Original Article

Where limitations create opportunities: An overview of the evolution of medical education in the post-COVID era

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Abstract

Background & Objective: The COVID-19 pandemic has impacted medical education worldwide with several opportunities and challenges. This study aims to provide an overview of medical education's opportunities and challenges according to the experience of the COVID-19 pandemic in order to guide future endeavors in conducting the teaching-learning process in post-COVID era support.

Material & Methods: In this systematized review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, databases of PubMed, Cochrane, Scopus, Web of Science, and Eric, in addition to Google Scholar as a search engine, were searched to retrieve relevant original peer-reviewed, review, editorial, and commentary articles published from Dec 2019 to the end of Sep 2022.

Results: As per the qualitative synthesis, a total of 29 articles were included from the 1534 records that were identified. Reviewing the included articles showed that most of the relevant studies were considered Medical and healthcare students (51.8%) at undergraduate level (72.5%) in University settings (62.1%). As per the qualitative synthesis, a total of 29 articles were included from the 1534 records that were identified. Reviewing the included articles showed that most of the relevant studies were considered Medical and healthcare students (51.8%) at undergraduate level (72.5%) in University settings (62.1%). On the other hand, post-COVID medical education opportunities have been grouped into four main categories, which are teaching and learning processes, psychological impact, accessibility and education equity, and management and administrative affairs. Post-COVID medical education opportunities also consist of four main categories: teaching-learning process, psychological impact, accessibility and education equity, and management and administrative affairs.

Conclusion: Changes in teaching and learning processes in medical education caused by the COVID-19 pandemic created opportunities and caused important challenges that should be considered in the post-COVID era. In this regard, blended learning with the integration of technology using a flexible approach could be an effective recommendation.

Keywords: medical education, post-covid, opportunity, challenge, Iran

Introduction

The COVID-19 pandemic as an emergency state (1) had unprecedented negative effects on all facts of human life and affected the daily lives of many people all over the world (2). The virus severely limited in-person interactions and social activities (3). Education is one of the most affected areas by the COVID-19 pandemic (4,

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5). It greatly disrupted global educational systems (6). In this regard, lockdowns and social distancing measures caused continuous disruption of medical education routines (7), following which educational institutions were unable to provide the standard educational curriculum (3). Actually, this crisis forced educators to switch the content delivery and assessment methods (8) from an in-person to an online and virtual format (9). By the way, several inventive strategies, like utilizing various software/apps to take online courses, have been implemented, not exclusively to finish the course but also to remain in steady contact with the students (10).

These inevitable changes created many challenges for students, faculty members, and university medical staff (11). These challenges varied from inadequate equipment and technical problems (7) to the restructuring of teaching-learning strategies (12) and mental/ emotional health problems (13). However, this challenging condition has led to the new technology being acknowledged by organizations that were impervious to take on it (10). In a way, educational systems and professionals were implementing efficient strategies to mitigate the pandemic's negative effects on education (14). Such strategies create opportunities for medical students, such as increased engagement (15), self-directed learning (16), flexibility and ease of access to the course material (17), and the ability to manage and control the learning process (18). Additionally, in the era of COVID-19 and during distance education, educational institutions have provided opportunities to assist medical students in developing reflective, adaptive problem-solving, leadership, and lifelong learning skills, all of which are necessary for adapting to a rapidly changing healthcare environment (19).

Several studies with various methodologies have been published about the challenges and opportunities raised by the COVID-19 pandemic in medical education, which emphasized the necessity of adopting evidence-based approaches for implementing innovative teaching-learning strategies (7). Accordingly, we did not find a review article aiming at not only covering such experiences during the pandemic but also categorizing them to guide the way forward in the COVID-19 era. Hence, considering the importance of understanding these opportunities and challenges that help in planning medical education in the post-COVID era, this study aims to provide an overview of the opportunities and challenges of medical education based on the experiences of the COVID-19 pandemic to guide future endeavors in conducting the teaching-learning process in the post-COVID era.

Material & Methods

Design and setting(s)

This study was a systematized review using content analysis in the data synthesis phase (20). We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement by the Cochrane Collaboration to conduct this systematized review (21). Indeed, a systematized review is one of the literature review types that may include only some components of a systematic review. In fact, we included all types of study design in this review (22).

