

## Students' opinion concerning alterations to undergraduate medical education during the COVID-19 pandemic: a narrative review

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### Abstract

**Background:** During the Coronavirus disease 2019 (COVID-19) pandemic, various changes occurred regarding undergraduate students' medical education. Although some research on the matter has been done, to the authors' knowledge, very few reviews consider medical students' overall point of view during the pandemic's first and second years.

**Methods:** We systematically searched the PubMed database twice using the "Advanced" settings; the last search was on 9<sup>th</sup> October 2022. The keywords used to search relevant literature included: i) (Distance learning) AND (COVID-19) AND (medical students' perception) and ii) (medical education) AND (SARS-CoV-2) AND (online learning opinion). All in all, 47 publications met the inclusion criteria for this review.

**Results:** In most cases, the medical curriculum was modified to an online format, and clinical placements were canceled, which exhibited several advantages for the students, such as more personal time and a sense of flexibility and comfort. Nonetheless, the student's overall point of view regarding distance learning tends to be rather negative than positive. That is mainly due to the variety of difficulties they faced because of it. The biggest issue that arose at the first (response) and the second (recovery) phase of the pandemic seems to be the lack of interaction between students and their professors and the non-existent student-to-student interactions.

**Conclusions:** Most students stated that once the pandemic was over, they would wish for either a full return to conventional teaching or the implementation of a blended strategy. Medical students appreciate the ability to continue their education amidst the pandemic. Nonetheless, they expressed various issues that must be addressed if online learning needs to be continued. Medical educators need to be aware of these issues to ensure the best didactic tactics in case a health crisis of a similar magnitude appears in the future. HIPPOKRATIA 2024, 28 (3):83-92.

**Keywords:** Distance learning, Coronavirus disease 2019, COVID-19, severe acute respiratory syndrome coronavirus 2, SARS-CoV-2, medical students' perception, medical education, online learning opinion

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### Introduction

The Coronavirus disease 2019 (COVID-19) pandemic has, among other effects, a serious impact on medical education. In most countries, the traditional educational curriculum of medical students is based on lectures and face-to-face teaching. Following the pre-clinical years, students attend clinical rotations and clerkships accompanied by bedside teaching<sup>1-3</sup>.

During the COVID-19 pandemic, the mode of teaching strategies was modified several times, depending on the periods of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) peak transmission, and numerous changes were implemented regarding medical education for students to be able to resume their theoretical and practical training<sup>4-7</sup>.

Most available literature focuses on a certain period of the pandemic. This review article aims to explore and display medical students' point of view on education alterations, referring to both the first and the second year of the pandemic, as both theoretical education and practical training were severely affected. Medical students' overall point of view should be carefully considered in case a health crisis of a similar magnitude occurs in the future.

### Methods

A systematic search of PubMed database was conducted twice using the "Advanced" settings; the last search was on 9<sup>th</sup> October 2022. The keywords used to search relevant literature included: i) (Distance learning) AND (COVID-19) AND (medical students' perception)

and ii) (medical education) AND (SARS-CoV-2) AND (online learning opinion).

The inclusion criteria for the articles were: i) full text, freely available articles written in English language, ii) both qualitative and quantitative studies reporting medical students' opinions on changes that took place in the curriculum of Medical Schools during the COVID-19 pandemic, iii) review articles summarizing the above-mentioned changes, iv) articles in the reference list of the previous categories, that also adhere to the previously mentioned inclusion criteria.

