REVIEW ARTICLE

Major changes and pedagogical challenges in the curriculum of physicians in the post-pandemic of COVID-19: a systematic review

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Highlights

✓ Inclusion of public health-focused pandemic management disciplines in medical curriculum;

✓ Reinforce in future doctors the importance of using scientific knowledge when establishing treatments;

✓ The challenges of the COVID-19 pandemic and the controversy surrounding the prescription, by many doctors, of drugs without proven efficacy against the disease should result in some changes in medical courses;

✓ In Brazil and in the world, professional associations and specialists in medical education are beginning to discuss improvements that may be necessary to make future doctors more adapted to deal with this type of challenge.

Abstract

Introduction: Respiratory disease (COVID-19) caused by the new coronavirus (SARSCoV-2) has spread around the world causing respiratory illnesses and deaths. The COVID-19 pandemic caused an unprecedented crisis in the field of education. It is essential to reflect on the role of educational systems in curricular training, especially for doctors. **Objective:** The present study prepared a systematic review to analyze the main curriculum changes in medical education institutions around the world. **Methods:** The present study followed a systematic review model (PRISMA). The search strategy was performed in the PubMed, Cochrane Library, Web of Science and Scopus, and Google Scholar database, using scientific articles from 2009 to 2021. **Results:** As a corollary of the literary search system, 155 studies were analyzed and submitted to eligibility analysis, and then 55 high to moderate quality studies were selected. Biases did not compromise the scientific basis of the studies. It was analyzed that it is crucial that the academic education community learn from experience and prioritize a forward-thinking academic approach as practical solutions are implemented. The pandemic has brought about a lasting transformation in medicine with the advancement of telehealth, adaptive research protocols, and clinical trials with flexible approaches to achieving solutions. The studies analyzed in general did not address criticisms about the weaknesses of remote education, limiting themselves to defending it as the only viable strategy. There was no consensus on the inclusion of students in the practical activities of curricular internships and medical internships. A part of the studies defends the inclusion in hospital spaces as a way to contribute to overcoming the health crisis imposed by the pandemic. The studies evidenced the inclusion of pandemic management disciplines with a focus on public health in the medical curricula. **Conclusion:** The medical activity and curriculum underwent and are undergoing significant changes and adaptations. Thus, the doctor will need to develop other skills, without losing the traditional ones. The highlight is telehealth and soft skills, as they will allow students to connect to the best in world medicine, highlighting the importance of scientific knowledge when establishing treatments in cases of pandemics with a focus on public health.

Keywords: Medical education. Medical curriculum. Telehealth. Management Disciplines. COVID-19.

Introduction

Respiratory disease by the new coronavirus (SARS-CoV-2) in Wuhan City -China has spread around the world causing respiratory illnesses and deaths, whose disease is called COVID-19 [1]. Therefore, the World Health Organization (WHO) declared in January 2020 a Public Health Emergency of International Importance. On March 11, 2020, COVID-19 was declared by WHO as a pandemic [2,3].

In this scenario, the COVID-19 pandemic has caused an unprecedented crisis in the field of education, causing the mass closure of classes by educational institutions in more than 190 countries [4]. Thus, when entering the recovery phase of COVID-19, it will be essential to reflect on the role of educational systems in curricular training, especially for doctors [5]. The global health crisis and the ensuing blockade brought an unprecedented challenge to the professions, renewing awareness of their value to society [6].

In this regard, education systems will need to be at the center of this planning [7], rethinking how the economy must evolve to protect itself against adversity and define the necessary skills, education, and training. It is necessary to work closely with other sectors of government and the private sector to increase the attractiveness and prospects of the labor market for certain professions, including those considered essential for the common good, such as the qualification of the medical curriculum [7].

In this sense, it can be said that the medical activity and curriculum have undergone and are undergoing significant transformations and adaptations. This is a common conclusion among all those who have been working since March to confront COVID-19. Thus, the physician will need to develop other skills, without losing the traditional ones, which differentiate the occupation, such as constant updating in diagnoses, treatments, and the entire curricular structure [8].

In this regard, the use of telemedicine was limited or even prohibited and has now often become the only tool available. By 2030, more than half of the surgeries will be performed remotely. At the same time, so-called soft skills will be increasingly in demand. Therefore, the curriculum needs to be fully updated. Therefore, connecting students to the best of world medicine is a priority. The contact with science and medical innovation must be constant, in parallel with the learning generated by the main researches and reference publications, which are ways to connect the student to health technology [9].