The research question of the current systematized review was to identify the opportunities and challenges of medical education during the COVID-19 pandemic to guide the future teaching-learning process in the post-COVID era.

Participants and sampling

Search strategy and information sources

We conducted an advanced search in databases including PubMed, Cochrane, Scopus, Web of Science, and ERIC, in addition to using Google Scholar as a search engine. Moreover, gray literature databases, including GreyLit and OpenGrey, were searched. As per our study requirements, we considered scientific journals' original peer-reviewed, review, editorial, and commentary articles published from December 2019 to September 2022. The search was conducted on November 1st, 2022 (**Table 1**).

Table 1. Database search results

Resources	Number of records
ERIC	7
PubMed	1064
Scopus	247
Web of Science	136
Cochrane	71
Google scholar	9
Total	1534
Duplicates	151
Totals with duplicates removed	1383

An example of search query used to retrieve the papers was as follows: TS = (("medical education" OR ME OR "medical instruction" OR "medical pedagog*" OR "medical teaching" OR "medical training" OR "medical tuition" OR "Medical Sciences Education" OR "Health Profession Education" OR "Biomedical Education") AND ("post-COVID-19" OR "post-COVID" OR "post

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corona" OR "post-pandemic" OR "post-acute COVID-19")). After extracting articles, duplicated ones were excluded using Endnote X8.2.

Data collection methods

Study selection process

The inclusion criteria for this review were as follows: 1) English language, 2) original peer-reviewed, review, editorial, and commentary articles, 3) In line with the research objective, and 4) availability of articles' full texts. Gray literature was included in this review. Furthermore, the specific study design was not considered an inclusion criterion.

Data extraction

Screening process, critical appraisal, and data extraction: Initially, the titles and abstracts of all articles were reviewed by at least two independent researchers using a standardized checklist form to exclude irrelevant ones. A third researcher reviewed the articles in case of any inconsistency between the former reviewers to make the final decision about including the articles. According to the Kappa coefficient, the agreement coefficient between the first two researchers was 92%. Subsequently, two researchers performed an in-depth assessment of the full texts of the articles separately to determine their eligibility. During this process, any inconsistencies between the reviewers were resolved.

In the next step, data was extracted from each of the eligible articles, including the title, name(s) of the author(s), publication place and year, research sample or population, type of study, and objectives. Additionally, key findings and results were summarized and recorded, and an in-depth study of the entire text of the included studies was conducted using conventional qualitative content analysis. The PRISMA diagram was used to assess the retrieval, extraction, and removal of the articles. Furthermore, the Best Evidence Medical Education Checklist (BEME) and Critical Appraisal Skills Program (CASP) checklists were applied to investigate the quality of the articles.

Data analysis

In this systematized review, content analysis was employed during the data synthesis stage with a focus on the research question (20); we conducted conventional content analysis in which coding categories are derived directly from the text data. Accordingly, three main phases of preparation, organization, and analysis report (23–25) were adopted. In the preparation phase, the extracted data from the included studies was organized into two files: an Excel document that recorded each source's manifest data (i.e., explicit characteristics like title, year, type, and location) and a Word document that open-coded the content. We employed an inductive procedure to choose semantic units that were pertinent to our study topics during the organization phase. These units were given initial open codes, then codes with similar characteristics and semantic relevance were then clustered together. Finally, the t main categories, categories, and sub-categories extracted from the included studies were reported.

According to Graneheim and Lundman's criteria, four criteria of trustworthiness, including credibility, transferability, consistency, and confirmability (26), were considered in the current study. Accordingly, two researchers (M.A., R.M.) read the extracted texts of included articles repeatedly to immerse themselves in the data to recognize meaningful units (codes). They classified the codes into sub-categories and categories (**Table 2**).