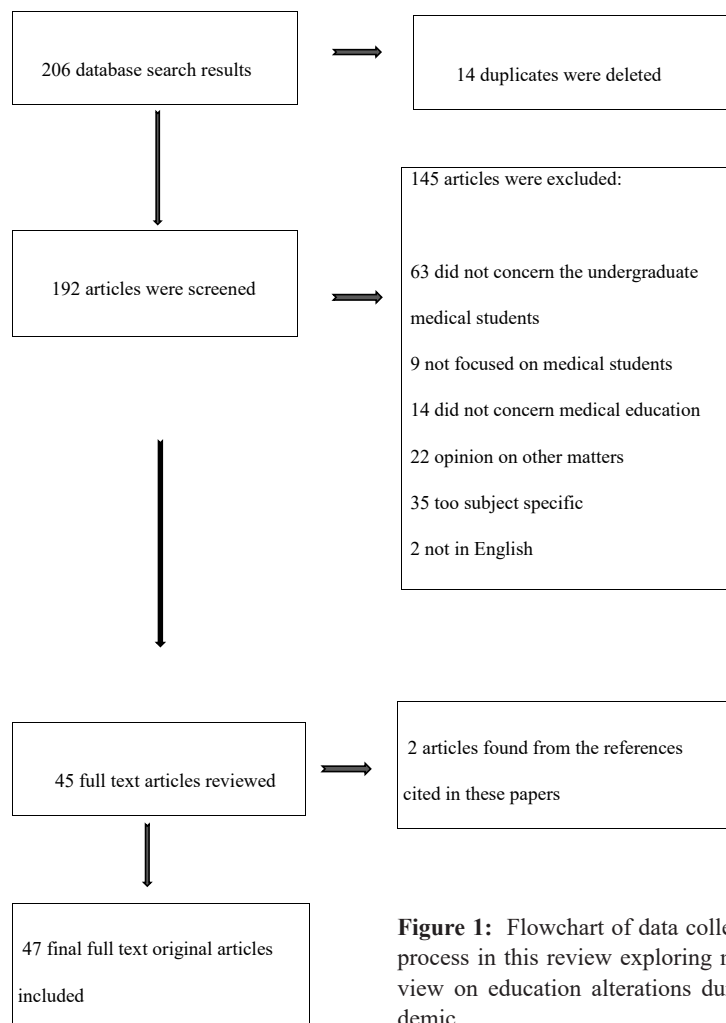
We used the following exclusion criteria: i) articles that did not refer to undergraduate medical education, ii) articles that examined health students in general (e.g., School of dentistry, pharmacy, nursing, etc.), and did not focus on and differentiate between medical students' opinion from others', iii) studies focusing on research questions that did not concern medical education (e.g., articles about medical students' psychology), iv) articles not referring to medical students' opinion on their education but on other matters, and v) specialized articles, for example, students' opinion on online radiology class.

## Results

Initially, 206 articles were identified (96 from the first search combination and 110 from the second one). Out of these, 47 original articles were eligible, based on the aforementioned criteria (Figure 1). The studies were conducted in Asian countries (26), Europe (12), Africa (6), USA (2), and one study was a collaboration between scientists from different continents (Table 1). Regarding their publication date, 17 were from 2020, 17 from 2021, and 13 from 2022.

### *Background of medical education during the pandemic*

The highly contagious COVID-19 disease urged the need for radical reform of undergraduate medical education during the pandemic. The literature search showed various curriculum changes were applied; online lectures and digital training activities replaced in-person training activities<sup>4,8</sup>. Most universities postponed their academic calendars for several weeks to achieve an e-learning' implementation<sup>9</sup>. The two forms of online medical education during the acute phase of the pandemic described in the available literature are synchronous and asynchronous e-learning.



**Figure 1:** Flowchart of data collection and study selection process in this review exploring medical students' point of view on education alterations during the COVID-19 pandemic.

**Table 1:** Characteristics of the 47 eligible original articles included in the current review aiming to explore and display medical students' point of view on education alterations during the first and the second year of the COVID-19 pandemic.