Therefore, the need to review the academic and curricular training of health professionals is mandatory and fundamental. The COVID-19 pandemic evidenced the ability of health professionals to respond to countless adversities. With overloaded teams and facing complex clinical and social situations of users, professionals and students working in care actions were challenged to exercise communication, management, and collaborative work skills, in addition to technical skills [8-11].

Still, the contents to be taught to physicians are being rethought, as well as the use of digital technologies for pedagogical purposes, teacher training to facilitate adjustments, and the review of the institution's evaluative culture. It is necessary to train medical professionals to face the challenges of the rapid changes in society, the labor market, and the conditions of professional practice [12]. International documents aligned with innovative proposals advocate that contemporary medical education should focus on student learning and be problem-based, incorporating active teaching-learning methodologies and experiences in diverse practice scenarios [13,14].

In Brazil, through the National Curriculum Guidelines (DCN), training in medical graduation should include not only the acquisition of cognitive and technical aspects but also the incorporation of skills that allow future physicians to transform their knowledge into actions that promote integral health through multidisciplinary cooperation and interdisciplinary practices. Curriculum structures integrating the basic and clinical cycles, the centrality of teaching in Primary Care, programmatic adequacy to the population's health needs, increased internship hours, student-centered pedagogical project, emphasis on continuing education, and teacher development are fundamental guidelines for changes [14].

Therefore, based on the current facts of COVID-19 and the impetus for the curricular revolution for physicians, this study prepared a systematic review to analyze the main curricular changes in medical education institutions around the world.

Methods

Study Design

The present study followed a systematic review model, following the rules of systematic review - PRISMA (Transparent reporting of systematic review and metaanalysis, access available in: http://www.prisma-statement.org/).

Search Strategy and Search Sources

The search strategy was performed in the PubMed, Cochrane Library, Web of Science and Scopus, and Google Scholar databases, using scientific articles from

2001 to 2021, using the MeSH Terms (descriptors) *"Medical education. Medical curriculum. Telehealth. Management Disciplines. COVID-19"*, and using Booleans "and" between MeSH Terms and "or" between historical discoveries.

Study Quality and Risk of Bias

Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident highlight was for systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument (Available in: https://training.cochrane.org/introduction-grade). The risk of bias was analyzed according to the Cochrane instrument (Available in: https://methods.cochrane.org/bias/resources/rob-2-revised-cochrane-risk-bias-toolrandomized-trials).

Results
Summary of Findings

As a corollary of the literary search system, 155 studies were analyzed and submitted to eligibility analysis, and then 55 high to moderate quality studies were selected (**Figure 1**), considering, in the first instance, the level of scientific evidence of studies in type of study such as meta-analysis, randomized, prospective and observational. Biases did not compromise the scientific basis of the studies.

After reading and analyzing selected articles on curriculum changes in medicine, it was analyzed that the academic educational community must learn from experience and prioritize a forward-thinking academic approach as practical solutions are implemented. One area where learners can serve and have a positive effect is as educators of their peers, patients and communities, using the tools available through social media and other modalities to help influence behaviors positively [15].

