

REVIEW ARTICLE

Bibliometric Analysis on Medical Education During Covid-19 Pandemic

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ABSTRACT

Medical education encompasses vast topics related to teaching-learning, among medical students. Bibliometric analysis is a scientific method to review properties of academic publications using quantitative statistical techniques. Aim of this study is to provide a bibliometric analysis of scholarly publications specifically on medical education related topics during the COVID-19 pandemic. The relevant documents on medical education were obtained from the Scopus database. Database search performed on 20th March 2022 and analysed using Microsoft Excel 365, VOSviewer and Harzing's Publish or Perish. A total of 1436 documents were retrieved from Scopus database, left with 782 documents after filtering. For the past 2 years, the total citations received are 4974, while 44% of the documents were never cited. The most productive journal is BMC Medical Education. Most cited article is entitled: Medical Student Education in the Time of COVID-19 published in 2020. Most frequently used author keyword is covid-19. Visualisation on citation analysis among countries reveal the strongest link by United States of America with other countries. The current study provides a bibliometric perspective on the available medical education related publications in addressing issues related to covid-19 that is useful to guide them in considering possible future studies. Malaysian Journal of Medicine and Health Sciences (2022) 18(14)1-9. doi:10.47836/mjmhs18.s14.13

Keywords: Teaching, Learning, Assessments, Medical students, Covid-19

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INTRODUCTION

Medical education in essence refers to the training of one to become a doctor/specialist. However, the overly simplified statement does not do justice to the inevitable vast scope of what medical education encompasses. As such, any subjects that are related to the process of training and issues faced in the curriculum involving the trainer, the trainee as well as the patient can fall under medical education. There are just too many topics that fall under the scope of medical education. However, some clear examples include curriculum, medical schools, postgraduate education, psychology, teaching, learning, assessment, performance, student selection and feedback.

The start of covid-19 pandemic is as declared by World Health Organisation (WHO) on 11th March 2020 (1). Changes in implementation of medical curriculum which

requires innovations and creative ways of overcoming the restrictions imposed during the pandemic has forced medical educators around the world to experience new ways of conducting teaching and learning and assessments in the interest of medical education. The abundance of research on the topic published to serve as a guidance and sharing of experiences and challenges in facing the medical education related issues during pandemic (2,3,4), help medical educators to find the best solution that best fits their medical program.

Merriam-Webster dictionary defines bibliometric as the application of statistical methods to the study of bibliographic data (5). Bibliometrics can be used to get an overview of a new research area, to locate potential collaborators – authors, institutions, countries (6). Citation data for bibliometrics analysis can be obtained from Web of Science (Clarivate Analytics), Scopus (Elsevier) and Google Scholar. Traditionally, bibliometrics refers to the number of times a research paper is cited, compare it against other publications in the same field. However, as bibliometric is gaining popularity, various metrics are now being developed

to provide more impactful information to researchers. In this study, focusing on medical education research during covid-19, bibliometric analysis helps to map out the prominent researchers, research themes, countries, relevant journal titles while hinting on popular topics that are of concern among medical educationists globally concerning issues related to covid-19 that more research carried out and being cited in those particular topics. Understanding this landscape will certainly guide future research in this area to address current and relevant research questions.

Hence, the current research aims to answer several research questions which are 1) how many documents related to medical education (specifically focusing on teaching, learning and assessment) during covid-19 have been published? 2) who are the most productive authors for that topic? 3) what are the most influential articles? 4) what are the most often used keywords by authors? 5) how does citation among countries look like? 6) what is the network pattern of co-authorship among authors? Thus, by answering these questions, future researchers in medical education could benefit by i) knowing the key players in medical education, in special topics of interest, ii) understanding various perspectives of what makes an article impactful