Year	Article	Type of Article	Country of origin	Student sample	Main Focus
2020	Kim et al <sup>10</sup>	Mixed-methods	Korea	151	The perception and attitudes of medical students About changes to clinical clerkship training programs in South Korea during the COVID-19 pandemic
2020	Ansar et al <sup>14</sup>	Cross-sectional Quantitative Descriptive study	Pakistan	600	Students' point of view regarding online teaching and assessment, as well as their preferences for the future
2020	Park et al <sup>16</sup>	Quantitative	Korea	73	Medical students' satisfaction regarding online teaching, assessment of its quality and the university's management of clinical rotations during Covid-19
2020	Zottman et al <sup>19</sup>	Quantitative	Germany)	49	Evaluation of medical students' opinion regarding online clinical case discussions
2020	de Ponti et al <sup>20</sup>	Quantitative	Portugal	115	Medical students' perceptions on fully online learning during the Covid-19 outbreak
2020	Dost et al <sup>21</sup>	Mixed-methods	UK	2,721	Medical students' perception on online teaching in terms of enhancing their education during the pandemic
2020	Fischbeck et al <sup>23</sup>	Quantitative	Germany)	203	Undergraduate students' opinion regarding an online physician-patient-communication interaction.
2020	Ohn & Ohn <sup>28</sup>	Quantitative	Malaysia)	32	Medical students' take on the integration of gamification method in their curriculum (regarding the teaching of electrocardiogram)
2020	Chen et al <sup>30</sup>	Quantitative	China	173	Medical students' evaluation of a blended learning strategy on laboratory courses
2020	Rajab et al <sup>32</sup>	Mixed-methods	Saudi Arabia	139	Medical students' evaluation of online learning tactics
2020	Olum et al <sup>33</sup>	Descriptive cross-sectional	Uganda	741	Medical students' perception regarding online education
2020	Khalil et al <sup>40</sup>	Qualitative	Saudi Arabia	60	Medical students' opinion on synchronized electronic teaching's effectiveness
2020	Sandhaus et al <sup>43</sup>	Quantitative	Israel	70	Medical students' overall satisfaction regarding electronic learning
2020	Alsoufi et al <sup>60</sup>	Quantitative Cross-sectional	Libya	3348	Medical students' attitude, knowledge and practices concerning e-learning
2020	Singh et al <sup>65</sup>	Quantitative	India	208	Medical students' feedback on online teaching in a medical university
2020	Nepal et al <sup>66</sup>	Cross-sectional mixed-methods Descriptive	Nepal	226	Medical students' point of view about online teaching in Nepal
2020	Wang et al <sup>67</sup>	Cross-sectional	China	99,559	Medical students' opinion on online learning, in relation to their previous online learning experiences
2021	Motte-Signoret et al <sup>3</sup>	Cross-sectional mixed-methods	France	146	Perception of both learners and teachers on online teaching
2021	Menon et al <sup>13</sup>	Descriptive quantitative	India	319	Medical students' perception of online classes.
2021	Snekalatha et al <sup>35</sup>	Quantitative	India	97	Medical students' perceptions towards online assessment tools
2021	Bączek et al <sup>39</sup>	Quantitative	Poland	804	Medical students' perception of online teaching methods
2021	Kang & Kim <sup>41</sup>	Quantitative	Korea	425	The tactics used for medical students' online Learning and their views on them
2021	Gupta et al <sup>42</sup>	Cross-sectional mixed-methods	India	248	Teachers' and taught opinion on online learning & the benefits and drawbacks of the methods used

