses to the COVID-19 pandemic. N Engl J Med 2020; 382: e96.
32) Southworth, E. & Gleason, S. H. (2021). COVID 19: A cause for pause in undergraduate medical education and catalyst for innovation. Hec Forum 33, 125-142.
33) Raymond-Hayling O. What lies in the year ahead for medical education? A medical student's perspective during the COVID-19 pandemic. Med Educ Online 2020; 25(1).
34) Nic Dhonncha E, Murphy M. Learning new ways of teaching and assessment: the impact of COVID-19 on undergraduate dermatology education. Clin Exp Dermatol 2021; 46(1): 170-171.
35) Hammond D, Louca C, Leeves L, Rampes. Undergraduate medical education and Covid-19: engaged but abstract. Med Educ Online 2020; 25(1).
36) Sabzwari S. Rethinking assessment in medical education in the time of COVID-19. Med Ed Publish 2020; 9.
37) Sandars J, Patel R. The challenge of online learning for medical education during the COVID-19 pandemic. Int J Med Educ 2020; 11: 169-170.
38) Diem A, Wolter SC. The use of bibliometrics to measure research performance in education sciences. Res High Educ 2013; 54(1): 86-114.
39) Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009; 6: e1000097.
40) Aggarwal A, Lewison G, Idir S, Peters M, Aldigee C, Boerckel W,…Sullivan R. The state of lung cancer research: a global analysis. J Thorac Oncol 2016; 11(7): 1040-1050.
41) Zhai X, Cui J, Shao J, Wang Q, Chen X, Wei X,…Li M. Global research trends in spinal ultrasound: a systematic bibliometric analysis. BMJ Open 2017; 7(10): e015317.
42) Zou X, Yue W L, Vu HL. Visualization and analysis of mapping knowledge domain of road safety studies. Accident Anal Prev 2018; 118: 131-145.
43) Corbin JM, Strauss A. Basics of qualitative research: techniques and procedures for developing grounded theory (3rd ed.). 2008, Thousand Oaks, CA: Sage.
44) Köhler T., Stemmler M. Normative versus impassive configure frequency analysis in personality research -their use discussed in a reanalysis of data on situation-bound anxiety. Eur J Personality 1997; 11(1): 69-79.
45) Yildirim A, Simsek H. Qualitative research methods in the social sciences. Ankara, Turkey: Seckin, 2013.
46) Van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics 2010; 84: 523-538.
47) GraphPad Prism [Computer software]. La Jolla, 2020; CA: GraphPad SoftwareInc. Retrieved from http://www.graphpad.com/scientific-software/prism/.
48) Fan J, Gao Y, Zhao N, Dai R, Zhang H, Feng X, ... , Bao S. Bibliometric analysis on COVID-19: a comparison of research between English and Chinese studies. Front Public Health 2020; 8: 477.
49) Müller SM, Mueller GF, Navarini AA, Brandt O. National publication productivity during the covid-19 pandemic-a preliminary exploratory analysis of the 30 countries most affected. Biology 2020; 9(9): 271-283.
50) De Felice F, Polimeni A. Coronavirus Disease (COVID-19): A Machine learning bibliometric analysis. in vivo 2020; 34(3 suppl): 1613-1617.
51) Tao Z, Zhoui S, Yao R, Wen K, Da W, Meng Y, Yang K, Liu H, Tao L. COVID-19 will stimulate a new coronavirus research breakthrough: a 20-year bibliometric analysis. Ann Transl Med 2020; 8: 5-28.
52) Nasab FR, Rahim F. Bibliometric analysis of global scientific research on SARSCoV-2 (Covid-19). MedRxiv 2020; 1-27.
53) Sa'ed HZ, Al-Jabi SW. Mapping the situation of research on coronavirus disease-19 (COVID-19): a preliminary bibliometric analysis during the early stage of the outbreak. BMC Infect Dis 2020; 20(19: 1-8.
54) Tran BX, Ha GH, Nguyen LH, Vu GT, Hoang MT, Le HT, ... Ho R. Studies of novel coronavirus disease 19 (COVID-19) pandemic: a global analysis of literature. Int J Environ Res Public Health 2020; 17(11): 4095.
55) Wang P, Tian D. Bibliometric analysis of global scientific research on COVID-19. J Biosafety and Biosecurity 2021; 3(1): 4-9.
56) Pal JK. Visualizing the knowledge outburst in global research on COVID-19. Scientometrics 2021; 3: 1-21.
57) Hossain MM. Current status of global research on novel coronavirus disease (Covid-19): A bibliometric analysis and knowledge mapping. F1000Research 2020; 9: 374-388.