Table 2. A sample of the main category, subcategory, initial code, and raw text

Main Category	Subcategory	Initial code	Raw text
Accessibility & education equity	Networking	- Developing social networks - Strengthen connections and collaboration across countries	"The transition into virtual spaces and the need to rapidly share information and best practices across the world have facilitated the development of larger social networks and expanded the social space of the CLE, which now transcends traditional geographical boundaries." (51) "The development of robust virtual communities of practice and harnessing of the power of collaborative networks will be imperative for adapting the CLE to dynamic regulations about social distancing." (51) "This is an opportunity for the academic sector to converge, strengthen connections across countries and continents, and collaborate." (30)

Another researcher (M.A.) did the analysis independently. Any differences between the findings were resolved by consensus. By making thick descriptions and incorporating contextual details, we

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ensure transferability. The researchers attempted to set aside their own biases and assumptions while data analysis followed the dependability and confirmability of the results.

Results

Out of 1534 records identified, a total of 1383 citations were screened, of which 156 were found eligible for this study. Based on the qualitative synthesis, 29 articles are included in the current review (Figure 1). Characteristics of the included studies categorized based on different variables have been suggested in Table 3. Most studies were published in 2021 (48.2%)—the geographical range of papers covered mostly Asian countries (48.2%). Medical and healthcare students (51.8%), who were mostly undergraduates (72.5%), were the most common participants in the included studies.

The challenges of medical education in post-COVID time

The challenges of medical education in the post-COVID era were characterized into five main categories, 13 categories, and 29 sub-categories (Table 4). The primary categories comprised communication issues, teaching and learning processes, psychological impacts, technical difficulties, and management and administrative affairs.

Communication issue: Under the main categories of communication issues, two categories were identified: 'Student interactions and networking'. Three challenges regarding 'Student interactions' were stated. The literature points to a difficult problem: people's interactions in virtual environments appear to differ from those in face-to-face settings. This distinction was also observed in the way that students interacted with their teachers and patients. Students also reported feeling as though they were having less than ideal social interactions.

Additionally, losing the opportunity to expand their professional network was considered a networking challenge.

The teaching-learning process: Three categories of 'learning environment', 'educational experiences', and 'remote assessment' are categorized in this main category. The first category highlighted the existing barrier of interruptions by family members, especially children, to the online learning environment. The second category, 'educational experiences', focuses on the competent delivery of essential educational experiences to future healthcare providers, particularly in clinical skills acquisition. Delayed feedback from instructors was identified as a challenge that could cause stress and confusion among students and affect the student-instructor interaction. Three subcategories were identified for the third category, 'remote assessment', which included preparation, implementation, and protection difficulties. This category presented a number of difficulties, including the need for training and preparation for a variety of online platforms, the deployment of comprehensive assessment programs, the dearth of assessment tools in e-learning environments, the integration of distance examination methods into the system of distance practical education being difficult, academic dishonesty during assessments, and lower overall learning experience scores following extended virtual learning.

Two main categories emerged from the psychological effects of distant learning: 'faculty' issue' and 'students' issue'. Students felt alone as a result of the physical strain of distance learning, which had major psychological effects like exhaustion, burnout, worry, and stress.

Additionally, students are increasingly becoming dependent on technology, creating a challenge called technology addiction. Similarly, the shift from the medical school to the home setting caused faculty members to experience social isolation in online teaching. Moreover, using technology and creating online lectures increased faculty workload due to being unaccustomed to the software and the process. The findings also suggested another challenge among elder faculty, called technophobia, which is a discouraging factor that obstructs the effective application of technology.

Technical issues: This main category consisted of four subcategories, namely 'technical skills', 'infrastructure', 'technical support', and 'security & privacy issues'. The first category highlighted inadequate technical skills, mentioning that faculty members need training in employing online tools effectively in their routine teaching, learning, and assessment activities, as well as orienting the students in using technological tools. In this regard, unfamiliar software was an important factor. Additionally, the second category addressed limited infrastructure and resources, including problems with poor internet connection and lack of digital device accessibility, which were impeding online learning. The category of technical support highlights the issue of inadequate IT personnel with the necessary expertise to provide efficient technical assistance. In the category of privacy and security issues, students expressed concerns about their private physical space, personal lives, and socioeconomic situations being exposed through video

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conferencing. Both students and faculty members experienced fear of security issues during online learning.