2021	Muflih et al <sup>44</sup>	Descriptive cross-sectional correlational	Jordan	1210	I. Medical students' perspectives concerning online education.
2021	Li et al <sup>45</sup>	Quantitative	China	118,030	II. An assessment of medical universities preparedness for this transition
2021	Shabila et al <sup>46</sup>	Mixed-methods	Iraq	37	Medical students' point of view regarding electronic teaching
2021	Wang et al <sup>47</sup>	Qualitative	China	2,378	Medical students' beliefs about the online medical curriculum
2021	Tuma et al <sup>48</sup>	Descriptive cross-sectional	Collaboration Iraq and USA	636	Online medical education challenges as perceived by medical students
2021	Shahrivini et al <sup>53</sup>	Mixed-methods	USA	104	Medical students' and instructors' view on online learning
2021	Bhattarai et al <sup>58</sup>	Descriptive cross-sectional	Nepal	318	Medical students' point of view regarding remote teaching
2021	Chalise et al <sup>59</sup>	Descriptive Cross-sectional	Nepal	513	Medical students' perception towards online learning in a medical college in Kathmandu
2021	Pokryszko-Dragan et al <sup>62</sup>	Mixed-methods	Poland	620	Medical sciences' students with a positive attitude towards online learning
2021	Gismalla et al <sup>61</sup>	Cross-sectional mixed-methods	Sudan	358	Polish medical students' take on online learning, aiming to enhance the future electronic teaching experience
2021	Song et al <sup>64</sup>	Quantitative cross-sectional	China	488	Medical students' point of view on the implementation of e-learning in a developing country
2022	Tsiartas et al <sup>4</sup>	Cross-sectional quantitative	Greece	905	Medical students' and teachers' take on electronic learning in the medical school of Tongji University
2022	Mortagy et al <sup>8</sup>	Cross-sectional quantitative	Egypt	4,935	The multifaceted impact of the pandemic on the Greek undergraduate medical community.
2022	Wang et al <sup>17</sup>	Descriptive cross-sectional	China	213	Medical student's use and perception of online Medical education in Egypt.
2022	Suzuki et al <sup>37</sup>	Cross-country qualitative	Collaboration Japan, Hungary Slovakia, Norway	18	I. The relationship between students' point of view regarding their teachers' role in online classes.
2022	Alkalash et al <sup>38</sup>	Descriptive cross-sectional	Saudi Arabia	223	II. An assessment of the way the students utilized the virtual environment
2022	Cowan et al <sup>49</sup>	Mixed-methods	USA	174	Positive and negative aspects in electronic teaching methods mentioned by the medical students
2022	Tayem et al <sup>50</sup>	Cross-sectional descriptive	Bahrain	331	Medical students' take on online learning and its' effect on their knowledge and academic performance
2022	Elshaer & Sobaih <sup>51</sup>	Quantitative	Saudi Arabia	1,200	Medical students' take on online learning, so as to improve the electronic medical curriculum in the near future
2022	Dyrek et al <sup>52</sup>	Quantitative Cross-sectional	Poland	615	Medical students' take on online learning in Bahrain
2022	Steiner-Hofbauer et al <sup>54</sup>	Cross-sectional mixed-methods	Austria	872	Medical students' point of view regarding the usage of the Blackboard platform in order to continue their education amidst the Covid-19 pandemic
2022	Rotar-Pavlic et al <sup>55</sup>	Qualitative	Slovenia	16	Polish medical students' take on online learning
2022	Virumbrales et al <sup>56</sup>	Mixed-methods	Spain	483	Medical students' opinion on online learning and their thoughts and preparedness on their future profession
2022	Rohila et al <sup>63</sup>	Cross-sectional quantitative	India	332	Medical students' opinion on distance learning
					Medical students' and teachers' opinion on the shift to online learning, so as to enhance the electronic teaching experience in the future
					Medical students' and their staff's point of view on electronic learning

Synchronous e-learning consists of real-time live transmissions and virtual student-teacher interactions. Small group classrooms offering interaction, active participation, and live large group teaching and chat rooms have often been utilized<sup>10,11</sup>. The most used platforms for online learning are Zoom, Microsoft Teams<sup>8</sup>, Google Meet, Skype for Business, Adobe connect<sup>12</sup>, WebX<sup>10</sup>, Google classroom<sup>12</sup>, and WhatsApp Groups<sup>13</sup>. Asynchronous e-learning primarily consists of online articles, slide decks, and pre-recorded slide-based lectures<sup>14</sup>.