58) Monaghan AM. Medical Teaching and Assessment in the Era of COVID-19. J Med Educ Curric Dev 2020; 7: 1-3.
59) Richardson MA, Islam W, Magruder M. The Evolving Impact of COVID-19 on Medical Student Orthopedic Education: Perspectives from Medical Students in Different Phases of the Curriculum. Geriatr Orthop Surg Rehabil 2020; 11:1-5.
60) Chatterjee I, Chakraborty P. Use of information communication technology by medical educators amid covid-19 pandemic and beyond. J Educ Technol Syst 2020; 49(3): 310-324.
61) Chick RC, Clifton GT, Peace KM, Propper BW, Hale DF, Alseidi AA, Vreeland TJ. Using technology to maintain the education of residents during the COVID-19 pandemic. J Surg Educ 2020; 77(4): 729-732.
62) Ashokka B, Ong, SY, Tay K H, Loh N, Gee CF, Samarasekera DD. Coordinated responses of academic medical centres to pandemics: Sustaining medical education during COVID-19. Med Teach 2020; 42: 762-771.
63) Jervis CG., Brown LR. The prospects of sitting 'end of year' open book exams in the light of COVID-19: A medical student's perspective. Med Teach 2020; 42(7): 830-831.
64) Olum R, Atulinda L, Kigozi E, Nassozi DR, Mulekwa A, Bongomin F, Kiguli S. Medical education and e-learning during covid-19 pandemic: awareness, attitudes, preferences, and barriers among undergraduate medicine and nursing students at makerere university, Uganda. J Med Educ Curric Dev 2020; 7:1-9.

65) Kronenfeld JP, Ryon EL, Kronenfeld DS, Hui VW, Rodgers SE, Thorson CM, Sands LR. Medical Student Education During COVID-19: Electronic Education Does Not Decrease Examination Scores. Am Surg 2020; 0: 1-7.
66) Kaya M, Erbay, E. Global Trends of the Researches on COVID-19: A Bibliometric Analysis via VOSviewer. Ankara Sağlık Bilimleri Dergisi 2020; 9(2): 201-216.
67) Aristovnik A, Ravšelj D, Umek L. A bibliometric analysis of COVID-19 across science and social science research landscape. Sustainability 2020; 21: 9132.
68) Hamidah I, Sriyono S, Hudha MN. A Bibliometric analysis of Covid-19 research using VOSviewer. Indones J Sci Technol 2020; 5(2): 209-216.
69) Taghrir MH, Borazjani R, Shiraly R. COVID-19 and Iranian medical students; a survey on their related-knowledge, preventive behaviors and risk perception. Arch Iran Med 2020; 23(4): 249-254.
70) Guo J, Liao L, Wang B, Li X, Guo L, Tong Z, ...,Gu Y. Psychological effects of COVID-19 on hospital staff: a national cross-sectional survey of China mainland. Available at SSRN 3550050. 2020.
71) Karakose T, Malkoc N. Psychological impact of the COVID-19 pandemic on medical doctors in Turkey. Soc Behav Pers 2021b; 49(1): 1-10.
72) Simione L, Gnagnarella C. Differences between health workers and general population in risk perception, behaviors, and psychological distress related to COVID-19 spread in Italy. Front Psychol 2020; 11: 1-17.
73) Tan BY, Chew NW, Lee GK, Jing M, Goh Y, Yeo LL, ... , Sharma VK. Psychological impact of the COVID-19 pandemic on health care workers in Singapore. Ann Intern Med 2020; 173(4): 317-320.
74) Helliwell JA, Bolton WS, Burke JR, Tiernan JP, Jayne DG, Chapman SJ. Global academic response to COVID-19: Cross-sectional study. Learned Publ 2020; 33(4): 385-393.
75) Horbach SP. Pandemic publishing: Medical journals strongly speed up their publication process for COVID-19. Quant Sci Stud 2020; 1(3): 1056-1067.
76) Karakose T, Yirci R, Basyigit H, Kucukcakir A. Investigation of associations between the effects of COVID-19 fear on school administrators and nutrition and problematic eating behaviors. Prog Nutr2021; 23(2): e2021187.
77) Homolak J, Kodvanj I, Virag D. Preliminary analysis of COVID-19 academic information patterns: a call for open science in the times of closed borders. Scientometrics 2020; 124(3): 2687-2701.
78) Boschiero MN, Carvalho TA, de Lima Marson FA. Retraction in the era of COVID-19 and its influence on evidence-based medicine: is science in jeopardy?. Pulmonology 2021; 27: 97.

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