Management & administrative affairs: This main category in two categories of 'financial issue' and 'policymaking concern' were discussed. Financial issues, as the first category, refer to the extra cost imposed on medical schools, students, and faculty because of essential infrastructure and the Internet of distance education. One of the policy-making concerns falls under the second category, where the absence of institutional policies and strategies poses significant challenges. This is especially troublesome in low-income nations, because extra barriers may arise from the absence of such policies. It draws attention to the fact that creating successful policies and plans of action to deal with these problems requires more time and funding. Furthermore, socioeconomic limitations were linked to variations in access to online education, which must be taken into account.

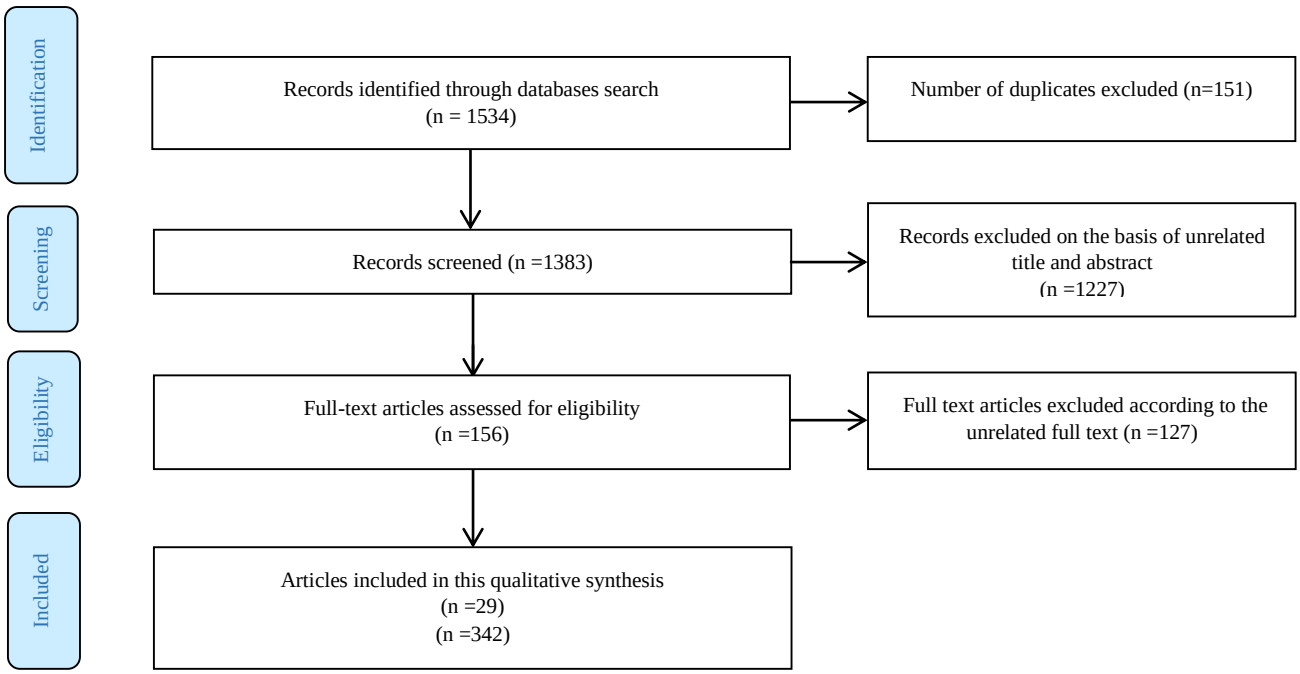


Figure 1. PRISMA flow diagram: Steps of study selection

Table 3. Characteristics of included studies categorized based on different variables

Study characteristics	Number of studies	(%)
Year of publication		
2019	1	3.5
2020	7	24.1
2021	14	48.3
2022	7	24.1
Continent		
Asia	14 (6 Middle Eastern Countries)	48.3
America	8	27.5
Europe	4	13.8
Australia	2	6.9
America and Europe	1	3.5
Type of studies		
Cross-sectional study/Descriptive study/Survey	8	27.5
Mixed method study	2	6.9
Qualitative study	5	17.2
Cohort study	1	3.5
Review study	10	34.5
Report	2	6.9
Others (Forum)	1	3.5
Participants		
Medical and healthcare student	15	51.8
Resident	2	6.9