Students were also suspended from university hospitals, as they posed potential targets and transmitters of the virus<sup>2,15</sup>. Their practical courses were either postponed or indefinitely cancelled<sup>2,9,10</sup>. To continue their practical education, practical training was reestablished online<sup>2,16</sup>. To do that, universities used virtual patient cases and online case simulations, allowing students to practice using them<sup>2,10,17-21</sup>. Teachers also introduced online videos of patient examinations, as well as remote patient care environments and telemedicine<sup>10,22-24</sup>. Case-Based, Problem-Based, and Team-Based learning were also used, as well as “gamification” (a concept involving game attitudes to influence learning-related behaviors in non-game contexts)<sup>13,25-27</sup>. Even before the COVID-19 pandemic, many universities had already begun applying telemedicine or hybrid learning in their curriculums (such as phone triage, ambulatory electronic visits, conferencing platforms, email, and phone calls), facilitating the implementation of e-learning<sup>1,3,6,12,21,28-31</sup>.

According to the literature, the education of final-year medical students was prioritized in some countries. No changes in their education were applied. Instead of providing digital training, several teaching hospitals relied upon medical student trainees to cope with the constantly increasing healthcare problems arising from the evolving pandemic<sup>14</sup>.

Several studies showed that final-year medical students' assessment was accelerated, and they were promoted to their career's next step before completing the required medical education. This was reported in some countries, such as Italy, the United Kingdom (UK), the USA, and Brazil, and was due to the essentiality of these students to the understaffed healthcare systems<sup>5,8,14,32</sup>.

Following the suspension of face-to-face education, exams were also conducted online. Objective clinical skills examinations were either postponed or cancelled<sup>1,4,5</sup>. The exams usually consisted of multiple-choice questions, theory examinations (pen-and-paper), and oral tests. Some universities applied Open Book Examinations<sup>5</sup>. A significant challenge for the universities was finding fool-proof examination systems so students could not cheat during their exams<sup>33,34</sup>.

Additionally, hospitals in some countries attempted to reinforce their health staff, enlisting medical students by calling them out to perform tasks according to their level of knowledge; that could be considered an alternative way for students to gain clinical competencies<sup>2,33</sup>. Students had to volunteer of their own free will and fulfill

a number of tasks under supervision<sup>33</sup>.

Moreover, medical students offered their help to healthcare workers and community members during the first year of the COVID-19 pandemic<sup>35,36</sup>. Apart from volunteering in call centers, some students chose to help citizens by assisting them with their shopping, educating peers, patients, and communities regarding the SARS-CoV-2 virus via social media<sup>2</sup>, providing social services such as support and assistance to senior citizens, offering free childcare and pet care, running errands, as well as collecting personal protective equipment (PPE) and donating it to health care centers and hospitals in need<sup>35</sup>. Medical students also assisted in contact tracing, applied their lab skills in research, and volunteered in centers that provided information on the SARS-CoV-2 virus. Some examples of students' volunteering groups are Harvard's Medical Students Response Team #GetMePPE, Co-op, and Covid sitters<sup>33,35</sup>. As stated, medical students have realized that the education procedure does not solely involve classes and clerkships. It is a relatively constant learning that integrates different principles and constantly adapts to changing circumstances<sup>35</sup>.

#### *Medical student's opinion concerning the new teaching methods enforced due to the high prevalence of the SARS-CoV-2 virus*

Medical students' point of view on the changes that the COVID-19 pandemic enforced were diverse; students pointed out both positive and negative aspects of them. The following section summarizes the advantages and disadvantages of online medical education, as assessed by the students.

#### *Advantages of online medical education versus conventional education*

I. Studies showed that online medical education eliminated the need for leaving home and driving long distances. As a result, it improved students' time management and personal productivity<sup>36,37</sup>. This fact also reduced expenditures and contributed to better financial handling<sup>20,38</sup>. The reduction in air pollution was another positive aspect of tele-education based on the literature<sup>38</sup>.

II. Medical students utilized the resulted extra free time to undertake new hobbies and spend time with their families. Moreover, they studied for their classes and residency tests, prepared for clinical placements and improved their physical and mental health<sup>14,20,39,40</sup>.

III. Furthermore, students studying abroad had the chance to return home<sup>20</sup>, observed at a large scale in universities with great numbers of international students, such as universities in the UK or China<sup>41</sup>. E-learning was also helpful for international students due to the flexibility of the provided asynchronous learning, resulting in the ability to keep up with their classes while being in a completely different time zone<sup>20</sup>.