Figure 1. Flowchart showing the article selection process.
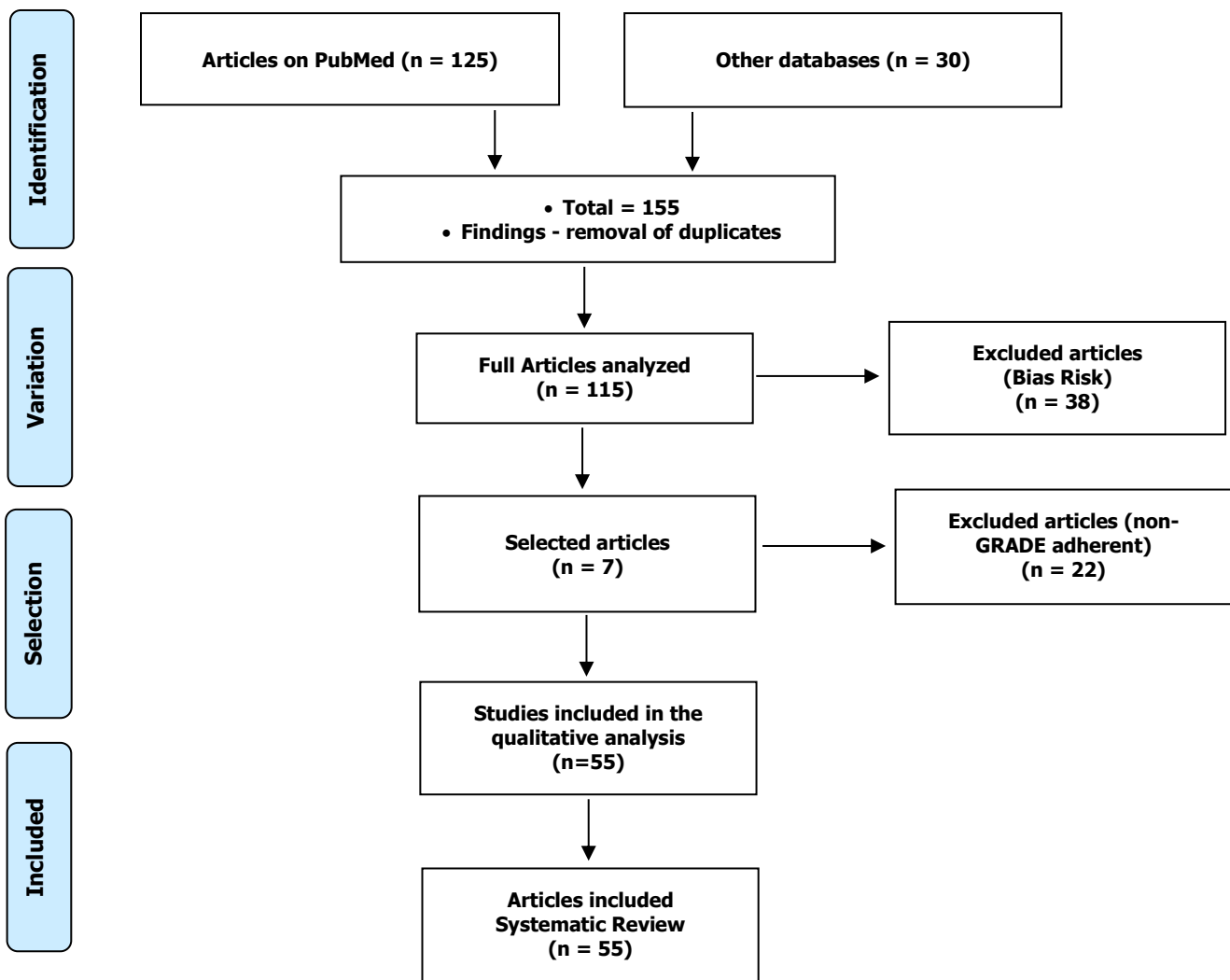
In this context, the pandemic has brought about a lasting transformation in medicine with the advancement of telehealth, adaptive research protocols, and clinical trials with flexible approaches to achieving solutions. In this regard, there are many examples where learning with difficulties produces experiences (eg HIV emergency, disaster response) that have changed discovery, science and patient care. Students and educators can help document and analyze the effects of current changes to learn and apply new principles and practices in the future. This is not only a time to contribute to the advancement of medical education in the scenario of innovation and transformation, but also to seek new efficient and effective guidelines for the teaching and learning process of undergraduate students and medical residents [15,16].

Thus, curricular changes are based on the reformulation of traditional pedagogical strategies and practices and the development of new teaching skills, adapting to information and communication technologies. The continuity of curricular medical education during the crisis caused by the pandemic can be justified by the need to train new professionals, mainly because doctors experience an increase in working hours and emotional suffering [16].

Despite the advent of new pedagogical practices for the formation of the medical curriculum, the speed with which the adaptations are being made can generate intellectual gaps in the formation of these students, as time is required for the effective exercise of these new strategies, especially in terms of it concerns training on them and mastery and implementation of digital platforms. These processes are essential to ensure the qualified use of such teaching instruments, since "users" must become familiar with and engage with this type of online learning [17].

Still, the lack of infrastructure and adequate technology can constitute barriers in medical education, especially in low- and middle-income countries [18]. In addition to this weakness, the reduction or absence of interpersonal relationships between students and teachers is highlighted, impeded by social distancing during the pandemic, producing negative effects for medical training, and hindering the exchange of ideas, knowledge and knowledge as a method of learning [19].