MATERIALS AND METHODS

Data source and search strategy

The database selected for this study is Scopus database and search was performed on 20th March 2022. Selection of search keywords are based on 3 parts which are i) population ii) area of study and iii) period of interest. Population of interest include keywords that depict the students in medical program and its synonyms. Area of study includes the keyword medical education in general and specifically for teaching, learning, assessment and its synonym. The period of interest include keywords that portray the time of the covid-19 pandemic. The search keywords used in article title, abstract and keywords in this study were *"medical stud*" OR "medicine stud*" OR "MBBS stud*" AND "medical education" OR teaching OR learning OR assessment OR "academic performance" OR performance AND "covid-19" OR covid19 OR coronavirus OR pandemic*. Search was limited to the period of January 2020 - 20th March 2022. Scopus database offers the advantage of performing several analytical functions such as 'document type'. Document type allowed to refine retrieval of publications based on types of documents whether it was journal article, books, book chapters. In this study, exclusion criterion was the document type other than journal articles and reviews. There is no exclusion criterion for language as documents in all languages were retrieved for analysis. Documents at all publication stage whether in final or article in press were included. A total of 1436 documents

were retrieved. Author then manually screened the title, keyword and abstracts to check the paper's relevancy to the scope and topic of the study and excluded 654 documents. The screening resulted in 782 documents to be further analysed.

Data analysis

Basic summaries were obtained from Microsoft Excel 365, detailed citation metrics and H-index were from free software called Harzing's Publish or Perish while visualisation of the citation analysis and co-authorships was done by VOSviewer. Citescore 2021, Scientific Journal Ranking (SJR) and Source-Normalised Impact per Paper (SNIP) were obtained from Scopus website. Citescore is an annual value, calculated by Scopus to measure the citation impact of a title (i.e. conference proceeding, journal, book series). SNIP scores are the ratio of a source's average citation count and 'citation potential'. SNIP enables direct comparison between fields of research.

RESULT

A search in Scopus database on 20th March 2022 returned 1436 documents. After filtering, the final number of documents for further analysis is 782, which consist of 710 articles and 72 reviews published between Jan 2020 – 20th March 2022, by 3949 authors in 160 scholar sources as shown in Table I – V. Number of documents published in 2020, 2021 and 2022 are 165 (21.1%), 516 (65.9%) and 101 (12.9%) respectively. In Table I, citation metrics showed that even within a short period of 2 years, there were already 782 documents produced for this topic and received very high total citations with an average of 2487 citations per year and 6.36 citations per paper. Percentage of citations for the documents of each publication year is 84.8%, 559% and 13.9% for 2020, 2021 and 2022 respectively.

Table I. Citation Metrics

Metrics	Data
Publication years	2 (2020-2022)
Citation years	2 (2020-2022)
Papers	782
Citations	4974
Citations/year	2487
Citations/paper	6.36
h-index	32
g-index	57

Most productive authors

Among 3949 authors involved in these publications, the most productive authors on this topic with 4 – 5 documents and total citations ranging from 9 – 43 are as shown in Table II.

Table II. Most Productive Authors

Author	TP	TC	h-index	Publication Year	Source Title
Lee, Y.M.	5	9	2	2021	Primary Care Diabetes
				2021	Korean Journal of Medical Education
				2021	Asia Pacific Scholar
				2021	Journal of Korean Medical Science
Guse, J.	4	15	2	2020	Korean Journal of Medical Education
				2021	Frontiers in Psychology
				2021	BMJ Open
				2021	Frontiers in Education
Park, H.	4	9	2	2020	GMS Journal for Medical Education
				2021	Primary Care Diabetes
				2021	Korean Journal of Medical Education
				2021	Asia Pacific Scholar
Sam, A.H.	4	23	2	2020	Korean Journal of Medical Education
				2022	Advances in Health Sciences Education
				2021	Clinical Teacher
				2021	Advances in Medical Education and Practice
Wang, W.	4	43	2	2020	Medical Education
				2022	Journal of Economic Behaviour and Organisation
				2021	BMC Medical Education
				2021	Medical Education Online
Wu, H.	4	43	2	2020	BMJ Open
				2022	Journal of Economic Behaviour and Organisation
				2021	BMC Medical Education
				2021	Medical Education Online
				2020	BMJ Open

Notes: TP=total number of publications; TC=total citations

In Table III, ten source titles were listed as the most active journals in publishing medical education related topics in covid-19 with total publication ranging from 11 - 59 documents and citations ranging from 26 – 607. Of these 10 source titles, BMC Medical Education has published the most with 59 documents. However, among the listed ten source titles, Anatomical Sciences Education appears to be leading in Cite Score 2021 with only 11 documents receiving high total citations of 189.