IV. This flexibility of the e-classes was helpful for the majority of the students regardless of their origin. Asynchronous learning especially offered students the

ability to organize their schedules independently and attend their classes from almost anywhere (with most students feeling more relaxed from the comfort of their homes)<sup>8,12,20,38,39</sup>. Several students stated that they had the chance to develop time management skills<sup>8,14,20</sup>. Medical students also reported more straightforward access to a significant quantity of information they could explore at their own pace during their e-learning experience<sup>38,39,42</sup>. E-learning was a self-directed educational process and a student-centered way of gaining knowledge<sup>20</sup>.

V. Lastly, the pandemic provided medical students with volunteering opportunities<sup>14,20,33,35</sup>. Students reported that by volunteering, gaining medical knowledge was easier due to the lack of performance anxiety. In some cases, the reduction in the clinical personnel of the hospitals offered the students the opportunity to a better training of their practical skills in a real-life setting<sup>14</sup>.

#### *Disadvantages of online medical education against conventional amphitheater and bedside teaching*

I. At the beginning of their e-learning experience, students faced serious problems regarding technological equipment and other technical issues, such as lagging e-learning platforms. Studies showed that the most commonly reported problems were a range of technical difficulties<sup>12,20,21,38,39,43</sup>. Students reported an inability to access the online lectures at the beginning of e-learning training. Problems such as poor internet connectivity, software failure, and audio problems during e-classes disturbed the students as well as their professors<sup>39,44,45</sup>. Outdated equipment and poor computer literacy on behalf of the teaching staff were also mentioned<sup>14</sup>. After a month of online teaching, though, most students gradually got sufficiently equipped with electronic means. Subsequently,

the earlier technical problems were substituted by the lack of learning motivation<sup>39,46-48</sup>.

II. Furthermore, medical students, in the clinical years of their education, expressed a rising concern about the reduction of their clinical skills. They voiced the opinion that online learning was insufficient in providing them with clinical knowledge and competencies<sup>12,14,20,33,39,42,49-52</sup>. To be more precise, students mentioned that there were defects in the online discussion sessions of clinical cases during e-classes<sup>14</sup>. Problem-Based, Team-Based, Case-Based learning, clinical skills practice, and physical examination could not be successfully taught online<sup>39</sup>. Medical students' dissatisfaction with clinical skills e-classes was also expressed because their opinions concerning e-learning were influenced by their year of study. Students in advanced years (clinical or closer to clinical years) were less satisfied with e-lectures compared to students from earlier years<sup>4,53</sup>. In addition, even students who were having clinical rotations in hospitals were often left unsupervised<sup>49</sup>.

III. Another major drawback of e-classes was the poor student-student and student-professor interactions. Specifically, many students mentioned that during e-lectures, communication with their teachers worsened<sup>14,14,20,38,39,54,55</sup>. Class interactions, discussions, and chances for students to express their questions demanded great effort<sup>14,56</sup>. Medical students also missed peer interaction, peer instruction, and face-to-face Team-based learning<sup>12,39</sup>. Many people mentioned that they also missed body language, something that troubled kinesthetic learners a lot<sup>39</sup>. Articles showing rates of students who were asked about interactivity are listed in Table 2.