Furthermore, the concentration of articles in high-income countries, published only in English and in medical journals, reflects the lack of scientific evidence in the production of evidence that considers the contexts of low- and middle-income countries. This contributes to the difficulties that are heightened during the pandemic in some countries, as the existing complexity in the field of medical education requires timely scientific research

and communication to implement effective actions. Thus, it is necessary that medical education, as a result of the COVID-19 pandemic, reinvents itself based on the diversity of the world, contributing to the expansion of social, educational, and political experiences and practices [15].

Major Pedagogical and Curriculum Changes in Global Medicine Courses

Based on the findings that make up this systematic review study, the studies analyzed in general did not address criticisms about the weaknesses of remote education, limiting themselves to defending it as the only viable strategy. However, the adoption of remote teaching methodologies can further accentuate social disparities as the right to quality education is threatened by digital social inequalities [20].

Added to this, there was no consensus on the inclusion of students in the practical activities of curricular internships and medical internships. A part of the studies defends the inclusion in hospital spaces as a way to contribute to overcoming the sanitary crisis imposed by the pandemic [21,22], and others highlight the risk of exposure of students to infection and the optimization of individual protective equipment [23,24]. But, equitably, the studies evidenced the inclusion of pandemic management disciplines with a focus on public health in the medical curricula [25]. **Table 1** highlights the major studies worldwide and the main pedagogical and curricular changes in medicine courses.

With the health crisis, Brazilian medical schools had the opportunity to revisit the previously advocated guidelines and verify their legitimacy to effect changes in academic training [14]. Thus, the destabilization of curriculum plans caused by social distancing affirmed the importance of reviewing the fundamental contents to be practiced systematically and frequently in the institution. The health crisis accentuated the need for educational planning that was adequate to the general plan of training. The readjustment of evaluation processes implied the recognition of the instituted teaching/learning process and demands to include the participating subjects (students and teachers) constituting an essential basis for the construction and consolidation of new work practices [29].

In this sense, the use of active teaching-learning methodologies would have the potential to redefine roles and catalyze new changes and, in virtual environments, could lead to an increase in the motivation of both students and teachers, strengthening the bonds of partnership and work [40]. Furthermore, the need to diversify methodological strategies, which place the student at the center of the teaching-learning process, was highlighted by teachers.

Table 1. Major pedagogical and curriculum changes in global medicine courses.