Table III. Most Active Source Title

Source Title	TP	TC	Publisher	Cite Score 2021	SJR 2020	SNIP 2020
BMC Medical Education	59	607	BioMed Central Ltd	3.7	0.809	1.651
GMS Journal for Medical Education	32	66	German Medical Science Publishing House	1.8	0.543	1.111
JMIR Medical Education	22	154	JMIR Publications Inc.	3.8	n/a	1.732
Medical Science Educator	21	113	Springer	0.9	0.257	0.329
Academic Medicine	20	166	Lippincott Williams & Wilkins	6.7	1.998	2.595
Medical Education Online	17	79	Taylor and Francis Ltd	4.7	1.00	2.149
International Journal of Environmental Research and Public Health	15	47	MDPI	4.4	0.747	1.356
PLoS ONE	15	156	Public Library of Science	5.5	0.990	1.349
Advances in Medical Education and Practice	12	26	Dove Medical Press Ltd	2.8	n/a	1.293
Anatomical Sciences Education	11	189	John Wiley and Sons Inc	8.4	1.126	2.490

Notes: TP=total number of publications; TC=total citations

Most influential articles

From 782 documents, 20 most influential documents which received highest citations are presented in Table IV with details such as authors, article title, publication year, cites and cites per year. The most highly cited article which received 569 citations is entitled “Medical Student Education in the Time of COVID-19” by a single author published in 2020 and has an average of 284.50 cites per year.

Table IV. Most influential (highly cited) articles

No.	Authors	Title	Year	Cites	Cites per Year
1	Rose S.	Medical Student Education in the Time of COVID-19 (7)	2020	569	284.50

CONTINUE

Table IV. Most influential (highly cited) articles (cont.)

No.	Authors	Title	Year	Cites	Cites per Year
2	Dedeilia A., Sotiropoulos M.G., Hanrahan J.G., Janga D., Dedeilias P., Sideris M.	Medical and surgical education challenges and innovations in the COVID-19 era: A systematic review (8)	2020	179	89.50
3	Longhurst G.J., Stone D.M., Duloherly K., Scully D., Campbell T., Smith C.F.	Strength, Weakness, Opportunity, Threat (SWOT) Analysis of the Adaptations to Anatomical Education in the United Kingdom and Republic of Ireland in Response to the Covid-19 Pandemic (9)	2020	130	65.0
4	Abbasi S., Ayoob T., Malik A., Memon S.I.	Perceptions of students regarding e-learning during covid-19 at a private medical college (10)	2020	126	63.0
5	Choi B., Jegatheeswaran L., Minocha A., Alhilani M., Nakhoul M., Mutengesa E.	The impact of the COVID-19 pandemic on final year medical students in the United Kingdom: A national survey (11)	2020	124	62.0
6	Khalil R., Mansour A.E., Fadda W.A., Almisnid K., Aldamegh M., Al-Nafeesah A., Alkhalifah A., Al-Wutayd O.	The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: A qualitative study exploring medical students' perspectives (12)	2020	123	61.50
7	Dost S., Hossain A., Shehab M., Abdelwahed A., Al-Nusair L.	Perceptions of medical students towards online teaching during the COVID-19 pandemic: A national cross-sectional survey of 2721 UK medical students (13)	2020	119	59.50
8	Al-Balas M., Al-Balas H.I., Jaber H.M., Obeidat K., Al-Balas H., Aborajooh E.A., Al-Taher R., Al-Balas B.	Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: Current situation, challenges, and perspectives (14)	2020	99	49.50

CONTINUE

Table IV. Most influential (highly cited) articles (cont.)