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Educator (Lecturers/Faculty members/Faculty Mentors/Educational leaders)	3	10.3
Health and medical research and education sector workers	3	10.3
Mixed	6	20.7
Level of medical education		
UME	21	72.5
GME	3	10.3
Mixed (UME, CME, GME)	5	17.2
Setting		
University	18	62.1
Academic hospital	1	3.5
Others (workplace, home, department)	3	10.3
Not mentioned	7	24.1

Abbreviation: UME, undergraduate medical education; GME, graduate medical education; CME, continuing medical education; %, percentage of the studies.

Table 4. The challenges of post-COVID medical education

Challenges		
Main Category	**Subcategory**	**Initial code**
Communication Issue	Student interactions	- Changing the teacher-student interactions nature (36) - Student inability to interact with professors and patients (3) - Sub-optimal social interaction (35)
	Networking	- Losing the opportunity of networking (60)
Teaching-learning process	Learning environment	- Interruptions by family or child (1, 61)
	Educational experiences	- Difficulty in learning clinical skills (48) - Inadequate provision of educational experiences (49) - Delayed feedback on students' activities (55)
	Remote assessment	- Preparation issues (30) - Implementation issues (3, 50, 62) - Proctoring issues (63)
Psychological Impact	Students' issue	- Sense of isolation (1, 51, 52, 55, 64) - Fatigue and burnout (1, 35, 56) - Anxiety (51, 52) - Stress (64) - Imposing technology addiction (55)
	Faculty issue	- Sense of isolation (51, 52) - Increase faculty workload (60) - Technophobia among the elder faculty (52)
Technical issues	Technical skills	- Inadequate technical skills (3, 30, 61) - Being unfamiliar with software (52, 65)
	Infrastructure	- Limited infrastructure and resources (3, 30, 57) - Poor & not stability of internet connection (1, 2, 57)
	Technical support	- Shortage of human resources (1)
	Security & privacy issues	- Fear of not being technically secure (55, 57) - Personal lives being exposed to others (65)
Management & administrative affairs	Financial issue	- Increased cost (30)
	Policy making concern	- Absence of institutional policies and strategies (3, 30) - Socioeconomic constraints (60)

The opportunities for medical education in post-COVID time

The opportunities of post-COVID medical education consist of four main categories, 12 categories, and 25 sub-categories (Table 5). The primary categories include the teaching and learning process, the psychological impact of education, accessibility, and equity in education, as well as management and administrative affairs.

The teaching-learning process: This main category consisted of six categories: 'learning environment', 'skill acquisition', 'variation in learning opportunities', 'remote assessment', 'curriculum reform', and 'educational resources'. Two opportunities concerning the 'learning environment' were identified. It was noted that online learning, as an emergency response to isolation caused by COVID-19, creates a safe environment and prepares for unexpected circumstances in the future. In such an environment, students have time and opportunities to engage interactively with studies, peers, mentors, and educators. The category of 'skill acquisition' considers the important skills acquired by students in new educational experiences, such as interprofessional cooperation, knowledge of community resources, quality improvement, and technology in medicine. Furthermore, online learning empowers students to take more ownership of their education as adult learners and have more flexibility and independence in studying for special personalized needs.

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Table 5. The opportunities of post-COVID medical education