Authors and Countries	Major Pedagogical and Curriculum Proposals
Liu et al. [25] (China)	❖ A research system was developed to support the development of high-level innovative public health talent. ❖ Formulation of a training program for "medical and preventiveintegration".
Liang, Ooi et al. [26] (Singapore)	❖ Technology, video conferencing, and online platforms are used to deliver lectures or tutorials via handheld devices and laptops; ❖ Teleconferencing can be used to demonstrate medical procedures and surgical techniques.
Klasen et al. [15] (Switzerland, Austria and Canada)	❖ Insertion of students into clinical work, with a balance between the importance of direct contact with the patient and the risk of exposure to the virus. ❖ Supervision, feedback, and evaluation were used.
Akers, Blough et al. [24] (United States)	❖ Clinical rotations were suspended and classes transferred to the virtual platform.
Schneider e Council [27] (United States)	❖ Distance education or online has become the rule; ❖ Several academic societies have combined resources to ensure thatmedical education takes place during this period.
Menon, Klein et al. [28] (United States)	❖ The removal of students from direct patient care contributed to reducing transmissions and the waste of personal protective equipment.
Mukhopadhyay et al. [29] (United States)	❖ Video conferencing platforms, pathology websites, free online educational resources, including social media and image collections were used for anatomical and clinical pathology.
Regier, Smith et al. [30] (United States)	❖ The genetics community is poised to fill the educational gap by creating telemedicine care and online learning modules.
Stokes [31] (United States)	❖ Conducting non-clinical activities in online environments without early clinical experiences.
Naik, Finkelstein et al. [32] (United States)	❖ A hybrid telesimulation model was developed to teach respiratory ventilator management strategies. ❖ Students were non-intensive care unit patient care providers with limited experience in managing ventilators. ❖ The use of video tutorials and interactive telesimulation was successful.
Calhoun et al. [33] (United States)	❖ An innovative virtual secretariat was developed. ❖ Efforts have been made to include rotation locations in critical decisions that will impact both medical students and faculty.
Hall et al. [34] (Canada)	❖ Adaptation of teaching programs to maximize learning. ❖ Continued focus on student/faculty well-being, medical educators will need to optimize existing training experiences, adapt those that are no longer viable, employ new technologies, and be flexible in the assessment of competencies.
Pather et al. [35] (Australia /New Zealand)	❖ Anatomy educators were mobilized to adjust their teaching approaches; ❖ Key opportunities include enabling synchronous teaching; ❖ Expand offerings to the remote learning space and adopt new pedagogies.
Arandjelovic et al. [9] (Australia)	❖ Teaching with telehealth; ❖ Adapting curriculum to include management of pandemic.
Moszkowicz, Duboc et al. [36] (France)	❖ Educational video conferencing via Google Hangouts. ❖ Can be applied to clinical and anatomy lessons. ❖ Modern learning methods and educational tools in response to non-attendance to lectures.
Tretter et al. [37] (United States, Canada, Lithuania, Netherlands, Ireland, India, United Kingdom and Sweden)	❖ Heart University aims to be the online resource for studying pediatric heart disease; ❖ It is an organized open-access library with educational material.
Cleland, Tan et al. [38] (Singapore)	❖ Move to online learning. ❖ Class sizes have been reduced and classes are run repeatedly. ❖ Innovative simulations were introduced to prepare seniors.
Singh, Srivastav et al. [39] (India)	❖ A new online classroom platform was implemented. ❖ The program attracted feedback from students. It can serve as a model for teaching and training.
Sahi, Mishra et al. [40] (India)	❖ The continuity of medical education is imperative; ❖ Pedagogical innovations involve technology-based teaching and simulation (online lectures, virtual simulators, webcasting, online chat rooms); ❖ Medical educators should develop and assess the sustainability and application of these innovations in clinical settings.

Lall e Singh [41] (India)	❖ Teaching via remote platforms and telehealth.
Zayapragassarazan [42] (India)	❖ The technology is used as an effective tool. Active teaching-learning activities will promote good study habits; ❖ This type of teaching requires faculty involvement, digital platforms, and planning educational activities.
Tokuç e Varol [43] (Turkey)	❖ All medical faculties transitioned from theoretical lessons to online; ❖ Clinical practices and examinations were postponed, and a new academic calendar was prepared; ❖ The faculties required technological infrastructure and technical staff for medical assistance.
Rasmussen, Sperling et al. [44] (Denmark)	❖ Change to a digital platform. ❖ Employed seniors as temporary residents and started courses in ventilatory therapy.
Gaber, Shehata et al. [45] (Egypt)	❖ Classes on the Zoom platform, dividing students into teams. ❖ Meetings with the leader of each team who created a WhatsApp group to facilitate communication. ❖ Reading material was made available in advance and students joined the tutor for feedback.
Longhurst et al. [46] (Ireland/United Kingdom)	❖ Anatomy faces challenges with distance education especially due to the lack of cadaveric exposure. ❖ Academics mentioned that time can restrict the quality and effectiveness of distance learning resources.
Sahu [47] (Trinidad and Tobago)	❖ Adoption of technology and assessment of student experiences. ❖ Counseling services must be available to support students' mental health and well-being. ❖ They must guarantee food and accommodation for foreign students.
Ashokka [48] (Malaysia/Singapore)	❖ Remote modes of medical education, maintaining the integrity of formative and summative assessments; ❖ Development of plans for the maintenance of essential activities.

In this context, it was found that some subjects seem more in line with developing feedback practices, actively engaging students in course planning, and emphasizing meaningful learning out of respect for each student's uniqueness and learning needs. Furthermore, it is necessary, however, that schools link up with medical associations, establishing a network of cooperation and collaboration for discussion and strengthening of initiatives. Investing in empirical research and critical reflection on ongoing practices, opening the field to new subjects, creating spaces for listening and speaking, can trigger changes and catalyze transformations in the discourses and educational practices of the training of physicians [49].

Thus, the current pandemic has resulted in a transformation in medical education for both undergraduate and graduate students. Clinical rotations for undergraduates have been suspended worldwide. During the COVID-19 pandemic, several medical schools immediately converted their entire clinical curriculum into online formats. Likewise, educational and clinical assessments have been converted to online assessments. Therefore, it is necessary to adopt a new educational and curriculum system that is safe and sustainable in the long term [50].