No.	Authors	Title	Year	Cites	Cites per Year
9	Alsoufi A., Alsuyihili A., Msherghi A., Elhadi A., Atiyah H., Ashini A., Ashwieb A., Ghula M., Ben Hasan H., Abudabuos S., Alameen H., Abokhdhir T., Anaiba M., Nagib T., Shuwayyah A., Benothman R., Arrefae G., Alkhwayildi A., Alhadi A., Zaid A., Elhadi M.	Impact of the COVID-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning (15)	2020	88	44
10	O'Byrne L., Gavin B., McNicholas F.	Medical students and COVID-19: The need for pandemic preparedness (16)	2020	82	41
11	Liang Z.C., Ooi S.B.S., Wang W.	Pandemics and Their Impact on Medical Training: Lessons from Singapore (17)	2020	82	41
12	Moszkowicz D., Duboc H., Dubertret C., Roux D., Bretagnol F.	Daily medical education for confined students during coronavirus disease 2019 pandemic: A simple videoconference solution (18)	2020	73	36.5
13	Wilcha R.-J.	Effectiveness of virtual medical teaching during the COVID-19 crisis: Systematic review (19)	2020	71	35.5
14	Meo S.A., Abukhalaf A.A., Alomar A.A., Sattar K., Klonoff D.C.	Covid-19 pandemic: Impact of quarantine on medical students' mental wellbeing and learning behaviors (20)	2020	71	35.5
15	Iwanaga J., Loukas M., Dumont A.S., Tubbs R.S.	A review of anatomy education during and after the COVID-19 pandemic: Revisiting traditional and modern methods to achieve future innovation (21)	2021	64	64

CONTINUE

Table IV. Most influential (highly cited) articles (cont.)

No.	Authors	Title	Year	Cites	Cites per Year
16	Hilburg R., Patel N., Ambruso S., Biewald M.A., Farouk S.S.	Medical Education During the Coronavirus Disease-2019 Pandemic: Learning From a Distance (22)	2020	60	30
17	Baticulon R.E., Sy J.J., Alberto N.R.I., Baron M.B.C., Mabulay R.E.C., Rizada L.G.T., Tiu C.J.S., Clarion C.A., Reyes J.C.B.	Barriers to Online Learning in the Time of COVID-19: A National Survey of Medical Students in the Philippines (23)	2021	48	48
18	Bączek M., Zagańczyk-Bączek M., Szpringer M., Jaroszyński A., Woźakowska-Kapłon B.	Students' perception of online learning during the COVID-19 pandemic: A survey study of Polish medical students (24)	2021	48	48
19	Sahi P.K., Mishra D., Singh T.	Medical Education Amid the COVID-19 Pandemic (25)	2020	48	24
20	Fatani T.H.	Student satisfaction with videoconferencing teaching quality during the COVID-19 pandemic(26)	2020	44	22

Most frequently used author keywords

There are 1451 author keywords and the top 20 keywords most frequently occurred in these publications are as shown in Table V. In publications related to medical education topics during the pandemic, the most often keywords used by authors ranged from covid-19 with 336 times being used to sars-cov-2 of 14 times occurrences. From the 20 keywords below, authors tend to use a broad range keyword that are usually more to teaching rather than assessment. A variety of keywords that are synonyms or similar to online learning can

Table V. Top 20 Author Keywords

Author Keywords	Occurrences	Author Keywords	Occurrences
covid-19	336	Coronavirus	27
medical education	217	online teaching	25
medical student/s	157	online education	23
online learning	54	Telemedicine	21
pandemic	50	undergraduate	20
e-learning	49	virtual learning	18
education	45	Telehealth	18
covid-19 pandemic	35	Virtual	18
distance learning	33	Curriculum	16
undergraduate medical education	28	sars-cov-2	14

be seen such as e-learning, distance learning, online teaching, online education, virtual learning.

Network visualisation

Visualisation of the data in terms of its relatedness helps in understanding the network among different units of analysis. Figure 1 shows visualisation on citation analysis by country which depicts the relatedness of items (countries) determined based on the number of times they cite each other. The size of the label and the circle of a country is determined by the weight of the country. The higher the weight of a country, the larger the label and the circle of the item country. The distance between two countries in the visualisation indicates the relatedness of the countries in terms of citation links. In general, the closer two countries are located to each other, the stronger their relatedness. For example, Figure 1 shows USA has the largest label and circle. It also shows USA is closer related to Australia than it is to South Korea. The strongest citation links between countries are also represented by lines. For some countries, the labels may not be displayed to avoid overlapping labels. The color of the country is determined by the cluster to which the country belongs. For example, Israel, Switzerland, France and New Zealand belong to the same cluster.