Opportunities		
Main Category	**Subcategory**	**Initial code**
Teaching-learning process	Learning environment	- Safe and comfortable learning environment (52) - Enhanced student engagement (30, 35)
	Skill acquisition	- Opportunity of cultivating multiple skills (66) - Enhancement of self-regulated learning through spaced learning and active recall (51–53)
	Variation in learning opportunities	- Integrating distance theoretical education and in-person practice (50, 51, 60, 64, 67, 68) - Benefiting from both synchronous and asynchronous virtual environments (30) - Expanding peer learning opportunities (53) - Increased use of simulation training and patient safety (60, 62, 64, 69) - The benefit of using videos (49)
	Remote assessment	- Venturing into newer modes of assessment (68) - Promoting self-directed learning (68)
	Curriculum reform	- Adding new topics to the medical curriculum (65, 70) - Dynamic movement to more learner-centered models (53, 62)
	Educational resources	- The opportunity of using web resources (36, 50, 55, 60)
Psychological Impact	Perception of virtual learning	- Students' positive change in their perception toward virtual learning (1, 35) - More acceptance of new generation of virtual learning (36)
Accessibility & education equity	Accessible learning	- Increased geographical accessibility (30, 55-57, 60) - Increased access to educational material (52, 56, 64, 67)
	Time management	- Time flexibility and time management (36, 48-54)
	Decreasing global disparities	- Exposure to different cultures and languages (71) - Experiencing different healthcare systems and resource settings (71) - Opportunity to learn from regional or international experts (54)
	Networking	- Developing social networks (51) - Strengthen connections and collaboration across countries (30)
Administrative affairs	Financial issue	- Reducing students' costs (56, 57, 71)

Interestingly, distance learning created 'variation in learning opportunities', which provided opportunities such as integrated distance education into in-person learning in a blended manner with theoretical versus practical and clinical teaching. In other words, virtual space supports the physical space. By the way, the advantages of both traditional and online teaching were combined. In this regard, the delivery of online lectures as practical sessions in asynchronous/ synchronous modes was beneficial for both learner and instructor. However, clinical skill training was also stated as the challenging point. Studies demonstrated that role play, demonstration, and group discussions among peer groups of students helped them to practice clinical skills. Similarly, simulations are commonly utilized to establish a secure and risk-free environment for medical science students and patients to learn and practice. Similarly, using videos to demonstrate essential procedural clinical skills could overcome the barrier of clinical training in online learning and remote platforms. On the other hand, following the isolation caused by COVID-19, along with the new approach to teaching methods, a new method of evaluation entitled 'remote assessment' was proposed more than ever. Despite the challenges and shortcomings of online exams as a substitute for conventional summative assessment, online assessment in the form of formative assessments and assessment of self-directed learning would be considered appropriate.

As per the fifth category of this main area, 'curriculum reform' was taken into account, which involved incorporating new subjects such as telehealth and online components into the medical curriculum. The dynamic movement from faculty-centered models to learner-centered ones should be taken into account for remote delivery of the curricula. Undoubtedly, the conversion of teaching and learning methods has provided exceptional opportunities for students to use and interact with web-based resources. This has enabled them to learn through a vast repository of images and videos, which are categorized as 'educational resources' and represent the final category within this main category.

Psychological impact: This main category is represented by the category 'perception of virtual learning', which provides insight into students' perspectives and experiences regarding the transition to remote learning and the conversion of the curriculum into online formats. Actually, the new generation of medical students is a favorable generation for digital education and training and is prone to benefit from virtual learning.

Accessibility & education equity: The four categories of 'accessible learning,' 'time management,' 'decreasing global disparities', and 'networking' are identified within this main category. The category of 'accessible

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learning' emphasizes the easy accessibility to educational material and the ability to overcome geopolitical barriers, allowing for easy, timely, and repeated access to online material. The 'Time management' category highlights the flexibility in using educational material, which is beneficial for effective time management. Apart from the aforementioned, 'decreasing global disparities' is another crucial area that emphasizes the importance of making educational materials broadly accessible and exposing pupils to a variety of cultures, languages, healthcare systems, and resource situations. Students' professional development is further enhanced by this exposure, which gives them the opportunity to engage with local, national, and international specialists. The final category, 'Networking', focuses on the growth of online communities and cooperative networks, which helps to create a diverse learning environment influenced by the specialization and institutional culture.

The last group of opportunities is one that focuses on money-related matters. Initiatives to lessen the financial load on students fall under this category. These initiatives can contribute to ensuring that all students, irrespective of their financial circumstances, have access to high-quality education.

Discussion

There have been several obstacles and opportunities for academic achievement brought forth by the COVID-19 epidemic. While a number of additional research have emphasized the possible approaches for resolving these issues, other intervention and review studies have shown the obstacles that medical education has encountered during this crisis. Therefore, the main aim of this study was to provide an overview of the opportunities and challenges of medical education based on the experiences of this phenomenon in order to develop a guide for the use of endeavors in conducting the teaching-learning process in the post-COVID era.