As a corollary to the response to this pandemic, many medical schools have suspended clinical internships and implemented tailored curricula to facilitate continued educational progress. Although the implementation of these new curricula has been described, an understanding of the impact on student learning outcomes is lacking [51].

In 2020, some authors followed Kern's 6-step approach to curriculum development to create and evaluate a new COVID-19 curriculum for medical students at the University of California San Francisco School of Medicine, evaluating learning outcomes. The main objective of the new curriculum was to provide third- and fourthyear medical students with an opportunity for on-the-job learning in the absence of clinical internships, specifically for students to develop internship-level milestones in the domains of learning and improvement competency with practice-based, professional, and systems-based practice. The curriculum is designed to match students with faculty-led projects taking place primarily in virtual formats. A total of 126 students signed up for the curriculum and responded to a survey about their learning outcomes (100% response rate). Of the 35 possible milestones at the internship level, there were 12 milestones for which more than half of students reported the development, competency domains, including practice-based learning and improvement, professionalism, and interpersonal and communication skills. Thematic analysis of the students' qualitative survey responses demonstrated 2 central motivations for curriculum participation: identity

as physicians in training and patient involvement. Six core areas of learning were developed during the curriculum, interprofessional teamwork, community resources, technology in medicine, skill-building, quality improvement, and specialty-specific learning. This analysis demonstrates that students can develop competencies and achieve rich workplace learning through project-based experiential learning, even in virtual clinical workplaces. In addition, knowledge of community resources, technology in medicine, and quality improvement was developed by the curriculum more readily than in the traditional stages and could be considered as integral learning objectives in future curriculum planning [51].

The Telehealth Revolution in the Medical Curriculum

As the COVID-19 pandemic spreads around the world, all sectors of society were forced to re-imagine, reorganize and restructure, and a revolution was imposed, mainly in the education sector, putting technology at the center of adaptations. In this context, medical education was similarly transformed in a matter of months by the telehealth revolution, and medical educators are just beginning to explore the different possibilities that telehealth offers students. As such, telehealth allowed medical students to observe and actively participate in patient care remotely during the COVID-19 crisis [52,53].

In this sense, the teaching and learning experience through telehealth renewed the importance of careful medical history, along with an examination based on the perceptive observation that was perhaps becoming a lost art. In this way, students and resident physicians had the opportunity to quickly learn the fundamentals of telehealth, and contribute valuable suggestions from their perspectives as digital natives [54].

Based on this, innovative and collaborative service models (such as the Echo Project) must be thoroughly evaluated and, if proven, must be improved and expanded.

Online telehealth consultations with local, regional, and national experts will be standard. New portable telemedicine kits, add-ons, and smartphone apps, including virtual stethoscopes, otoscopes, ophthalmoscopes, pulse oximeters, blood pressure monitors, EKGs, glucometers, spirometers, and many other tools will allow providers to collect more vital information during a health meeting. telehealth [54,55].

Besides, medical research will increasingly involve virtual recruitment, screening, and monitoring. Virtual learning for medical students will progressively become a standard, as medical schools and residency programs are simultaneously tweaking curricula to include robust training in telehealth as a central component of medical education [53].

Also, thanks to telehealth, medical students were able to learn from local and world experts on topics of interest, as many medical societies made online lectures and webinars widely available and often free to access. Thus, online conferencing is suitable for traditional teaching formats such as lectures followed by question and answer, but more interactive teaching formats such as workshops, roundtables, and poster group discussions have proven challenging in an online environment [52].

In addition, telehealth tools have allowed global experts to collaborate in the care of critically ill patients with COVID-19, working together to understand how this virus works and what the best interventions can be. This telehealth-based collaborative learning experience is already inspiring to reimagine and globalize medical education [55].

Conclusion

The medical activity and curriculum underwent and are undergoing significant transformations and adaptations in the COVID-19 pandemic. Thus, the doctor will need to develop other skills, without losing the traditional ones. The highlight is telehealth and soft skills, as they will allow students to connect to the best in world medicine, highlighting the importance of scientific knowledge when establishing treatments in cases of pandemics with a focus on public health.

Data sharing statement
No additional data are available.

Conflict of interest
The authors declare no conflict of interest.

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