IV. Additionally, many students experienced financial issues during the pandemic. It is important to keep in

**Table 2:** Studies demonstrating students' opinions regarding e-lectures' interactivity.

Article	Student Sample	Country	Students' point of view concerning online lectures' interactivity
1. Tsiartas et al <sup>4</sup>	905	Greece	79.2 % of the students stated that student-teacher interaction had worsened, 46.9 % responded that their participation in the class Decreased, 30.3 % stated that their participation was unaffected
2. Singh et al <sup>65</sup>	208	India	92.3 % of the responders stated that there were a lot of chances for them to ask questions during the lectures but the 43.9 % stated that the interaction with their professors was worse than face-to-face teaching.
3. Rajab et al <sup>32</sup>	139	Saudi Arabia	Communication with the professors posed a challenge for 59% of the responders.
4. Dost et al <sup>21</sup>	2721	UK	59.73 % thought that online classes were interactive enough but overall not engaging or enjoyable and provided them with limited opportunities to ask questions.
5. Wang et al <sup>47</sup>	2,378	China	49.45% felt as if online classes lacked interaction.
6. Bączek et al <sup>39</sup>	804	Poland	70 % of students were concerned about the lack of interaction with the patients, 45 % commented that their interaction with the professors was reduced. Only 4 % chose interactivity as an advantage of e-learning
7. Gismalla et al <sup>61</sup>	358	Sudan	24 % of the students were worried about the interaction towards each other and their professors.
8. Alsoufi et al <sup>60</sup>	3,348	Libya	54.1 % thought interactivity to be achievable via tele-education
9. Gupta et al <sup>42</sup>	248	India	27.8 % felt that the classes' interactivity was insufficient, 25.0 % thought that their questions could not be answered via electronic means

mind that university students are a financially vulnerable socioeconomic group. They had to purchase expensive technological equipment to participate in their classes, which may have worsened their economic situation and caused them anxiety<sup>10,57-59</sup>. Some students were even afraid that after the pandemic, they would no longer be able to afford college costs<sup>32</sup>, especially those living in developing countries where high-speed internet packages and technological means such as computers and phones are expensive to buy<sup>57,60</sup>.

V. Many students also felt the flexibility afforded by the e-learning status was harming them, as they had problems with self-motivation and self-discipline. As a result, they found it hard to manage their time correctly and to study the content needed<sup>10,21,61</sup>. Students also faced problems finding a quiet place to study, participate in their classes, or take exams. They were easily distracted by their parents or other family members<sup>12,20,39,46,49</sup>. Especially those students trying to manage children, siblings, or elders who are present at the house at the same time, who seemed to have experienced a significant amount of difficulty<sup>32</sup>.

VI. Students also experienced adaptation stress to the electronic means unfamiliarity with them and technophobia, even if scarcely mentioned<sup>39,62</sup>. The higher workload was mentioned, too, provoking laziness or burnout syndrome<sup>20,39,63</sup>. Furthermore, a feeling regarding the insufficiency of online medical education to replace their in-person classes was highly expressed<sup>42</sup>.

VII. Other disadvantages of e-learning were the following: patient discomfort and detached interaction with the students via e-visits, difficulty in maintaining academic integrity during e-exams due to the resourcefulness of the students when it comes to cheating, problems with the timing of the tutorials and its frequent change on behalf of the professors<sup>20,39</sup>.

It is notable that the majority of the students, when asked, stated that in the future, they would either prefer a full return to traditional teaching methods or integrate a hybrid strategy<sup>13,32,44,64-66</sup>. A smaller proportion expressed their wish to continue participating in distance learning techniques<sup>32,44,64</sup>.

## Discussion

This review of the literature aimed to investigate medical students' point of view regarding the necessary changes in undergraduate medical education during both years of the COVID-19 pandemic worldwide. The pandemic has had a severe effect on medical education. Its curriculum was, in most cases, radically transformed. In-person lectures were replaced by online learning. This fact led to a wide range of mixed reactions and feelings. Medical students have mainly appreciated the chance to continue and/or complete their education amidst the pandemic. They identified a variety of advantages of the changes, such as reduced commuting costs, increased personal time, returning to their homes, comfortability, and flexibility afforded, and voluntary activities available

for them at the time<sup>12,14,20,21,33,39</sup>.

Nevertheless, students described the significant difficulties resulting from the integration of online teaching techniques. These can mainly be summarized as the reduction in students' clinical exposure, poor student-student and student-professor interactions, financial issues, problems with self-motivation, as well as technical issues<sup>10,39,64</sup>. Concerning the latter, though, hope abides in that most of the survey respondents belonged to the millennial and post-millennial generations, resulting in an increased familiarity of the students with the usage of electronic means, as only a limited number of the responders admitted having insufficient computer skills (2 %) <sup>31</sup>. Increased familiarity with advanced technology and computer science simplified the use of online medical learning<sup>31,66</sup>.