DISCUSSION

This study sets to answer several research questions which can be answered by using bibliometric analysis. Bibliometric analysis has been used in medical education research to provide overview of the research in particular topic, to analyse top cited publications and to determine trends. An example would be a study in 2013 where bibliometric analysis was conducted to review medical education studies published in 2 different categories of journals – in general and internal medicine and medical education journals (27). Bibliometric analysis is also effective in analysing the top-cited articles where characteristic of medical education research tends to get cited the most (28). By understanding the characteristics of these publications, researchers would have an idea what other scientists are looking for and learn how to make their own research and articles more impactful. A more recent bibliometric was conducted in 2021, where the bibliometric analysis focused on knowledge syntheses publications (29). This study used keywords such as knowledge synthesis, literature review, metasynthesis and other controlled vocabulary terms. There was one study similar to our study in using bibliometric analysis on medical education publications during covid-19 however, there are several aspects that made our study different. First, the study was conducted in January to December 2020, a period much earlier than ours where Covid-19 had just hit the world and there had not been that many related publications (30). The study only obtained 446 documents from their search database. The database used was Web of Science Core Collection (WoSCC) which was different from ours. Another difference is that they included most document types in the analysis including proceedings and letter to the Editor while ours only focused on original articles and review articles.

At the onset of this study, six research questions were posed. Results showed 782 documents related to medical education were published during the covid-19 pandemic. The most productive authors only published around 4-5 documents within these 2 years on the topic. Some of the documents published by these authors received high citations however, none of them achieved an h-index of more than 2 for publications on this topic. Lee Y.M. is the most productive authors with five publications where 4 papers were published in 2021 and one in 2020.

The most impactful article which has the highest citations, employs a general title on medical education.



Fig.1: Network visualisation map of the citation analysis by country
Note: Unit of analysis = country
Maximum number of countries per document = 10
Minimum number of documents of a country = 2
Minimum number of citations of a country = 1
 [of the 133 countries, 60 meet the thresholds. Some of the items are not connected to each other. The largest set of connected items consists of 56 items is shown].

Figure 2 shows visualisation on co-authorship by author which depicts the relatedness of authors determined based on the number of co-authored documents. Co-authorship visualisation help researchers to understand the research network among scholars in the field. Based on the results, an average of 5.15 authors per paper were involved for publications in this topic. In Figure 2, the minimum number of documents of an author was set to 2, and minimum citations set to 1, allowing 183 authors that meet the threshold. Only the biggest set of connected authors are shown which consist of 9 authors.

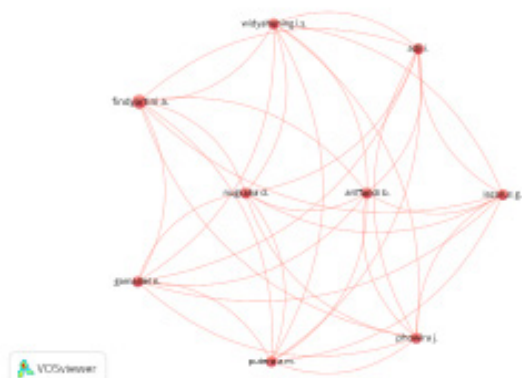


Fig.2: Network visualisation map of the co-authorship by author
Note: Unit of analysis = Author
Counting method: Fractional counting
Maximum number of authors per document = 25
Minimum number of documents of an author = 2
Minimum number of citations of an author = 1
 [of the 3949 authors, 183 meet the thresholds. Some of the items are not connected to each other. The largest set of connected items consists of 9 items is shown].

The article entitled “Medical Student Education in the Time of COVID-19” by Rose S. was cited 569 times since its publication in 2020. It is a viewpoint article where author shared her views and raised pertinent and highly relevant issues pertaining to the concern of medical education during the trying times of a pandemic. Therefore, it reaches out to a wider circle audience involved in medical education. The timely publication of this article on 31st March 2020 which closely followed the official announcement of a Covid-19 pandemic by WHO on 11th March 2020 and the availability of the article on open access further contributes to it being highly read and cited. Having published at quite an early phase of the pandemic in 2020, the availability of such scholar publication on the much relatable and current topic seems to lay a foundation for other research sub-topics in medical education and hence tends to be highly cited by other researchers in subsequent years.