The research results regarding medical education in the post-COVID period were divided into two main categories: opportunities and challenges. There are five main kinds of challenges that have been identified: barriers to communication, obstacles to teaching and learning, psychological effects, technical issues, and management and administrative issues. The post-COVID medical education options, on the other hand, fell into four primary categories: better management and administrative procedures; increased accessibility and equity of education; psychological support for learners; and development of the teaching-learning process.

The main categories extracted from the included studies demonstrated three common main categories in both the challenges and the opportunities: the teaching-learning process, psychological impacts, and management and administrative issues. Each of these main categories is illustrated in detail as follows.

Teaching-Learning Process: Medical students and faculty now have more opportunities to investigate the potential of virtual learning platforms in the teaching-learning process because of the demand for social distancing. It has been discovered that using technology-based learning in conjunction with other cutting-edge teaching techniques is more successful than using a conventional method. The medical community has embraced this strategy, which has given instructors and students alike a variety of learning possibilities (19, 27–29).

The novel methods of delivering online education in preclinical medical curricula received positive responses from both students and faculty (30). Likewise, simulation-based education as an alternative to practical skills training, including virtual reality to simulate medical procedures and diagnostic and therapeutic decision-making, can create practical learning opportunities that are safe, ethical, and effective (31, 32). However, the move to online education has also brought with it a new set of difficulties that need to be resolved in the post-COVID world. For example, online training cannot fully mimic the conventional method of learning through direct observation of live patients to get first-hand experience of clinical findings and patient interaction dynamics, which is an essential component of clinical education (31).

Another innovative strategy in response to the crisis in the teaching-learning process refers to the assessment in which medical schools shift to online assessment (19), while there is concern about unprotected online exams (30, 33) and their effects on the knowledge and practice of future doctors (34). Accordingly, developing a set of graduate attributes or 'soft skills' among students should be required. Furthermore, quality assurance strategies that will monitor the online assessment would be essential (30). The educational system and academics should endeavor to adopt the blended mode in the teaching and learning process to benefit from the advantages of the two educational methods and simultaneously cover the weaknesses of both approaches.

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Psychological Impacts: It is noteworthy that medical students have experienced considerable psychological effects from remote learning during the COVID-19 epidemic. While some studies have found that virtual learning has negative psychosocial effects, such as increased depressive symptoms, anxiety, and stress due to the changes in their learning environment (37–39), positive student perception (1, 35) and acceptance of virtual learning (36) can be seen as opportunities. while a result, it is critical to address students' psychological needs while they adjust to their new learning environment. Furthermore, classes that incorporate practices such as mindfulness meditation and relaxation training have been shown to lower stress, improve emotional regulation, and increase students' resilience.

In the post-COVID era, management and administrative difficulties will also be crucial aspects that require attention. These issues can be broadly classified into financial and policy-making concerns. For many students, faculty members, and institutions, the high cost of digital gadgets (41), Internet bundles (40), the creation and upkeep of online learning platforms, and the adoption of innovative teaching approaches has proven to be an obstacle. However, virtual learning is considered to be a relatively cheaper mode of education in terms of the lower cost of transportation and accommodation (41). In terms of cost, e-learning is often considered a more affordable option than traditional education. This is because many virtual learning expenses are recurring, which reinforces the idea that e-learning is a cheaper alternative, especially when considering economies of scale.

Additionally, COVID-19 has caused political instability, an absence of institutional policies and strategies (3, 30), a lack of resources, and unfavorable government policies that complicate medical education efforts. These issues, which have led to poor educational experiences and limited space for virtual clinical and practical training, will need to be considered as valuable experiences in the post-COVID era.

Two major obstacles were addressed: communication issues and detailed technical issues.