Concerning the interactivity of online lectures, most students expressed that during e-classes, the communication between them and their professors worsened. Students were also concerned about their significantly reduced interaction with the patients in real-life clinical settings. Even though some stated that interactivity was achievable through electronic means, communication during e-lectures still posed a challenge for several students (Table 1).

Interestingly, the available literature presents some major areas of agreement and disagreement. Some studies document the free time students gain due to online learning and the opportunity to organize their own time as a positive aspect<sup>14,36-38</sup>, while there is also evidence that other students had difficulties managing their time without supervision and could not focus sufficiently on their lectures<sup>10,21</sup>. Furthermore, even though most students were pleased to return to their homes<sup>8</sup>, they eventually started feeling uncomfortable due to lack of personal space, slow internet connection etc<sup>2,12,20,31</sup>. Nonetheless, the existing studies agree that due to online classes, medical students have lost the opportunity to practice their clinical skills, resulting in rising anxiety among them<sup>20,31,33,39,49-52</sup>. Also, many studies note the lack of technological infrastructure at the beginning of online learning as an important aspect<sup>12,20,21,31</sup>. Interestingly, papers written in developing countries express rising concern about online learning, as internet packages are very expensive and not everyone can access them, causing a considerable economic burden on universities and students in these countries<sup>57,60</sup>. Therefore, a question arises regarding whether online learning is, in fact, accessible to everyone. What is intriguing, though, is that the available literature seems to agree mostly on the negative aspects of medical education during the COVID-19 pandemic and to contradict itself regarding the positive ones.

The previously mentioned disadvantages led to a sense of rising anxiety among students regarding their skills and concerns about wasting time that could be dedicated to mastering clinical knowledge<sup>5,10,12,14,20,31,33,59</sup>.

The results of this review demonstrated that the vast majority of the students prefer the traditional teaching

methods or a hybrid strategy to e-learning. A small percentage of students prefer to continuously join distance learning methods, which is intriguing, as young adults prefer electronic teaching over face-to-face. Results proved medical students' urge to return to in-person education and attend lectures in the classroom. They also wish to integrate the knowledge they earned during e-lectures into their future learning strategies. Undoubtedly, medical universities and teaching hospitals should properly integrate digital learning methods into a well-structured teaching curriculum. The aim of this change should be to combine the advantages of in person and e-learning methods and improve the quality of medical education globally<sup>13,32,44,64,65-69</sup>. Universities across the world should also be able to adapt to different circumstances without affecting the quality of education.

This review article has several strengths and limitations. The strength of this paper is the fact that the findings are based on a large number of papers published during the pandemic. Also, it considers the literature on the first and second years of the COVID-19 crisis, which is important as the medical students' overall point of view on the matter is being presented. Regardless, the current study's design is subject to limitations; only the PubMed database was searched, and methods of statistical analysis used by the article's authors were not considered. Further studies need to be conducted to report and compare medical students' perceptions concerning medical education during the different stages of the COVID-19 outbreak, aiming to develop a high-quality medical education program in the post-COVID-19 era.

### Conclusions

During the COVID-19 crisis, medical education underwent many changes, most demanding innovative technological infrastructure, as well as medical students' and their professors' willingness to participate in them. Most of the available literature agrees on the negative aspects of the pandemic on medical education. The fact that medical students' opinion regarding their education was more likely to be negative than positive is in line with that. The greatest disadvantage of tele-education, implemented by the universities during both years of the pandemic, is the lack of student-teacher and student-patient interaction. All in all, the majority of medical students tend to agree that after the COVID-19 crisis is over, they prefer either a full return to conventional classrooms or the implementation of a blended strategy. The university education system should develop new technologies and innovative educational strategies for similar future crises.

### Conflict of interest

The authors declare that they have no conflicts of interest.

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