The most often used author keywords are covid-19, medical education and medical student/s which have been used 336, 217 and 157 times respectively. Citation among countries showed USA and Australia tend to cite each other more than USA and South Korea.

Co-authorship network pattern is revealed only among authors who have at least 2 published documents with at least 1 citation showed links among nine authors which include researchers such as Findyartini A., Widyahening I.S., Putera a.m. and others. The network pattern however is not dense due to the short duration of two years in this study which limits the probability of more authors to network as co-authors on medical education related publications.

Citation metrics give an overview of the cumulative performance of these publications in terms of number of documents as well as how frequent the documents have been cited. It was shown that even within a short span of less than 3 years, citations on these documents are high and will continue to increase as years go by. It is also very encouraging to see that 56% out of 782 publications have been cited even during the short span of time. Citations take time to accrue, although a paper usually reaches its highest citation within 2 years of publication. As stated in the results, the more recent the documents, the less likely it will get high citations.

Most active source titles show that among the popular journals to publish studies addressing topics in medical education, teaching and learning, assessment related to covid-19 pandemic period are BMC Medical Education, GMS Journal for Medical Education, JMIR Medical Education and others (Table III). Researchers might have higher success rate should they consider publishing in those journals. It can also be seen that from among the most active source titles, the three most impactful journals were BMC Medical Education, Anatomical Sciences Education and Academic Medicine based

on its total citations (Table III). Prominent journals in medical education such as Clinical Teacher, Medical Education and Medical Teacher however are not among the source titles that are actively publishing on this topic during this period.

Covid-19 pandemic has certainly challenged medical educators and medical students all over the world in experiencing teaching and learning. These challenges inadvertently affected research in medical education as well. As educators and learners are separated in time and place due to social distancing, the adoption of open distance education has been accelerated (31). However, in areas where critical physical encounters are important, such as in the clinical years, in residency selection – this has been negatively affected. During the period of containment of covid-19, students were removed from hospital area. This affected their exposure to clinical settings, restricted their ability to choose their specialty of interest (32). As physical contact is limited during the pandemic, most research related to medical education were carried out using online forms which can be easily administered and collected. In qualitative research where it involved in depth interview or focus group discussion (FGD), researchers have opted to use the online video conferencing platform (32). These were some of the alternatives that research in medical education has to adapt to counter the challenges. This, however has the risk on privacy and confidentiality of the information shared or discussed during FGD when research participants getting online from their own place, may either disclose or overhear sensitive information (33).

CONCLUSION

A collection of bibliography data of 782 medical education related publications from the Scopus database, authored by 3949 scholars published in 160 academic journals. The current study provides an overview of the current landscape of publications responding to medical education issues in times of covid-19 pandemic. Citation metrics of the publications, productive authors, prominent source titles and influential publications are important considerations for fellow researchers to help them navigate their next research topics.

ACKNOWLEDGEMENTS

The author thanks Prof Ts. Dr. Aidi Ahmi, Universiti Utara Malaysia for his guidance as well as his endless sharing of knowledge and experience in conducting bibliometric analysis.

REFERENCES

1. WHO director-general's opening remarks at the media briefing on covid-19. WHO. 2020 [cited 2022 Apr 1]. Available from: <https://www.who>.