Communication Issues: Despite the numerous benefits of virtual learning in medical education, face-to-face interactions between medical experts and students continue to impact students' capacity to observe, practice, and perfect their abilities. It's important to note that online learning might be difficult for certain students since it lacks the face-to-face interactions with peers and instructors that traditional learning environments offer. This may result in less teamwork, feedback, and motivation among pupils. In other words, remote learning would be caused by poor teacher-student interactions (42, 43). To improve the interaction in this challenge, it is recommended that virtual platform training be provided to both medical students and faculty members. To enhance educational interaction, it would be beneficial to create assignments and engage in conversations that provide timely feedback on virtual platforms. However, the particular characteristics of social media prepare students for specific communication skills that meet a variety of educational objectives in formal and informal settings (44).

Technical Issues: Distance learning obviously poses technical challenges to both students and teachers. Lack of access to technology caused many students, especially from low-income families, not to have access to computers, tablets, or high-speed internet required for online learning leading to inequalities in education. According to studies, the digital gap has had an impact on student learning outcomes during the COVID-19 epidemic (45). In addition, technological issues such as sluggish internet connectivity (46), software glitches, and device malfunctions can disrupt online classes, causing frustration for both educators and students. Technical issues can also impede virtual discussions, assignment submissions, and evaluation processes, leaving insufficient learning chances.

The integration of technology into medical school allows students to gain skills that improve their adaptability and prepare them for future clinics. The clinic of the future will likely rely more heavily on physicians' technological knowledge (47). In the post-COVID era, digital access and the inequality of resources must be addressed to ensure that all students and teachers can actively engage in distance learning.

One specific opportunity considered Accessibility and Education Equity.

Accessibility and Education Equity: Education equity includes accessible learning that overcomes space and time restrictions (36, 48–54) in the educational process. Actually, this chance by repeated access to educational material (30, 55-57) provides an opportunity for medical students as well as health care providers to be lifelong learners in the post-COVID era. In addition, the removal of geographical borders in medical education provides a unique opportunity to form cooperation networks on a wide scale. However, low- and middle-income countries have experienced barriers in transitioning to virtual modalities, which is an important challenge to education

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equality. Therefore, achieving greater equity in global medical education should be prioritized (58).

To sum up, the discussed issues, blended learning, which combines face-to-face learning and e-learning (59), could overcome the barriers and utilize the opportunities of both approaches. This approach also helps educational institutions, instructional designers, and administrators to enhance the teaching and learning process. It is essential to put in the necessary efforts, including providing professional development for faculty members who are new to the online teaching modality, to make this hybrid approach successful in providing meaningful learning to students, both for instructors and educational institutions. Preparing a better learning environment in the form of blended learning requires more flexibility in creating courses as well as formative and summative assessments (27).

Despite the researchers' efforts, this study has some limitations that should be considered. One limitation was the inclusion of studies in English. Another limitation could be that selecting databases or formulating search strategies may have resulted in missing relevant publications.

Conclusion

The COVID-19 pandemic has been a major disruptive change to medical education worldwide, and rapid and innovative use of technology is considered to maintain the teaching and learning process. By resolving the pandemic, this transformative change has had positive impacts and opportunities and caused important challenges that need to be addressed in the post-COVID era. A blended learning approach, which integrates emergent technology and offers a flexible approach based on the educational context and environment, could be an effective recommendation.

Ethical considerations

This study was part of a research project entitled Opportunities, Threats, and Approaches of Medical Science Education, Medical Research and Healthcare Services in the Post-Corona Era, approved by the Research Ethics Committees of the University of Medical Sciences Islamic Republic of Iran in 2022 (code: IR.AMS.REC.1401.029) available at: https://ethics.research.ac.ir/IR.AMS.REC.1401.029.

Artificial intelligence utilization for article writing

Authors declare that they have not used generative AI and AI-assisted technologies in the writing the article.

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Conflict of interest statement

The authors declare that they have no competing interests.

Author contributions

B.L. and A.O.M. initiated the idea and supervised the research. A.M., M.A., and R.M. designed the study. Sh. A and M.A. conducted the search strategy. S.B., A.Z., A.R., and M.P. extorted data from included articles. M.A., R.M., and A.M. conducted the content analysis. M.A., R.M., and AM made a major contribution to writing the draft of the manuscript. All authors read, commented on, and approved the final manuscript.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

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