- int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020.
2. Farooq F, Rathore FA and Mansoor SN. Challenges of online medical education in pakistan during covid-19 pandemic. *J Coll Physicians Surg Pak.* 2020;30(6): p. 67-69. doi: 10.29271/jcsp.2020.Supp1.S67
 3. Jiang Z, Wu H, Cheng H, Wang W, Xie A and Fitzgerald SR. Twelve tips for teaching medical students online under covid-19. *Med Educ Online.* 2021;26(1): p. 1854066. doi: 10.1080/10872981.2020.1854066
 4. Iancu AM, Kemp MT, Gribbin W, Liesman DR, Nevarez J, Pinsky A, Pumiglia L, Andino JJ, Alam HB, Stojan JN, Walford E and Schiller JH. Twelve tips for the integration of medical students into telemedicine visits. *Med Teach.* 2021;43(10): p. 1127-1133. doi: 10.1080/0142159X.2020.1844877
 5. *Bibliometrics 2022* [cited 2022 Mar 31]. Available from: <https://www.merriam-webster.com/dictionary/bibliometrics>.
 6. *Bibliometrics: A practical guide 2022* [cited 2022 Mar 31]. Available from: <https://subjectguides.york.ac.uk/bibliometrics>.
 7. Rose S. Medical student education in the time of covid-19. *JAMA.* 2020;323(21): p. 2131-2132. doi: 10.1001/jama.2020.5227
 8. Dedeilia A, Sotiropoulos MG, Hanrahan JG, Janga D, Dedeilias P and Sideris M. Medical and surgical education challenges and innovations in the covid-19 era: A systematic review. *In Vivo.* 2020;34(3 Suppl): p. 1603-1611. doi: 10.21873/invivo.11950
 9. Longhurst GJ, Stone DM, Duloherly K, Scully D, Campbell T and Smith CF. Strength, weakness, opportunity, threat (swot) analysis of the adaptations to anatomical education in the united kingdom and republic of ireland in response to the covid-19 pandemic. *Anat Sci Educ.* 2020;13(3): p. 301-311. doi: 10.1002/ase.1967
 10. Abbasi S, Ayoob T, Malik A and Memon SI. Perceptions of students regarding e-learning during covid-19 at a private medical college. *Pak J Med Sci.* 2020;36(COVID19-S4): p. S57-S61. doi: 10.12669/pjms.36.COVID19-S4.2766
 11. Choi B, Jegatheeswaran L, Minocha A, Alhilani M, Nakhoul M and Mutengesa E. The impact of the covid-19 pandemic on final year medical students in the united kingdom: A national survey. *BMC Med Educ.* 2020;20(1): p. 206. doi: 10.1186/s12909-020-02117-1
 12. Khalil R, Mansour AE, Fadda WA, Almisnid K, Aldamegh M, Al-Nafeesah A, Alkhalifah A and Al-Wutayd O. The sudden transition to synchronized online learning during the covid-19 pandemic in saudi arabia: A qualitative study exploring medical students' perspectives. *BMC Med Educ.* 2020;20(1): p. 285. doi: 10.1186/s12909-020-02208-z
 13. Dost S, Hossain A, Shehab M, Abdelwahed A and Al-Nusair L. Perceptions of medical students towards online teaching during the covid-19 pandemic: A national cross-sectional survey of 2721 uk medical students. *BMJ Open.* 2020;10(11): p. e042378. doi: 10.1136/bmjopen-2020-042378
 14. Al-Balas M, Al-Balas HI, Jaber HM, Obeidat K, Al-Balas H, Aborajooch EA, Al-Taher R and Al-Balas B. Distance learning in clinical medical education amid covid-19 pandemic in jordan: Current situation, challenges, and perspectives. *BMC Med Educ.* 2020;20(1): p. 341. doi: 10.1186/s12909-020-02257-4
 15. Alsoufi A, Alsuyihili A, Msherghi A, Elhadi A, Atiyah H, Ashini A, Ashwieb A, Ghula M, Ben Hasan H, Abudabuos S, Alameen H, Abokhdhir T, Anaiba M, Nagib T, Shuwayyah A, Benothman R, Arrefae G, Alkhwayildi A, Alhadi A, Zaid A and Elhadi M. Impact of the covid-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning. *PLoS One.* 2020;15(11): p. e0242905. doi: 10.1371/journal.pone.0242905
 16. O'Byrne L, Gavin B and McNicholas F. Medical students and covid-19: The need for pandemic preparedness. *J Med Ethics.* 2020;46(9): p. 623-626. doi: 10.1136/medethics-2020-106353
 17. Liang ZC, Ooi SBS and Wang W. Pandemics and their impact on medical training: Lessons from singapore. *Acad Med.* 2020;95(9): p. 1359-1361. doi: 10.1097/ACM.0000000000003441
 18. Moszkowicz D, Duboc H, Dubertret C, Roux D and Bretagnol F. Daily medical education for confined students during coronavirus disease 2019 pandemic: A simple videoconference solution. *Clin Anat.* 2020;33(6): p. 927-928. doi: 10.1002/ca.23601
 19. Wilcha RJ. Effectiveness of virtual medical teaching during the covid-19 crisis: Systematic review. *JMIR Med Educ.* 2020;6(2): p. e20963. doi: 10.2196/20963
 20. Meo SA, Abukhalaf AA, Alomar AA, Sattar K and Klonoff DC. Covid-19 pandemic: Impact of quarantine on medical students' mental wellbeing and learning behaviors. *Pak J Med Sci.* 2020;36(COVID19-S4): p. S43-S48. doi: 10.12669/pjms.36.COVID19-S4.2809
 21. Iwanaga J, Loukas M, Dumont AS and Tubbs RS. A review of anatomy education during and after the covid-19 pandemic: Revisiting traditional and modern methods to achieve future innovation. *Clin Anat.* 2021;34(1): p. 108-114. doi: 10.1002/ca.23655
 22. Hilburg R, Patel N, Ambruso S, Biewald MA and Farouk SS. Medical education during the coronavirus disease-2019 pandemic: Learning from a distance. *Adv Chronic Kidney Dis.* 2020;27(5): p. 412-417. doi: 10.1053/j.ackd.2020.05.017
 23. Baticulon RE, Sy JJ, Alberto NRI, Baron MBC,

- Mabulay REC, Rizada LGT, Tiu CJS, Clarion CA and Reyes JCB. Barriers to online learning in the time of covid-19: A national survey of medical students in the philippines. *Med Sci Educ.* 2021;31(2): p. 615-626. doi: 10.1007/s40670-021-01231-z
24. Baczek M, Zaganczyk-Baczek M, Szpringer M, Jaroszynski A and Wozakowska-Kaplon B. Students' perception of online learning during the covid-19 pandemic: A survey study of polish medical students. *Medicine (Baltimore).* 2021;100(7): p. e24821. doi: 10.1097/MD.00000000000024821
 25. Sahi PK, Mishra D and Singh T. Medical education amid the covid-19 pandemic. *Indian Pediatr.* 2020;57(7): p. 652-657. doi: 10.1007/s13312-020-1894-7
 26. Fatani TH. Student satisfaction with videoconferencing teaching quality during the covid-19 pandemic. *BMC Med Educ.* 2020;20(1): p. 396. doi: 10.1186/s12909-020-02310-2
 27. Sampson, M., Horsley, T. A Bibliometric Analysis of Evaluative Medical Education Studies. *Academic Medicine.* 2013;88(3): p.421-427. doi: 10.1097/ACM.0b013e3182820b5c
 28. Azer, S.A. The Top-Cited Articles in Medical Education. *Academic Medicine.* 2015;90(8): p. 1147-1161. doi: 10.1097/ACM.0000000000000780
 29. Maggio, LA., Costello, JA., Norton, C., Driessen EW. And Artino Jr AR. Knowledge syntheses in medical education: A bibliometric analysis. *Perspect Med Educ.* 2021;10: p. 79-87. doi: 10.1007/s40037-020-00626-9
 30. Karakose, T., Yirci, R., Ozdemir, T.Y., Kocabas, I., Demirkol, M. Investigating the scientific landscape of global research on medical education related to coronavirus disease-2019 (covid-19): A bibliometric analysis and visualization. *Acta Medica Mediterranea.* 2021;37(5): 2445-2456 doi: 10.19193/0393-6384_2021_5_379
 31. Papapanou, M. Routsis, E., Tsamakis K, et al. Medical education challenges and innovations during COVID-19 pandemic. *Postgraduate Medical Journal.* 2022;98:321-327. doi: 10.1136/postgradmedj-2021-140032
 32. Elsayy F, Malik RB, Kazi M and Ladan Z. A UK perspective on the effect of the COVID-19 pandemic on medical student career perceptions. *Med Educ Online* 2020;25: 1810968. doi: 10.1080/10872981.2020.1810968
 33. Varma DS, Young ME, Kreider CM, Williams K, Vaddiparti K, Parisi C, et al.. Practical considerations in qualitative health research during the Covid-19 pandemic. *International Journal of Qualitative Methods.* 2021;20:1-5. doi: 10.1177/16094069211043755